Aviation Week & Space Technology

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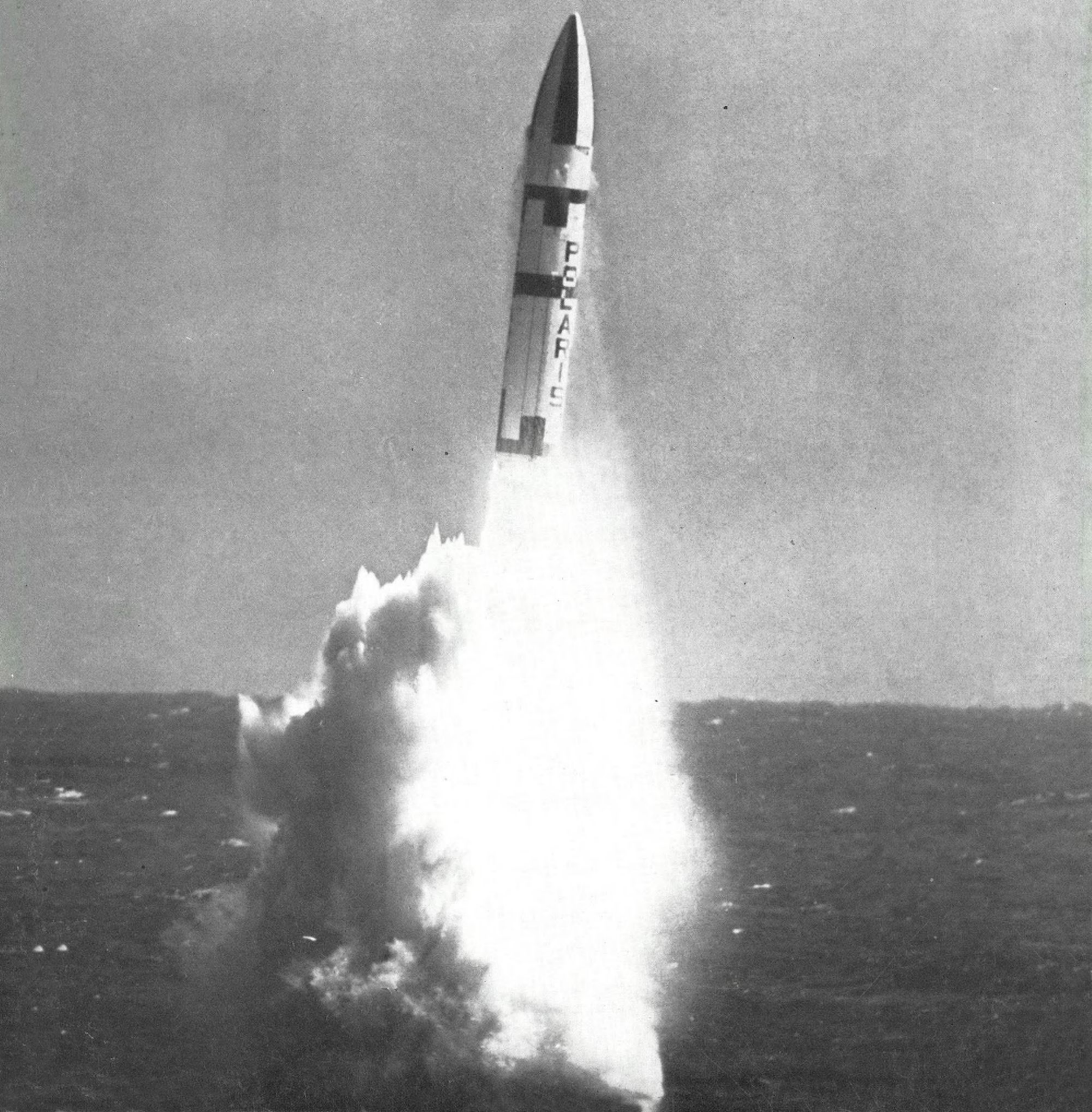
November 18, 1963

Syncom 2 Relays Broadband TV, Telemetry Data

Polaris A-3X Fired From Submarine



ENVIRONMENT: *Whatever encompasses the aggregate of all external and internal conditions affecting the existence, growth, and welfare of product quality.* The standard of excellence that earns the title "BEST OF BREED" is the constant aim of Voi-Shan in the manufacture of precision aerospace fasteners. There is no compromise in production processes to reach the required degree of satisfaction demanded. Every stage from the receiving of raw materials through to the final shipment of the finished product receives constant attention and rigorous control. Unique engineering skills and the most modern inspection testing equipment are used throughout every phase to achieve superior product refinement . . . a purposeful environment. Shown above is a selection of the numerous fastening concepts produced at Voi-Shan. They include a wide variety of proprietory fasteners and show examples of high performance bolts, all available in a wide range of materials. Weight/master locknuts, conical seals, and Quick Release pins add to the extensive range of specialized Voi-Shan products. Numerous Specials, manufactured to customer specifications, are produced for virtually every airframe, missile and engine manufacturer. The emphasis placed upon Voi-Shan engineering originality and technical experience is demonstrated by the extensive research and capability exercised in the materials used. For example, metallurgical research entails many new titanium alloys, new-super alloys for high temperature applications, very high-strength exotic materials and refractory materials for use at exceedingly high temperatures. In addition, engineering service and product literature is an important part of Voi-Shan service. A field representative is always on call to serve a customer's design problem and comprehensive technical brochures are available on all of the products manufactured by Voi-Shan. Inquiries on your letterhead are invited.

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Douglas Aircraft Company has selected Sundstrand Aviation to supply constant speed drives to power a-c electrical systems on the new Douglas DC-9 short-to-medium-range "Compact Jets," scheduled for delivery in early 1966.

The constant speed drives, rated at 40 kva, are of the new Sundstrand "compact" geared differential design—providing significantly longer life, higher reliability, lighter weight, and lower operating costs than were previously attainable with this type of equipment.

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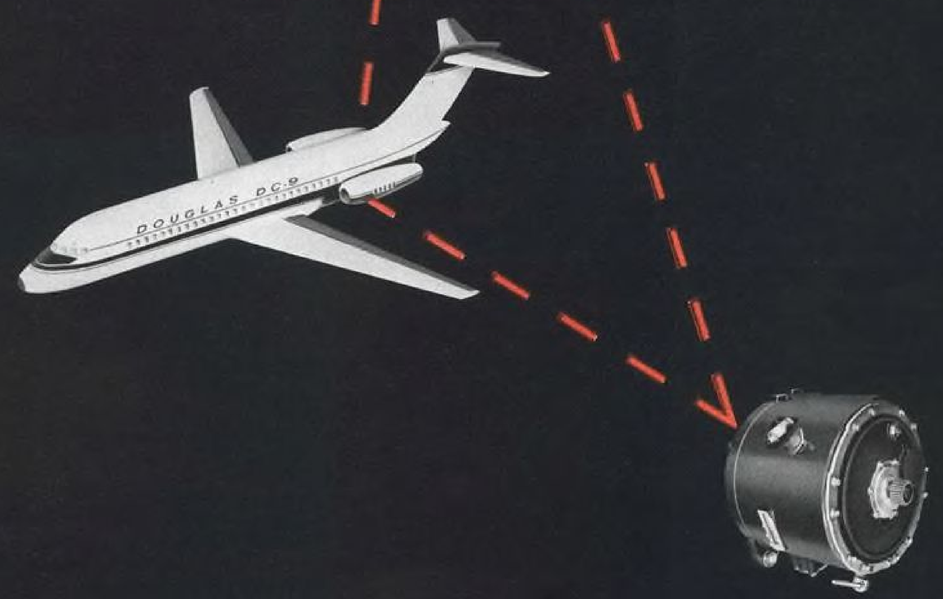
new "compacts"!

DC-9



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The PTB-100 is a numerically controlled, hydraulically actuated, fully automatic machine that slashes the high cost of bent tubes. It's so new, Boeing hasn't even got one installed yet.

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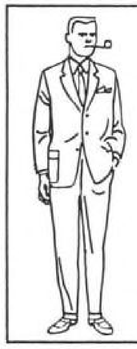
Note: If you can't wait 30 days, write for full information, to Ken Clarke at Giannini's subsidiary, Datex, P.O. Box 667, Monrovia, California.



This is Tony Hummel.

He is our Sales Engineer in Dayton.

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Giannini Controls Corporation

1600 South Mountain Avenue, Duarte, California

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62 SECOND MAZE: *Synchronize your watches: you have exactly 62 seconds to get from A to Z. 3, 2, 1 . . . GO!*

FINK* RATE GYRO

Squeals on Gemini Booster Systems

Translation: Giannini rate gyros will be used on the Gemini launch vehicle. Each gyro package will detect excessive rate of change in the launch vehicle's attitude and activate an abort system through the modified TITAN II's malfunction detection system.

If—NASA forbid—a Gemini launch goes sour, there'll be at least two men glad that Martin-Baltimore put Giannini on the team to squeal on any malfunctioning booster systems or components.

**FINK: Dates from 1892 Homestead Strike; guard, detective, informer, squealer, or stool pigeon.*

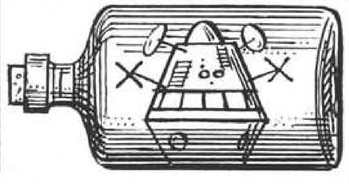
GIANNINI'S AIRBORNE STICK-SHAKER

Multi-engine aircraft used to vibrate when approaching a stall. Now, the big new jets can fly right into one. No vibration; no warning. Just all of a sudden, you're in the Twilight Zone.

Giannini's engineers went to work on the problem by discarding the old warning standards: airspeed and stagnation point sensing. Instead, they concentrated on the true parameters of jet stall: angle of attack and flap setting. That's how our stick-shaker Stall Warning was born.

Today, a Giannini-equipped jet makes no unscheduled VTOL's because of a special electronic/electromechanical system that constantly monitors the lift-determining factors of flap setting and angle of attack. When the stall point is approached, the system shakes the control columns, approximating the old aerodynamic warning vibration.

For details, ask a Cargomaster pilot. Better yet, ask Giannini.



MULTIPLE SPECS ARE FOR THE BIRDS

Pressure transducers about 1″ in diameter and 1.6″ long are fairly easy to find. Some are hermetically sealed. Some take 35 G vibrations. Some have dynamic error bands down around 1%.

However, big birds like Saturn or Thor Delta need all of these in a single package. That's why a certain leading transducer manufacturer, located in Duarte, California, has found an ingenious way to make a small, light, accurate, vibration resistant, hermetically sealed potentiometer output pressure transducer that withstands corrosive media and has a range of 0 to 10 psia minimum to 0 to 350 psia maximum. As a result of this accomplishment, you'll find about 16-dozen of these multiple-spec beauties on every Saturn booster.

If you're interested, the name of the company responsible for this measurement *tour de force* and complete specifications on their 451319 pressure transducer will be supplied on request.

AEROSPACE CALENDAR

Dec. 2-4—Annual World-Wide Information Officers' Conference, U. S. Army, Washington, D. C.

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

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

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

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

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

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

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

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

(Continued on page 7)

AVIATION WEEK & Space Technology

November 18, 1963

Vol. 79, No. 21

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AEROSPACE CALENDAR

(Continued from page 5)

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

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

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

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

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

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

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

Jan. 20-22—Aerospace Sciences Meeting, American Institute of Aeronautics and Astronautics, Hotel Astor, New York, N. Y.

Jan. 25—Seventh Annual Inland Empire Quality Control Conference, American Society for Quality Control, California State Polytechnic College, Pomona, Calif.

Jan. 27-30—20th Annual Technical Conference, Society of Plastics Engineers, Chalfonte-Haddon Hall Hotels, Atlantic City.

Jan. 27-29—Conference on Control and System Optimization, Monterey, Calif. Sponsors: Society for Industry & Applied Mathematics; American Institute of Aeronautics and Astronautics; Institute for Mathematical Statistics; U. S. Naval Post Graduate School.

Jan. 27-30—Applications Forum on Antenna Research, University of Illinois' Midwest Electronics Research Center, Urbana, Ill.

Jan. 29-31—44th Annual Meeting, American Meteorological Society, University of California, Los Angeles, Calif.

Jan. 29-31—Solid Propellant Rocket Conference, American Institute of Aeronautics and Astronautics, Palo Alto, Calif.

Jan. 30-31—Annual Computer Applications Symposium, IIT Research Institute, La-Salle Hotel, Chicago, Ill.

Feb. 3-7—Fifth Annual Lectures in Aerospace Medicine, USAF School of Aerospace Medicine, Brooks AFB, Tex.

Feb. 5-7—Fifth Winter Convention on Military Electronics, Institute of Electrical and Electronics Engineers, Ambassador Hotel, Los Angeles, Calif.

Feb. 13-15—Golden Gate Metals Conference, American Society for Metals, Fairmont Hotel, San Francisco, Calif.

Feb. 19-21—International Solid-State Circuits Conference, Institute of Electrical and Electronics Engineers, Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa.

Mar. 2-6—Fifth Conference on Applied Meteorology (Atmospheric Problems of Aerospace Vehicles), Atlantic City, N. J. Sponsors: American Meteorological Society; Federal Aviation Agency.

Mar. 9-10—Aerodynamic Testing Conference, Marriott Twin Bridges Motor Hotel,

(Continued on page 9)

AEROSPACE CALENDAR

(*Continued from page 7*)

Washington, D.C. Sponsors: American Institute of Aeronautics and Astronautics; U. S. Navy.

Mar. 23-26—International Convention, Institute of Electrical and Electronics Engineers, Coliseum and New York Hilton, New York, N. Y.

Mar. 25-27—Aerospace Bearing Conference (unclassified), El Tropicano Motor Hotel, San Antonio, Tex. Sponsors: USAF; Southwest Research Institute.

Apr. 1-2—Fifth Symposium on Engineering Aspects of Magnetohydrodynamics, Institute of Electrical and Electronics Engineers, Massachusetts Institute of Technology, Cambridge, Mass.

Apr. 1-3—Fifth Annual Structures and Materials Conference, American Institute of Aeronautics and Astronautics, Riviera Hotel, Palm Springs, Calif.

Apr. 6-8—International Conference on Nonlinear Magnetics (Intermag), Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington, D. C.

Apr. 13-16—Third International Flight Test Instrumentation Symposium, College of Aeronautics, Cranfield, England.

Apr. 19-25—International Conference & Exhibit on Aerospace Electro-Technology, Institute of Electrical and Electronics Engineers, Westward-Ho Hotel, Phoenix.

Apr. 24-May 3—1964 German Air Show, Hanover Airport, Hanover, West Germany.

May 4-6—Aerospace Propulsion Meeting, American Institute of Aeronautics and Astronautics, Cleveland, Ohio.

May 5-6—Fifth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, San Diego, Calif.

May 11-13—16th Annual National Aerospace Electronics Conference (NAECON), Institute of Electrical and Electronics Engineers, Biltmore Hotel, Dayton, Ohio.

May 19-21—International Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Idlewild Airport, N. Y.

May 25-27—General Aviation Design & Operations Meeting, American Institute of Aeronautics and Astronautics, Wichita.

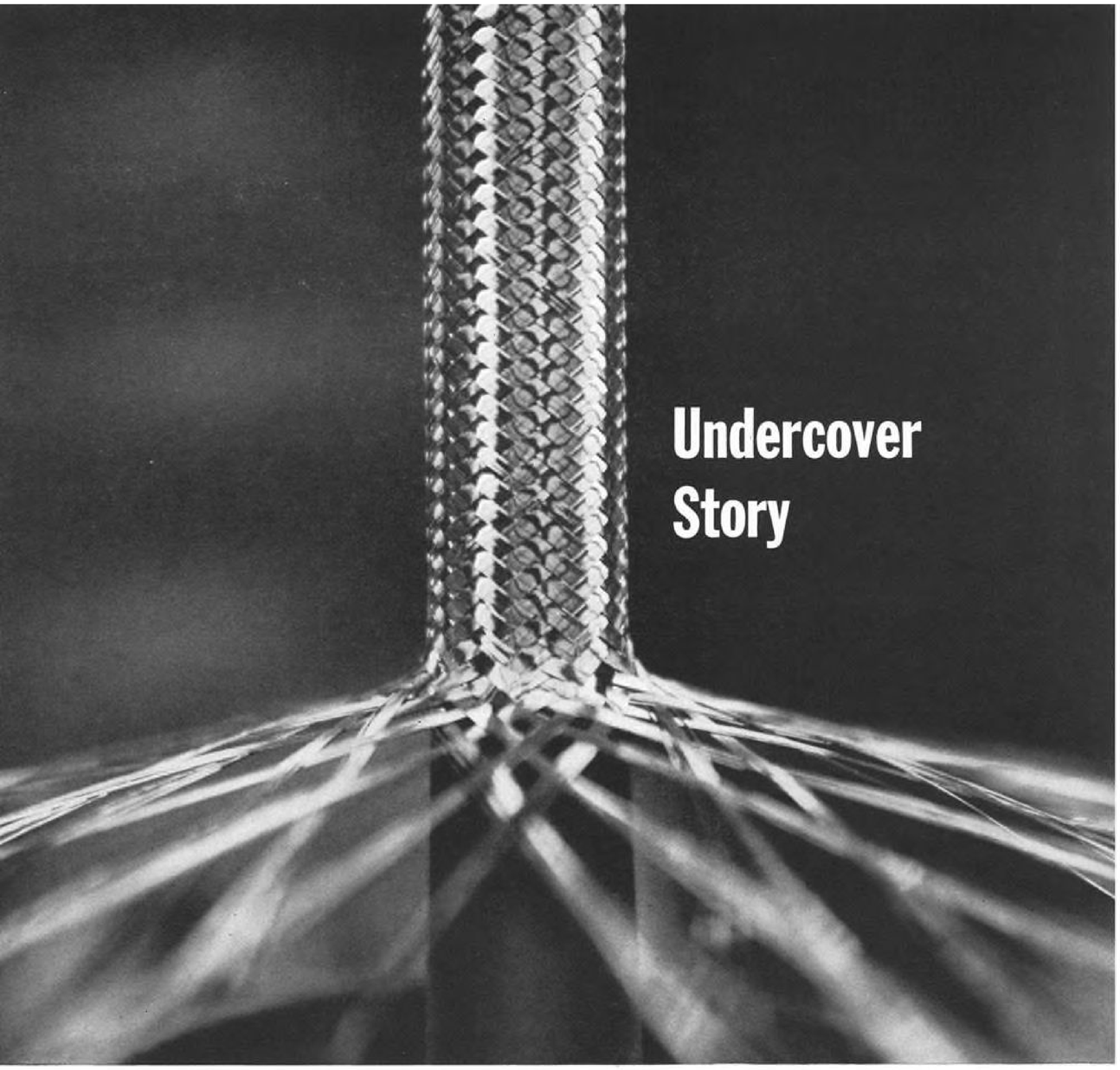
May 26-28—Second International Forum for Air Cargo, Sheraton-Mt. Royal Hotel, Montreal, Canada. Sponsors: Society of Automotive Engineers; American Institute of Aeronautics and Astronautics; Canadian Aeronautics & Space Institute.

June 2-4—National Telemetering Conference, American Institute of Aeronautics and Astronautics/Institute of Electrical and Electronics Engineers/Instrument Society of America, Biltmore Hotel, Los Angeles, Calif.

June 2-4—National Symposium on Global Communication (GLOBECOM VI), Institute of Electrical and Electronics Engineers, University of Pennsylvania and Sheraton Hotel, Philadelphia, Pa.

June 29-July 2—First Annual Meeting & Technical Display, American Institute of Aeronautics and Astronautics, Sheraton Park Hotel, Washington, D.C.

Sept. 7-13—1964 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.



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RELIABILITY: This, mind you, is a record of actual use of our clocks, timers, counters, miniature memories, etc. The record is supported by two life tests of the individual magnetic Core-Transistor Logic modules (CTL's), with which these equipments are made. The Tests have logged 3½ million module hours over 5 years — no failures, and 1½ million module hours over 2 years — no failures. These numbers are for complete logic elements — but compare them with numbers for single components!

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Viewer also shows the pattern of recorded sound in audible range applications. Even determines whether tools, heads, or guides are magnetized.

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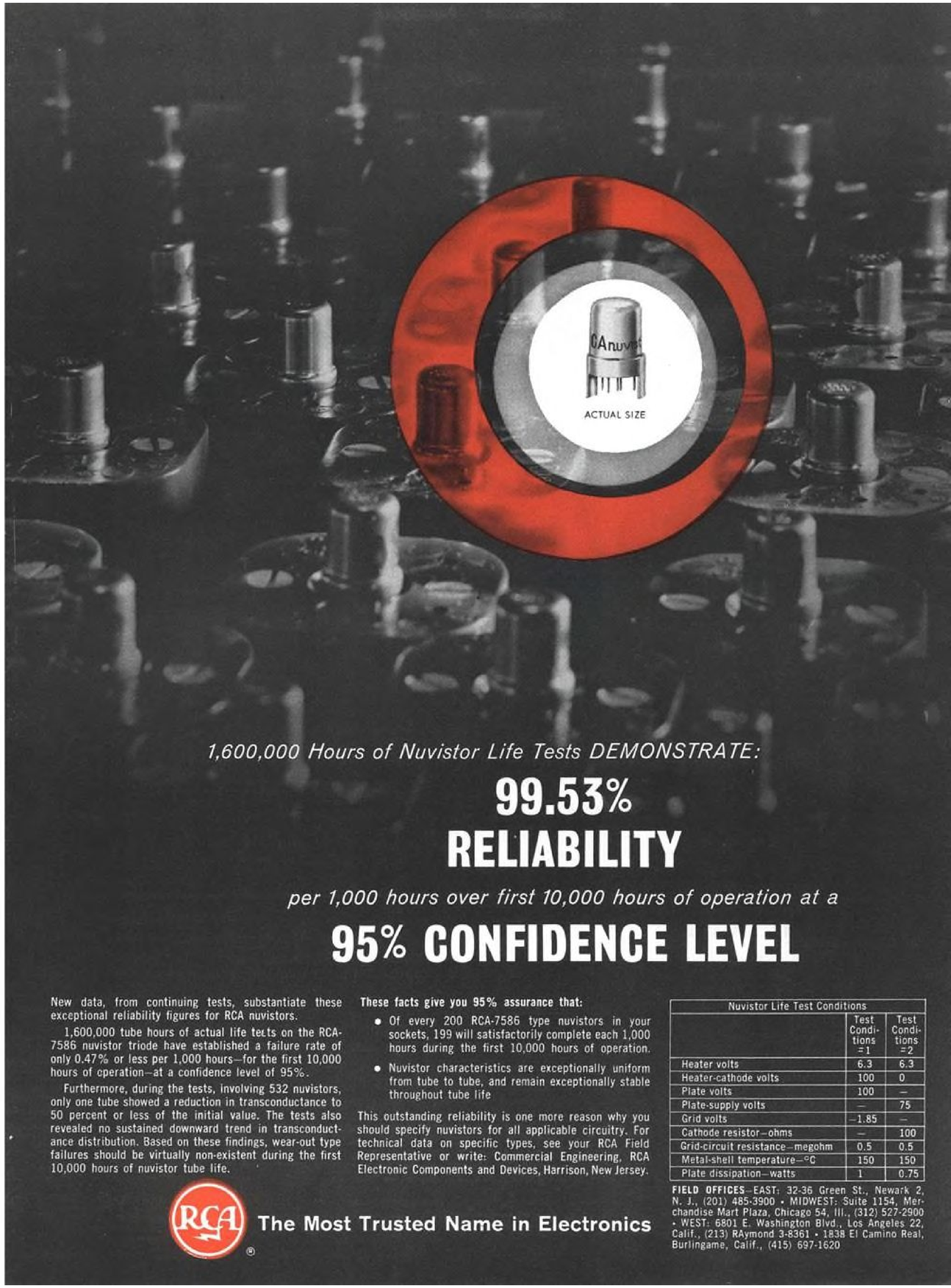

1,600,000 Hours of Nuvistor Life Tests DEMONSTRATE:

99.53% RELIABILITY

per 1,000 hours over first 10,000 hours of operation at a

95% CONFIDENCE LEVEL

New data, from continuing tests, substantiate these exceptional reliability figures for RCA nuvistors.

1,600,000 tube hours of actual life tests on the RCA-7586 nuvistor triode have established a failure rate of only 0.47% or less per 1,000 hours—for the first 10,000 hours of operation—at a confidence level of 95%.

Furthermore, during the tests, involving 532 nuvistors, only one tube showed a reduction in transconductance to 50 percent or less of the initial value. The tests also revealed no sustained downward trend in transconductance distribution. Based on these findings, wear-out type failures should be virtually non-existent during the first 10,000 hours of nuvistor tube life.

These facts give you 95% assurance that:

- Of every 200 RCA-7586 type nuvistors in your sockets, 199 will satisfactorily complete each 1,000 hours during the first 10,000 hours of operation.
- Nuvistor characteristics are exceptionally uniform from tube to tube, and remain exceptionally stable throughout tube life

This outstanding reliability is one more reason why you should specify nuvistors for all applicable circuitry. For technical data on specific types, see your RCA Field Representative or write: Commercial Engineering, RCA Electronic Components and Devices, Harrison, New Jersey.

Nuvistor Life Test Conditions		
	Test Conditions =1	Test Conditions =2
Heater volts	6.3	6.3
Heater-cathode volts	100	0
Plate volts	100	—
Plate-supply volts	—	75
Grid volts	−1.85	—
Cathode resistor—ohms	—	100
Grid-circuit resistance—megohm	0.5	0.5
Metal-shell temperature—°C	150	150
Plate dissipation—watts	1	0.75

RCA® **The Most Trusted Name in Electronics**

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VIBRATION NEWS

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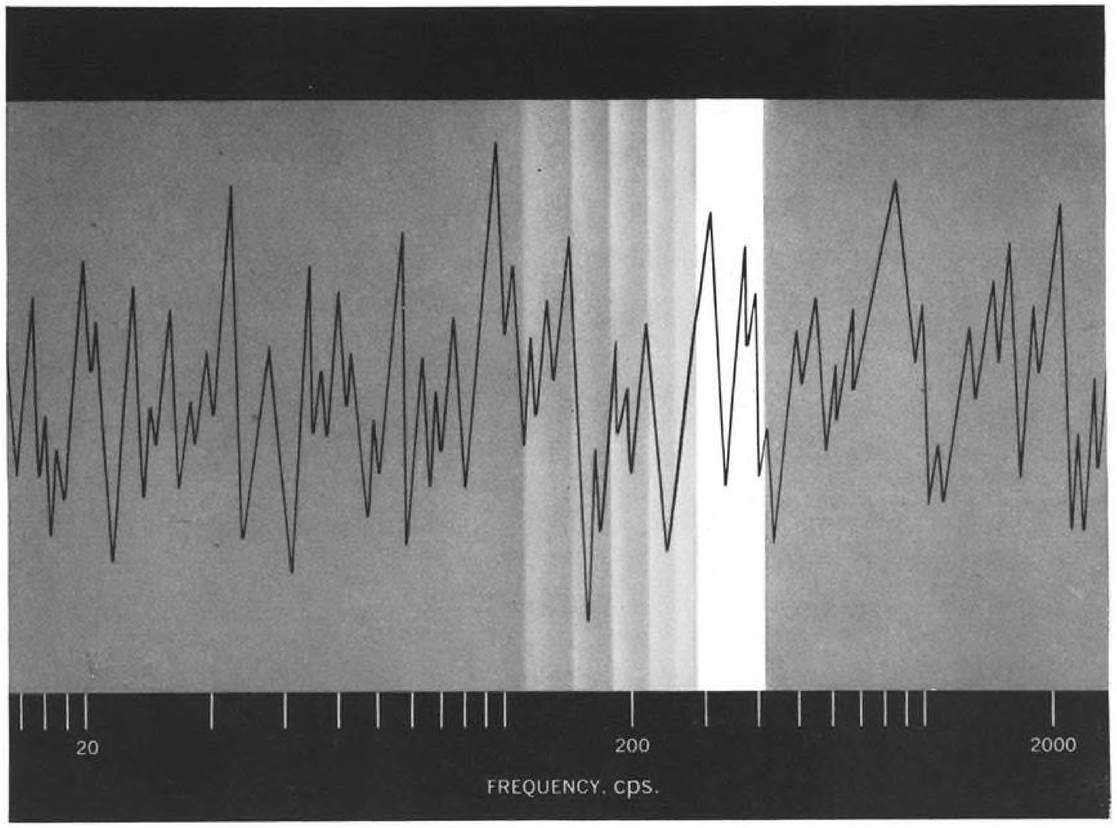

MB introduces SWEEP RANDOM— a new, low-cost method of random vibration testing

MB Electronics now offers industry the Narrow Band SWEEP RANDOM system. This new technique in random vibration testing is designed to create stresses and accelerations at all levels similar to those provided in the more expensive wide band random test. It is easy to operate and inexpensive enough to be used with the smallest simulation test system in general use today.

The new MB SWEEP RANDOM method reduces the total force required for wide band testing by sweeping slowly over the frequency range with an intense narrow band excitation, in contrast to the low acceleration density excitation of the wide band test.

This results in a reduction of from one third to one half the force ratings heretofore required for simulated random vibration tests. Considerable cost savings are also realized with this new MB system.

The MB SWEEP RANDOM system is ideally suited for testing components and sub-assemblies of systems which might be given a final qualification test by wide band random techniques.

For more detailed information on the SWEEP RANDOM system write to MB Electronics, 781 Whalley Ave., New Haven 8. Conn.

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CONTENTS

COVER: Lockheed-Navy Polaris A-3X, 2,500-naut. mi. fleet ballistic missile, bursts through the surface of the Atlantic Ocean in the first successful firing of the weapon system from a submerged submarine (AW Nov. 4, p. 32; Nov. 11, p. 33). First and second stage engines are built by Aerojet-General and Hercules Powder Co., respectively. General Electric all-inertial system guided the missile 2,000 mi. down the Atlantic Missile Range to impact point.

PICTURE CREDITS
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EDITORIAL

Rosier Horizons

The U.S. airline industry, which is the pace-setter for the world, has broken out of the turbulence of its jet transitional period and is now speeding toward rosier horizons. Last week (AW Nov. 11, p. 44) Transport Editor L. L. Doty predicted a record profit in 1963 for the major U.S. trunklines and international carriers. Mr. Doty's forecasts have a habit of becoming fact with the passing of time, and the data for the first nine months of the year makes a strong case for his conclusions. In addition, extraordinary good flying weather over the entire country during the Fall promises that the prosperity trend will continue through what is usually a marginal quarter.

We think that 1963 will take its place in airline history as the year that managements emerged successfully from their struggles to solve the economic problems of the jet age, although the operational people mastered the technical problems of jet transports several years earlier. Not all airlines will share this prosperity, either in 1963 or in the predictable future, but these few fall into two categories:

- **Airlines with unique** and non-typical management problems.
- **Some foreign flag carriers** whose countries are more concerned with operating their airlines as instruments of national policy than as economic assets.

In retrospect, the jet transitional period has proved to be considerably shorter than many authoritative prophets in this industry anticipated. The technical problems were considerably less than expected. Indeed, the jet transport, and particularly its powerplants, have set new standards of airline reliability and service. The economic problems were considerably more acute. But considering that the jets' initial impact occurred only about three years ago, this is not an unduly long period for any industry to absorb a major revolution in its business.

There have been a number of contributing factors, in addition to good weather, for the airlines' prosperity in 1963. There has been a general improvement in passenger service, as most airlines took a new and kindlier view of their ticket-buying clients. There is more and better communication between the airline and its passengers, including the major progress resulting from electronic reservations systems. However, some airlines are still reluctant to be candid with their customers on schedule delays, where a policy of accurate information would save the passenger time and worry and preserve good will for the airline. Completion of jet age airports at many major terminals throughout the world has helped ease the strain of handling the larger jet loads, although air traffic control in terminal areas still leaves much to be desired.

The jet age attracted substantially more passengers in U.S. domestic traffic and on the key North Atlantic international route during 1963, and also saw the start of a major growth in revenues from the beginning of international jet cargo operations. The impact of the jet cargo plane will play an important role in maintaining airlines on their plateau of prosperity.

In addition, the recent performance of the U.S. airlines has made a basic change in the attitude of investors and the financial community toward this business. Many airline stocks have more than doubled their price in the past few years, while in mid-1963, the climb in airline stock prices continued at a rate faster than the general market (AW Oct. 7, p. 40).

The jet age has forced some new concepts on the regulatory agencies concerned with air transport. The technical capabilities of the jet transport are difficult to constrict within the limitations of the routes of a purely regional carrier. Without sufficient route mileage to really stretch its wings and fly a high daily rate of utilization, the jet cannot perform with economic efficiency. The Civil Aeronautics Board has already changed the regional character of Delta and National airlines by extension of their routes in the Southern Transcontinental Case, but the impact of jet technology on its regulatory policies is far from finished.

There are still some vexing unsolved problems that can modify the outlook for continued airline prosperity. The most serious are the achievement of all-weather operations, and an air traffic control system that can handle the growing volume of major terminal operations now being generated. The all-weather landing capability is being pursued with considerable technical vigor, but there is an air of mustiness in the approaches to the air traffic control problem. It is evident that not only new equipment but fresh thinking and new concepts are required for the creation and operation of a traffic control system capable of permitting maximum utilization of jet capabilities.

The fare muddle must be transmogrified from its present system of complex inequities to a simplified, nondiscriminatory structure that can be understood equally well by the airlines and their customers. There is no excuse for more than 50 different fare possibilities between New York and Miami, or for the situation on the North Atlantic that penalizes the regular traveler and rewards the one-timer as a result of the group fare farce.

Airline managements are doing an increasingly better job of coping with their jet age problems. But they will need all the help they can get from their regulatory agencies in adapting their policies to recognize the realities and the potentials of the jet age.

—Robert Hotz

WHO'S WHERE

In the Front Office

Leonard C. Mallet, a director, United Aircraft Corp., East Hartford, Conn.; he is a vice president of United and president of Pratt & Whitney Aircraft Div.

Marvin Whitlock, a director, United Air Lines, Inc.; he is senior vice president-operations. Mr. Whitlock replaces the late Eric Johnston on the board.

Kenneth F. Mundt, senior vice president, Aerojet-General Corp., El Monte, Calif.

Dr. Robert R. Bennett, vice president and director of advanced systems program management, TRW Space Technology Laboratories, Redondo Beach, Calif.

Alastair Michael Adair Majendie, a director of S. Smith & Sons (England) Ltd., and managing director of Smiths Aviation Div.

William F. Riordan, administrative vice president, Rantec Corp., Calabasas, Calif., a subsidiary of Emerson Electric Manufacturing Co.; he continues as manager of Emerson's Spectral Technology and Applied Research Div. (Santa Barbara).

W. L. Hawks, executive vice president and a director, Pacific Scientific Co., Los Angeles, Calif.

H. F. Dougherty, vice president, Components Corp.; he continues as manager of Northern operations with offices in San Jose, Calif.

C. Gus Grant, vice president-operations, Ampex Corp., Redwood City, Calif.

Lt. Col. Robert F. Spence (USAF, ret.), Washington, D. C., representative for Riddle Airlines, Inc. Prior to retirement, Col. Spence was Chief, Defense News Branch, Office of the Assistant Secretary of Defense for Public Affairs, the Pentagon.

Nelson B. Fry, Jr., executive vice president, Allegheny Airlines, Inc., in charge of the company's new air service center at Greater Pittsburgh, Pa., Airport. Also: **W. Blake Thompson,** vice president and controller.

Col. Arthur W. Cruikshank, Jr., commander, Systems Engineering Group, Research and Technology Div. (RTD), Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio, and deputy commander of RTD.

Honors and Elections

Don Watson, of Pacific Western Airlines, Ltd., has been named president of the Air Transport Assn. of Canada for 1964. Named as vice presidents: **R. G. Lefrancois,** of Nordair Ltd., and **G. W. McPherson,** of Okanagan Helicopters.

Dr. Henry J. E. Reid, retired NASA official, has been selected by the National Aeronautic Assn. as an "Elder Statesman of Aviation" in recognition of his contributions to the progress of flight . . . Dr. Reid was director of the Langley Research Center from 1926 until May, 1960.

George Schairer, Boeing aerodynamicist, has been named as the 1963 Wright Brothers Lecturer by the American Institute of Aeronautics and Astronautics. The lecture will be delivered on Jan. 20 at the AIAA Aerospace Sciences Meeting, Hotel Astor, New York, N. Y.

(Continued on page 128)

INDUSTRY OBSERVER

► Look for a major Defense Dept. statement soon on the future of USAF's X-20 (Dyna-Soar) program. Defense Secretary Robert S. McNamara reportedly was not impressed by the X-20 portion of a Titan 3/Dyna-Soar briefing he received last month at Martin-Denver.

► **Detailed requirements for an astronaut training aircraft with a 50-naut. mi. altitude capability have been submitted by Edwards AFB program planners to USAF Headquarters. The configuration would require more than a single propulsion mode to satisfy altitude and operational requirements.**

► Douglas Aircraft Co. has won National Aeronautics and Space Administration's competition for the follow-on program definition phase of the manned orbital research laboratory (MORL). The phase will be broken into two six-month portions—each funded at about $1.5 million. The second portion is expected to be coordinated with results of the pre-program definition phase for USAF's orbital space station (OSS). Contractor for the USAF station phase is expected to be chosen next month. The USAF study phase will be completed well before the second portion of the MORL program definition work.

► **Federal Aviation Agency has requested industry bids for a modular-design digital computer suitable for air traffic control functions and eventually expected to be procured in quantity and installed at 22 air route traffic control centers. Proposals are due Jan. 6, and the winner will be selected within 30 days after that date. The modular design is planned to permit computer capacity to be tailored to the needs of each ARTC center and to allow expansion of its functions.**

► Decision on whether to continue orbital threat technology studies—performed for Advanced Research Projects Agency by industry firms and submitted last month—will not be made until Defense Dept. Research & Engineering completes its review before the end of the year. Companies which submitted studies included Boeing, Douglas, General Electric, Martin and TRW Space Technology Laboratories.

► **Army Missile Command is considering a program for a rocket with high targeting accuracy to meet requirements of an anti-radar mission and destruction of large-gun positions. Both USAF and Navy have plans for anti-radar missiles (AW Oct. 28, p. 19).**

► NASA may support feasibility demonstration of a full-length, 260-in.-dia., solid propellant motor (AW Nov. 4, p. 23) with modest funding if USAF's Space Systems Div. cannot convince DOD that an investigation of technology beyond the half-length, 260-in. motor is essential. Aerojet-General and Thiokol have invested in facilities for development of the 260-in. motor, but DOD seems disinclined to extend the program because there is no Air Force requirement for a solid booster of this size.

► **Douglas Aircraft Co. will receive a sole-source contract from the Navy to conduct a mission analysis evaluation of the supersonic combustion ramjet (Scram) concept. The award stems from an unsolicited proposal by Douglas.**

► Reports for USAF's Project Forecast indicate that a long-range aircraft with multi-mission capability and a fighter-type plane to be used mainly for close support will get the same heavy emphasis in USAF plans as a military space station with logistics cargo and personnel spacecraft.

► **First test of Lockheed Propulsion Co.'s 156-in. motor segment using a jet tab for thrust vector control will be conducted in late April, 1965. The second test firing under a program sponsored by Space Systems Div. would occur about four months later. The jet tab will be mounted on the nozzle, which probably will have an exit plane diameter of about 4½ ft.**

► Program to develop a field-effect type transistor capable of withstanding intense nuclear radiation is being planned by the Army's Aberdeen Proving Ground. Qualified bidders must register by Nov. 29. Reference code is RFP-RD-APG-48-64.

Washington Roundup

NASA Eyes Titan 3

Administrator James E. Webb of the National Aeronautics and Space Administration is showing interest in using the USAF-Martin Titan 3 to launch such future heavy payloads as observatory satellites.

Titan 3 is designed to put 28,000 lb. into earth orbit and could become a standard launch vehicle for the civilian space agency. Webb has been discussing the possibility with Dr. Harold Brown, director of defense research and engineering.

An intended byproduct of these discussions is more NASA-Defense Dept. unity in the U. S. space program. Air Force would gain additional justification for its booster.

Federal Aviation Agency is moving to reorganize its research and development activities to obtain a more efficient grouping of technical specialists. New air traffic control, navigation and communication development divisions are expected to be formed before year's end from the present electronic systems development and system management divisions.

Gilpatric's Successor

Pentagon insiders predict Army Secretary Cyrus R. Vance will succeed Roswell L. Gilpatric as deputy defense secretary and that Kenneth E. BeLieu, assistant Navy secretary for installations and logistics, will replace Vance.

Gilpatric is expected to leave the Pentagon shortly after appearing before the McClellan subcommittee this week to answer challenges about his role in the F-111 (TFX) contract award to General Dynamics.

The subcommittee's voluminous record detailing Gilpatric's relationships with General Dynamics while deputy defense secretary will bring charges that he should have disqualified himself from participating in the competition (AW Nov. 11, p. 27). Chairman John L. McClellan plans to break precedent in the F-111 hearings by opening the sessions this week to the public.

Former Navy Secretary Fred Korth is slated to follow Gilpatric to the witness stand, possibly later this week. Then comes the final witness—Defense Secretary Robert S. McNamara. The subcommittee had to resort to its subpoena power to obtain some records from Ford Motor Co. about McNamara's relationship with Boeing when the two companies worked together on the B-47. It was the first time during the investigation that a company refused to give the subcommittee records without a subpoena.

Objective of obtaining the Ford records was to determine if McNamara had displayed any bitterness against Boeing during that period which might have influenced his F-111 decision. No such prejudice was documented by the records.

Military Dollar Impact

Comptroller Charles J. Hitch is heading a Defense Dept. effort to provide aerospace contractors with market research information so they can prepare themselves for sudden shifts or reductions in military spending.

First step in the effort is to develop better information on just what impact military spending does have on the economy. Defense Dept. plans to prepare a questionnaire for the Census Bureau to obtain this information in the next census. Then the hope is to issue a five-year forecast of military and space spending.

Hitch will detail the plan next week before a Senate manpower subcommittee headed by Sen. Joseph S. Clark. Sen. George McGovern also will appear before the subcommittee to explain his bill to establish a National Economic Conversion Commission to help industry shift smoothly to non-military activities if the arms race slows down or changes direction (AW Nov. 11, p. 31).

Sen. McGovern over the next several weeks also will write letters to a cross-section of the aerospace industry asking about plans to convert military operations to civilian efforts. He feels, for example, that airframe companies should be thinking about applying their techniques to prefabricated housing.

Defense Dept. plans and the McGovern bill will remain in the discussion stage for the rest of this year, but are expected to result in specific actions next year.

New Ranger Shot

Jet Propulsion Laboratory has told its deep space tracking station to prepare for another Ranger shot in February. The sixth launch was postponed again last month when tests disclosed faulty diodes. Ranger 5 experienced a power failure Oct. 18, 1962, and missed the moon by 450 mi. This fifth successive failure caused NASA to postpone the Ranger 6 shot from January of this year to December (see p. 30).

Soviet newspaper Izvestia recently criticized Astronaut Alan B. Shepard for buying into the First National Bank of Baytown, Tex., rather than concentrating his full attention on space flight. The government publication said business temptations were exerting heavy "gravitational pull" on U. S. astronauts.

—Washington Staff

New 12,000-Mi. Cargo Aircraft Is Sought

USAF drops CX-4; CX-X concept calls for extended, unrefueled, nonstop flights with 180,000-lb. payload.

By Larry Booda

Washington—Air Force has set its aim at global mobility by issuing a new requirement for a heavy strategic cargo aircraft that could fly to most potential trouble spots in the world without depending on facilities outside the continental United States. This concept is called the CX-X.

In a major policy change, Air Force two weeks ago canceled the specific operational requirement (SOR) for the CX-4 concept (AW Oct. 21, p. 33), and substituted the new one. The effect is to delay development of the heavy lift aircraft in order to take advantage of technical improvements in structures, materials and engines that are expected in the next two years. The CX-X would be able to fly 10,000 to 12,000 mi. without refueling and carry up to 180,000 lb. of cargo.

Requests for component development and study funds are being written into the Fiscal 1965 Defense Dept. budget request as part of a program change request.

As preparation of this budget entered its final phase, there were these other developments in the air lift area:

• **Defense Secretary Robert S. McNamara** has placed pressure on the Air Force to renew and increase its air fleet to provide worldwide mobility to the Army. Congress has urged that Fiscal 1964 funds be re-budgeted to increase procurement before Fiscal 1965.

• **Purchases** of Lockheed C-130 and C-141 and Boeing C-135 aircraft will be increased.

• **Military transport** aircraft will remain in the subsonic speed category. Defense Dept. said it has no requirement for a supersonic transport.

• **Decision to fulfill** the military requirement for a medium-range transport is still pending. The procurement has been delayed for two years; indications are that it will be delayed further.

CX-X Capacity

The CX-X requirement would lead to an aircraft which, in sufficient numbers, could transport an Army division and all of its equipment, including tanks and portable bridges, to an overseas destination, and then return nonstop and unrefueled. Cargo pods and personnel pods would be extracted from the rear hatch of the aircraft by either a ground-installed snatch system or by use of extraction parachutes.

The aircraft would not need to touch down, eliminating the requirement for a prepared landing surface. Cruising speed will be 75 to 100 kt. less than current jet transports.

These are some of the state-of-the-art improvements expected to be incorporated in the CX-X:

• **Propulsion.** Air Force technical planners have determined that the ideal powerplant will be the high bypass ratio turbofan engine. This would be a turbine engine that would drive air past the outside of the compressor and power section casings at a bypass ratio of three to 10, as compared with the ratio of two to one for current turbofans.

Specific fuel consumption is expected to be less than the most efficient reciprocating aircraft engines. The regenerative turboprop will not be used because it is considered to have originated in an earlier period of technology and may not match the specific fuel consumption of the high bypass ratio engine. Engine development will be started earlier than other CX-X components because it is estimated that powerplant development will take six years.

• **Structures.** Principal structural innovation will be boundary layer control (BLC). Increased range or lift can be gained through use of BLC. USAF feels development of BLC is advanced sufficiently for application whenever the design phase of the airframe is begun (AW June 24 ,p. 52).

• **Materials.** Increased use of lightweight metals other than aluminum, plastic and metal honeycombs, high-temperature ceramic-metal combinations for the engines and other plastic parts will tend to lighten the basic aircraft.

The CX-X will have a gross weight between 375,000 and 500,000 lb. This is the same size as the CX-4, but it will have greater range and payload. The CX-4 SOR called for a 100,000-lb. payload and a range of 4,000 mi. It would have had to be refueled in a rear protected area after having delivered its cargo.

Some Defense Dept. studies have gone far beyond the immediate future in visualizing modernization of the military air lift fleet. They foresee air lift capabilities increasing to the point where extremely heavy cargo could be transported by air in such quantity that sea lift could be ignored in the event of an all-out war, in which enemy submarines would be used against shipping of the U. S. and its allies.

Air Lift Cheaper

The theory is that air lift would be cheaper than the cost of sea lift and anti-submarine forces combined. Present aim in air lift costs is five cents per ton-mile. The C-141 is expected to approach this figure, and the CX-X would be considerably below that when carrying a full load of 180,000 lb. for 5,000 mi.

However, air lift modernization plans at present do not include supersonic transports. A high Defense Dept. official told AVIATION WEEK & SPACE TECHNOLOGY that since there is no military requirement for a supersonic transport, the department has no interest in undertaking project management of the national supersonic transport program now assigned to the Federal Aviation Agency. His reasoning was that the military should stick to meeting its own requirements, and that the Air Force has enough to do already.

In the medium transport area, both the Air Force and Navy wanted to buy Grumman Gulfstream twin-turboprop aircraft for use of U. S. military missions overseas and service utility units. Fairchild has tried to sell its F-27 twin-turboprop local service airline transport to the services (AW Nov. 11, p. 49). The question of whether to buy off-the-shelf aircraft such as these, or to start from the beginning with an aircraft designed to meet military requirements, is a factor in the current indecision.

At present, the air lift of the Military Air Transport Service (MATS) and the Tactical Air Command can carry only about 10% of a division's equipment in addition to the personnel.

Because of this deficiency, the current doctrine is to pre-position heavy equipment overseas. Two ships loaded with this gear are anchored in the Western Pacific and equipment sufficient for two divisions is in Europe.

Pre-positioning, however, suffers from a major cost-effectiveness fault. The troops stationed in the continental U. S. must have identical equipment with which to train, thus increasing costs.

Pre-positioning, therefore, is a temporary expedient to be used only until more air lift and lighter equipment is developed and produced.

Modernization of U. S. military air lift began shortly after President Kennedy took office, and was accelerated as a result of the Cuban missile crisis. In an unprecedented effort, the activities of many commands were disrupted to carry 12,000 Marines to Guantanamo Bay (AW Nov. 19, 1962, p. 29). Two lessons were learned from that air lift: that there had been insufficient preplanning for such a contingency, and that U. S. air lift lacked both quantity and quality.

Operation Big Lift (AW Oct. 28, p. 26) was an attempt to remedy the first deficiency. It will be followed by the air lift of two divisions to the Pacific with advance notice of only a few hours. Such operations cost about $10 million each.

First major pullback of transport aircraft stationed overseas since Operation Big Lift will involve three Lockheed C-130 squadrons stationed at Evereux, France. They will be reassigned to Lockbourne AFB, Ohio, and the three squadrons remaining there will operate on a rotational rather than on a permanent basis.

The regular scheduled military air routes flown in Europe and the Near East by the Evereux-based aircraft will be taken over by MATS.

Current plans to increase air lift purchases are aimed at taking care of the second deficiency.

To augment the defense-operated air lift, the commercial airlines will continue to be encouraged to purchase jet equipment that will be committed to the Civil Reserve Air Fleet (CRAF), subject to military use in emergencies. The encouragement takes the form of preferential treatment in award of contracts for carrying military passengers. Additional preferential treatment will be given airlines whose new CRAF jet aircraft are readily convertible to cargo service.

Increasing the military air lift could affect the size of the sea lift available for military use by diverting funds which would have gone into replacing ships that carry 94% of dry cargo tonnage and 57% of tanker tonnage, and are 15 or more years old.

AMP Propellant

Washington—Kerosene type fuels were selected over liquid hydrogen to power the Air Force advanced manned penetrator (AW Nov. 11, p. 25) because kerosene fuels can be fitted into the current technology of engines and structures for Mach 4 flight speeds. Hardware for hydrogen technology is much further down the time scale, USAF planners feel, even though it could produce Mach 6 speeds and greatly extended ranges. Advanced manned penetrator (AMP) is intended as the replacement for the Boeing B-52 bomber in 1972 (AW Oct. 21, p. 31).

DOD Relents; Air Force Seeks Pilots

Washington—Air Force has finally convinced Defense Secretary Robert S. McNamara that it faces a critical pilot shortage and has received approval to increase the number of pilot trainees, to return the ratings of former pilots who meet standards, and to urge reserves to return to active service.

USAF has been trying for two years to make the point that although the number of pilots needed for strategic aircraft is being reduced as the bomber fleet decreases, the need by other commands for pilots is growing in these two areas:

• Military air lift, reflecting the Kennedy Administration emphasis on global mobility (see p. 26).

• Tactical fighters, principally the McDonnell F-4C and its follow-on, the General Dynamics F-111 (TFX), both of which require two pilots.

Air Force has found that at the same time it is losing pilots because of the phasedown of Boeing B-47s, increasing numbers of pilots with 20 or more years of service are leaving the Air Force.

The B-47 phasedown already has involved reduction of the fleet by about 900 aircraft, from a peak of 1,300 in the mid- and late-1950s.

The aircraft will be completely phased out of the USAF inventory by the end of Fiscal 1965.

B-47s are being retired from service at an increasing rate. A reduction of 19 B-47s and 22 Boeing KB-50 tankers was effected in England two weeks ago. B-47s were flown from the Pacific island of Guam to Australia, where they will be used as interim aircraft pending delivery of F-111As (see p. 34).

There are 13,700 Air Force pilots 40 to 45 years old, while only 6,300 in this age bracket are needed. There are 6,300 over 45, when the desired total is 450. Between 35 and 40, the requirement is 7,300, and the number presently on active duty stands at 6,800.

In the younger age groups, 19,000 pilots between 23 and 30 are needed, while the actual number is 9,500. In the 30-35 bracket, there are 11,500 against a requirement of 8,400.

Between Fiscal 1964 and Fiscal 1968, the over-all pilot requirements will decrease from 41,000 to 18,000—mainly because of the SAC phasedown—but at the same time the pilot inventory will shrink from 42,000 to 32,000, even with an increased training rate.

In recent years Air Force has sent an average of 1,500 officers per year to flight training. The figure asked for in Fiscal 1965 is 2,300. So far the entire input has come from academy graduates and Reserve Officer Training Corps graduates. An aviation cadet program may have to be re-instituted in the near future to fill the quotas.

Some NASA Funding Restored

Washington—Senate Appropriations Committee last week restored $90 million to the Fiscal 1964 National Aeronautics and Space Administration budget, bringing the total to $5.19 billion, but some reduction in this total is likely when House and Senate conferees arrive at a compromise.

Senate may vote on the NASA budget this week, and some House members are predicting a compromise bill that will give the space agency an operating budget of $5.15 billion for the current spending year.

Senate Appropriations Committee action on Nov. 13 provides these funds for NASA:

• **Research and development,** $4.006 billion, an increase of $80 million over House action.

• **Facilities construction,** $690 million, $10 million more than the House appropriated.

• **Administration and salaries,** $494 million, the same amount appropriated by the House.

The Senate group softened the language of a House amendment to the NASA bill prohibiting any of the funds from being used for a joint lunar program with Russia (AW Oct. 14, p. 37). Instead of a flat prohibition, the Senate committee proposed that the funds not be spent for such a joint program without the consent of Congress.

Senate Appropriations Committee's restoration of only $90 million to the $5.1 billion appropriated by the House is another setback for NASA Administrator James E. Webb. Webb pressed hard for the full $5.7 billion requested by President Kennedy. When Senate and House agreed on a $5.3-billion authorization, Webb said this amount was the minimum required to attain the Apollo manned lunar landing goal of 1970.

He made several pleas to the Senate independent offices appropriations subcommittee for $5.3 billion, citing possible delays in Apollo as his basic argument.

Length of the new missile, shown turning into Red Square, is approximately 50 ft., based on comparisons with SA-3 and SA-2, ahead (AW May 20, p. 54-55). Four new missiles were assembled prior to the parade, but only three took part in it.

Pre-parade assembly of Soviet missile forces at the Nov. 7 Bolshevik Anniversary celebration in Red Square shows size of the newly unveiled Russian surface-to-air weapon (last row, upper right) in relation to the SA-2 Guideline (first two rows, lower right), and SA-3 single-stage rocket (two rows, right center). The new weapon closely resembles the Guideline configuration. One of several versions of the Soviet Frog battlefield missile (upper left) has an unusual configuration that appears to include an inlet and duct running the length of the weapon. A fin is visible on it at the rear, indicating it is part of the missile and not the carrier structure. Tass, the Soviet news agency, called the new surface-to-air missile a long-range anti-aircraft rocket, but the Soviet chief of the general staff, Sergei S. Biryuzov, said that the Soviet armed forces have "the most perfect means capable of destroying in the air any enemy rockets," and that "some of this family of rockets were seen today by Muscovites." Previously seen battlefield missile types are at lower left.

Soviets Unveil New Air Defense Missile in SA-2, SA-3 Family

Nose probe shows most clearly in this front view of the new weapon (below). Increased diameter of the first stage compared with the second also is apparent. Tractor unit of the carrier is taller and wider than the SA-2 and SA-3 unit, but has a single pair of rear wheels instead of two tandem pairs on the SA-2 and SA-3 vehicle. Rings supporting the missile are clamped around the upper stage aft of the nose section and at the forward end of the first stage. The platform probably functions as a work platform and does not contribute to any direct support of the missile. None of the plumbing or tankage of the SA-2 and SA-3 trailer is used here. Size of the fins and the fact they are not in same longitudinal plane as on SA-2 may have influenced trailer design. Stub antennas on second-stage fins project rearward.

Trailing half of the first stage-fins on the new missile are cambered in opposite directions, probably for improved flow characteristics. Control surface and actuator are visible at the trailing edge of the large top fin on the second stage. Small fins on the second stage also are movable. Solid-propellant first stage lacks the plumbing and fairings visible on the upper stage. U. S. reaction was restrained, one source noting that fin area is large for an intercontinental ballistic missile intercept role, possibly limiting maneuverability to low Mach numbers and intercept to 40,000-50,000 ft. Discrimination between penetration aids and warhead probably would have to be done by the time the incoming object had reached 200,000 ft., leaving little time for launch and target acquisition.

Only Six NASA Payloads Orbited in 1963

By Alfred P. Alibrando

Washington—Only six of the 40 major satellites and probes scheduled in 1963 by the National Aeronautics and Space Administration have been launched so far this year—the lowest rate since 1960, when the agency put five satellites in orbit.

This year's launch activity reflects NASA's most difficult period since 1958-60, when launch failures exceeded successes. Contributing to postponements and the vastly reduced flight schedule were:

- **Technical problems** in two launch vehicles—Scout and Titan 2—and a number of spacecraft.
- **Longer-than-expected** operating life in orbit of some satellites—Relay, Tiros, Orbiting Solar Observatory—which resulted in delay of follow-on flights until those spacecraft in orbit are no longer useful.
- **Decision to conclude** Project Mercury with Maj. Gordon Cooper's MA-9 flight, thus eliminating two Mercury missions.

Although NASA had some trouble in getting flight-ready rockets and spacecraft to the launching pad, all six launches attempted this year have been successful. They were Syncom 1, Feb. 14; Explorer 17, Apr. 3; Telstar 2, May 7; Faith 7, May 15; Tiros 7, June 19, and Syncom 2, July 26.

Despite this record, the 1963 launch rate suffers when compared with the 18 satellites and probes, some of them spectacular firsts, launched in 1962. Among the 1962 flights were:

- **First Project Mercury** manned orbital flight by Marine Lt. Col. John Glenn, Jr., followed by the flights of Cdr. Scott Carpenter and Cdr. Walter Schirra.
- **Mariner 2's 109-day** fly-by mission to Venus, the world's first successful planetary flight.
- **Telstar,** first active communications satellite.
- **Ariel,** first international satellite.

NASA's light launch activity is underscored even more when compared with that of the Air Force, which has already launched 23 satellites this year, and Soviet Russia, which has put 15 payloads into orbit in 1963.

Among the U. S. flights postponed to the first quarter of 1964 was the first unmanned Gemini mission. Delay of this flight was due primarily to longitudinal oscillations (chugging) in the Titan 2, which the Martin Co. says has been largely eliminated (see p. 36).

Lack of flight activity this year is especially disappointing to some members of Congress who found the Glenn and Mariner flights key factors in building support for the space program among their colleagues and constituents last year. Rep. Olin E. Teague (D.-Tex.), chairman of the House subcommittee on manned space flight, lamented on several occasions that "it is difficult to sell this program when there isn't anything going on."

The program most severely hit by the difficulties experienced this year was the scientific satellite effort. Only one scientific satellite, Explorer 17 (S-6 Aeronomy satellite), has been launched so far in 1963. It proved highly successful, discovering a belt of neutral helium atoms about the earth.

Only chance for launch of another scientific satellite this year depends on whether NASA is able to correct an outgassing problem in the third stage motor of the Delta on which interplanetary monitoring platform 1 (IMP) is to be launched. The launch was postponed last week (see p. 31).

Scientific satellite flights postponed from 1963 to 1964 include the S-66 Polar Ionosphere Beacon, which was to have been launched from the Pacific Missile Range on a Scout; the S-48 Fixed Frequency Topside Sounder, also from PMR on a Scout; an Orbiting Solar Observatory (OSO) from the Atlantic Missile Range on a Delta; an S-52 international satellite from Wallops Island on Scout, and the first Eccentric Orbiting Geophysical Observatory (EGO), from AMR on an Atlas Agena.

S-66 has been held up because of random problems earlier this year in Scout—both the first stage motor and third stage guidance (AW Nov. 11, p. 34). In the other cases except EGO, satellites launched earlier are still working. EGO has been delayed by problems that developed in the spacecraft.

In the area of advanced research, two SERT (electrical engine) flights on Scouts and a Project Fire high-velocity re-entry test on an Atlas with an X259 upper stage were rescheduled because of delays in load preparation.

Relay 3, Telstar 3 and Syncom 3 communication satellite flights and a Tiros 8 weather satellite launch were postponed to 1964 because the previous satellite in the series continued to operate beyond the time the next payloads were to be launched.

First launch of Nimbus, which was to have been developed as an advanced operational weather satellite, was postponed from the third quarter of 1963 until early next year.

Although the Weather Bureau has decided not to use Nimbus as an operational satellite, NASA plans to launch three of the four being built by General Electric in a research and development program.

The 1963 schedule as projected by NASA last December does not include other slippages in the agency's programs which occurred earlier in 1962. Following the failure of the Ranger 5 spacecraft in October, 1962, NASA and Jet Propulsion Laboratory instituted a rigid test-to-destruction quality assurance program. Four Ranger flights which had been scheduled this year were removed from the 1963 schedule.

Later, Ranger 6 was scheduled for December but was again postponed indefinitely when testing of diodes used in the spacecraft disclosed that a gold bonding material used in them had flaked off (AW Oct. 28, p. 25). The diodes are being replaced with another type using a silver bonding material.

1964 NASA Launch Schedule

First Quarter

Mission	Launch Site	Launch Vehicle
Topside sounder (S-48)	PMR	Scout
Relay 2	AMR	Delta
Echo 2	PMR	Thor Agena
Air density/Injun	PMR	Scout
Gemini unmanned orbital	AMR	Titan
OSO 2	AMR	Delta
Fire 1	AMR	Atlas X259
International (S-52)	WI	Scout
Ranger 6	AMR	Atlas Agena
Relay 3	AMR	Delta
Centaur test 3	AMR	Centaur
Nimbus 1	PMR	Thor Agena
Polar beacon (S-66)	PMR	Scout
S-48 backup	PMR	Scout
Syncom 3	AMR	Delta
Air density/Injun backup	PMR	Scout
Second Through Fourth Quarter		
Apollo attitude control	WSMR	Little Joe 2
Eccentric observatory	AMR	Atlas Agena
Gemini orbital systems	AMR	Titan 2
Centaur test 4	AMR	Centaur
Ranger 7	AMR	Atlas Agena
Apollo boilerplate abort	WSMR	Little Joe 2
Ranger 8	AMR	Atlas Agena
Fire 2	AMR	Atlas X259
Meteoroid satellite	AMR	Saturn
Gemini manned mission	AMR	Titan 2
Ranger 9	AMR	Atlas Agena
Mariner Mars mission	AMR	Atlas Agena
Mariner Mars backup	AMR	Atlas Agena
Apollo spacecraft abort	WSMR	Little Joe 2
Surveyor dynamic model test	AMR	Centaur

AMR—Atlantic Missile Range; PMR—Pacific Missile Range; WSMR—White Sands Missile Range; WI—Wallops Island.

Minuteman Stage Tested

Cape Canaveral—Wing 6 Minuteman solid-propellant intercontinental ballistic missile, mounting a larger second stage containing a new propellant, was fired successfully from a silo here last week.

The advanced second stage uses one stationary nozzle, rather than the four movable nozzles of previous models. Thrust vector control is accomplished through hot gas secondary injection. Fuel is polybutadiene type, reputed to provide greater specific impulse. It is similar to the fuel used in the first stage and has a higher specific impulse than polyurethane, the fuel normally used in the second stage.

On Nov. 7, a Minuteman fired from a silo here veered shortly after launch and was destroyed. Burning propellant fell over a wide area of the Cape, but caused no injuries or damage. Model of the missile, the type of test and reason for failure were not revealed by the Air Force.

Five Centaur flights had been scheduled for 1963, but an explosion which destroyed the rocket 55 sec. after launch on the first Centaur flight on May 8, 1962, brought a review of the program. Management of the program was shifted from the Marshall Space Flight Center to the Lewis Research Center, and extensive design changes were made in the rocket.

Dr. Robert C. Seamans, Jr., NASA associate administrator, views some of the problems that contributed to 1963's low launch rate "as squaring away difficulties which existed before NASA was created or which developed in the early days of the agency."

Centaur, whose development was started by the Defense Dept., and Nimbus fall into these categories.

"As for some of the other delays and postponement," he said, "I think they are due to our involvement in projects where we are doing things for the first time. In building spacecraft such as EGO, and the Orbiting Astronomical Observatory, we are learning how to design, assemble and test advanced spacecraft—a new generation of spacecraft that are much more complex than the ones we have been flying so successfully."

NASA's earth orbital satellite programs have been remarkably successful. NASA has not failed in an attempt to orbit an earth satellite since the unsuccessful Mercury-Scout 1 communications test on Nov. 1, 1961. In the two years since, every one of its 21 earth satellite launches has been successful. In addition, except for Mercury-Scout 1, NASA has not had an earth satellite launch failure in 29 months.

Some NASA project managers have attributed this high success rate to stricter reliability requirements. Seamans said that except for Ranger, there has been no significant change in these requirements.

"Agency policy always has required rigid ground testing," he said. "The amount of testing—where to stop testing and launch—is a matter of balance. Costs and keeping a program going figure in these decisions."

Aero Spacelines Seeks Princess Flying Boat

Los Angeles—Aero Spacelines, Inc., operator of the converted Boeing Stratocruiser called the Pregnant Guppy (AW June 24, p. 80), is discussing plans with National Aeronautics and Space Administration for a new, much larger Super-Guppy using a modification of the Saunders-Roe Princess long-range flying boat. Three of these huge aircraft had been authorized for construction by the British government, but only one was completed.

The modified aircraft would have a main cabin interior height of 38 ft. and a width of 37 ft. It would be modified to handle the S-1C, first stage of the Saturn 5 vehicle, which is 138 ft. long and 33 ft. in diameter, excluding fins.

The Super-Guppy is planned to have a cross-country, nonstop payload capability of 200,000 lb. It would be powered by eight turbojets.

Estimated cost of the modified Princess prototype would be $15 to $18 million, Aero Spacelines says.

IMP Delayed; Tests Show Payload Peril

Washington—Launch of the first interplanetary monitoring platform (IMP) satellite has been delayed three to four weeks after ground tests indicated the payload would have been affected by heat or exhaust from the third stage motor of the Delta launch vehicle after burnout.

IMP was scheduled for launch Nov. 12. The Hercules-Allegany Ballistics Laboratory X-258 third stage motor was fired on a centrifuge Nov. 9 at Arnold Engineering Development Center. The firing resulted in a charred casing.

Delay will allow National Aeronautics and Space Administration to change sequencing so that the payload will be separated from the third stage earlier than originally programed.

The launch is the first use of the 5,500-lb. thrust X-258. Previous Delta vehicles have used the ABL X-248, which develops about 2,800 lb. thrust.

The IMP satellite (AW Nov. 4, p. 28) is designed to monitor solar proton flux and energy, primarily for manned space flights.

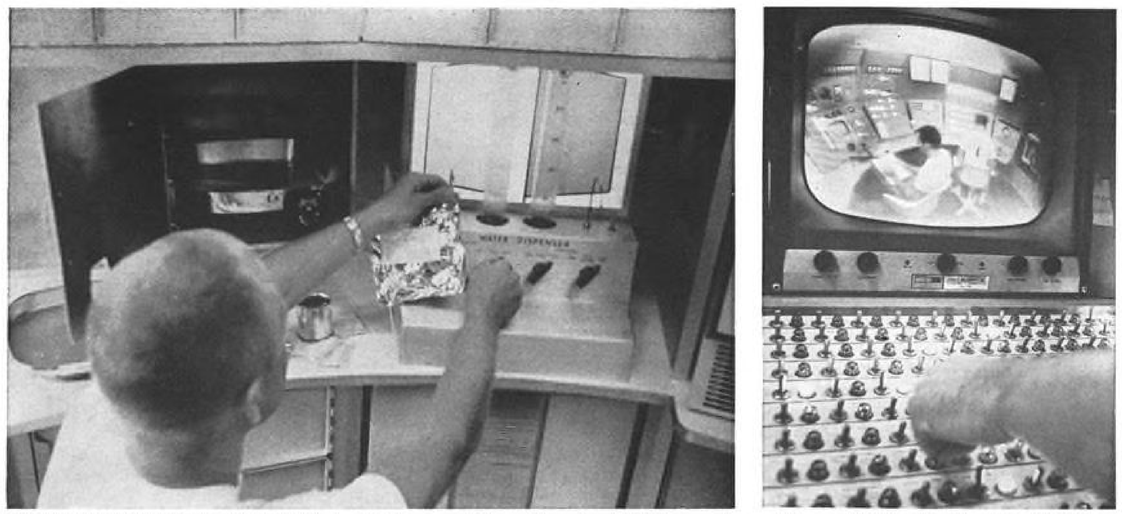
Saab 105 Tests

Geneva—Swedish air force flight evaluation trials on the Saab 105 jet trainer and light attack aircraft are scheduled to begin next month, probably at the air force flight test center at Linkoping.

Preliminary order of 130 aircraft hinges on the outcome of the comprehensive tests, which will span a two-month period, and Saab is hoping to land the contract in March.

First pre-production model—so-called because it was built with production tooling—has logged more than 80 hr. of flying time in company tests since its maiden flight June 29 and recently underwent minor modifications on its jet intakes and tail pipes to improve flow.

The second aircraft has now entered the final assembly phase at Saab's Linkoping factory and is due to fly in February or March.



CREWMAN IN GENERAL ELECTRIC's simulated space station adds water (left) to a package of freeze-dried food in the station's kitchen area. The food was prepared by adding sufficient 140F water to both heat it and restore the natural fluid balance. During the 30-day simulated mission, the crewmen were monitored on a closed television circuit while at their crew stations (right) and during their rest periods in the lower living quarters.

4 GE Engineers End 30-Day Chamber Test

By Donald E. Fink

Valley Forge, Pa.—Four General Electric Co. engineers have completed a 30-day simulated space station mission during which they performed station management and mission tasks in a 7 psi. atmosphere of 50% oxygen and 50% nitrogen. The operational portion of the test ended here Nov. 6, but the men currently are undergoing extensive physical and psychological examinations to determine the effects of their month-long stay in the chamber.

The simulator, 12 ft. in diameter and 24 ft. high, has two decks, with living quarters on the lower one and crew stations on the upper. It consists basically of a welded aluminum cylinder with channel stiffeners and spun aluminum top and bottom domes. It weighs 7,000 lb. and has four support legs. Dimensions of the station were chosen because they are compatible with the U.S.'s early-generation large boosters, according to Carl Cording, manager of the test project.

It was operated inside a 39-ft.-dia. vacuum chamber in GE's Space Technology Center. The men were monitored with closed-circuit television during the experiment. Only contact with the control team was a simulated Mercury communications network.

The station was unsealed and vented to the vacuum chamber, which was pumped down to the 7 psi. pressure. The simulator's environmental control system was located outside the vacuum chamber and the gas flow was ducted directly into the simulator. The exhaust flow from the simulator was vented into the chamber and then returned to the environmental control system. Station temperature was 75F and relative humidity in the simulated station 40%.

Interior materials for the station were selected for their low toxic content. Synthetic materials, such as plastics, were avoided because of the gases they would release into the system. An activated charcoal/hopcolite filter was included in the environmental control system, but it was by-passed to check any toxic build-up in the station. A small build-up of Benzene hydrocarbons was noted, but it was not enough to affect crewmen. Source of gas is unknown, but an interior paint is suspected.

A build-up of toxic gases forced suspension of a 30-day simulator test at Boeing Co. recently (AW Oct. 14, p. 33). The source of the vapors has since been identified as interior paints and materials. Boeing has refurnished the simulator and plans to conduct a 14-day test this month and a 30-day test after the first of the year.

Selection of the two gas atmosphere and the 7 psi. operating pressure also was partially governed by the toxic problem, according to Dr. Richard Lawton, head of GE's biomedical and human factors section. Lawton said a 100% oxygen atmosphere, such as that planned for the Apollo mission, probably will not be suitable for extended space station missions because of physiological effects. Tests recently conducted by Republic Aviation Corp. have indicated that after breathing pure oxygen for long periods of time, test subjects will experience high toxic build-ups and deteriorating vision.

Added to this is the problem of lung collapse which occurs when persons who have been breathing pure oxygen are subjected to high g-forces, as would be expected during re-entry. The approximate 20% nitrogen content in atmospheric air generally is credited with slowing this collapsing action.

Air Force currently is gathering data on these phenomena in a 30-day test at Brooks AFB, Tex., with four airmen who are breathing pure oxygen in a vacuum chamber with a pressure equal to that found at 27,500 ft. The chamber measures 25x9x9 ft. and has a living area and a separate sleeping area. The men are fed through an airlock, and an Air Force physician enters the chamber periodically to check them. This test is a follow-on to a 43-day test that ended Aug. 26. In that test, the subjects also breathed pure oxygen, but at sea-level pressure.

The effects of breathing pure oxygen and numerous other variables, such as total structure weight, blower power weight penalty, probability of aeroembolism formation and fire hazard, were investigated by GE in an effort to determine what the best compromise would be for a space station atmosphere.

When the results were plotted on graphs, they tended to show that nitrogen was the most practical diluent gas to use in the system and that the 7 psi. pressure constituted the best compromise between weight and crew safety.

During GE's simulated mission the men ate primarily freeze-dried foods—prepared by Libby, McNeill and Libby—with some fresh frozen foods and food pastes in squeeze tubes. The food pastes, which consisted of pre-prepared samples of the freeze-dried foods, were not well received, according to the test conductors, because of their consistency. The freeze-dried food was moistened in water heated to 140F.

The four men maintained a 24-hr. schedule which consisted of two 4-hr./3-hr. work-rest cycles, followed by a 4-hr./6-hr. work-sleep cycle. The shifts were alternated so that one man was sleeping at all times, while one was resting and two were operating the station or performing these specified tasks:

• **Reconnaissance**—Two men monitored projections of aerial photographs taken from 30,000 ft., with one of them responsible for locating pre-determined targets, fixing the quadrants and pressing a camera button. The other scanned a second projection of the same terrain for targets of opportunity and relayed their quadrants to the first man.

The still photo projections were flashed on the screens for 30 sec. to simulate image motion compensation, which GE engineers said probably would be built into any space station reconnaissance system.

• **Rendezvous and docking**—Each man practiced a simulated docking maneuver every fourth day, remotely controlling GE's space ferry simulator, which resembles a Gemini capsule.

The simulator, located in another building, was monitored inside the station on a closed television circuit which had a camera mounted in the docking port. The men remotely maneuvered the simulator, which rides on air pads and is controlled with cold gas jets, as a test of their ability to dock an unmanned logistics vehicle to the station.

• **Performance and reaction tests**—The men also were required to perform eye-hand coordination tests, which involved moving delicate hand controls to match single and double rows of lights with a center row that moved at random, and lengthy monitor watches on instrument panels to detect reading fluctuations.

Arithmetic tasks, involving number retention, digit span and concentration tests, also were performed by the men. In addition to these specific tasks, they had to continuously monitor the operation of the station, which was simulated with instrument and dial panels. Out-of-limits readings were introduced at random and the men were evaluated on their abilities to detect the trouble and make correct responses to it.

A regular biomedical check also was kept on each man with daily checks of the respiratory and cardiovascular systems. Nitrogen and calcium balances in their systems also were checked, and their body wastes were analyzed daily.

No major fluctuations were noted in any of the bodily functions, except that the perspiration and respiratory water loss seemed to be about 1.5 times normal. Data covering all physical functions are being analyzed at Temple University Medical Center, which provided biomedical support for the test.

Prior to the test the four men, who were chosen from 60 male and eight female volunteers, had undergone four days of physical and psychological tests.

Following the test, the men were asked to evaluate the physical layout of the station. Approximately half of the wall space in the living quarters was filled with tip-out cabinets for food storage and work area for food preparation. The rest of the compartment consists of closets, a lavatory, a double-deck rest area with a sleeping bunk on top and a couch below, and a small open floor area.

No major complaints were voiced, Cording said, except that in the cramped living quarters the sleeping crewman often was awakened when the crewman on rest cycle prepared food. Cording said in future simulation tests the bunks will be both light and sound proof.

Volume of the cabins, which have about 1,200 cu. ft. of free space, was considered adequate by the crewmen. They said there was little interaction or tension among crew members since one of them always was asleep. The other three were kept occupied separately, either on their rest cycle or at their mission tasks. The same volume should be adequate for a six-man crew, Cording said, by adding a second sleeping bunk.

Missile 'Pack' Tests

Two astro-inertial guidance systems originally built for use in the Skybolt air-launched ballistic missile are undergoing flight test in a Convair C-131B by Northrop's Nortronics Div. to determine feasibility of using one air-launched missile with precision guidance to direct a "pack" of missiles with lesser guidance capabilities to their target.

The lead missile might carry little or no warhead, which would be more than compensated for by the lower-cost, lighter-weight guidance and heavier warheads of the follower-missiles. In the Nortronic tests, one Skybolt system serves as the master reference while the other is "slaved" to it. Present test program, sponsored by USAF's Aeronautical Systems Div., calls for 100 flight hr.

Toxic Hazards Study

Study of potential respiratory toxicity hazards involved in operating life support equipment in spacecraft over prolonged periods in a high-oxygen environment will be performed by Aerojet-General Corp. at Aeromedical Research Laboratories, Wright-Patterson AFB, under a three-year contract expected to total approximately $1 million.

To be supervised by USAF's Aerospace Medical Div., Brooks AFB, Tex., the work involves a new facility to be completed next July at Wright-Patterson, including four 12-ft. dia. plastic domes.

Life support components will be functionally tested in various atmospheres at a variety of pressures up to 5 psi. Development of trace contaminants from materials, paints, lubricants and plastics, which might pose toxic hazards to astronauts, will be evaluated.

Atmospheres will be analyzed chemically and physically to determine which materials are present and what occurs in a closed environment. Aerojet-General will provide a team of 14 scientists and technicians.

USSR Launches 21st In Cosmos Program

Moscow—Soviet Union launched the 21st satellite in the Cosmos series Nov. 12, and said its purpose was to study radiation and communications for additional manned space flights.

Cosmos 21 is in an orbit of 142.1—120.9 mi., with an inclination of 64 deg., 50 min. and a period of 88.5 min. Previous satellite in the series, Cosmos 20, was launched Oct. 18.

Meanwhile, Russia has not amplified its previous general remarks concerning what it called the maneuvering Polyot 1 satellite, which was launched Nov. 1 (AW Nov. 11, p. 28). As of late last week, there was no indication from the Soviet press that the satellite is in orbit or still transmitting.

Shortly after the launch, Mstislav Keldysh, president of the USSR Academy of Sciences, stressed the importance of maneuvering satellites for in-orbit rendezvous for extended space flight, and for landing at pre-selected points on the earth.

Soviet Cosmonaut Andrian Nikolayev, who recently married the Russian woman cosmonaut, Valentina Tereshkova, said last week in New Delhi, where the two are visiting, that the Soviet Union is planning a manned spacecraft capable of a three-year planetary trip to Venus or Mars. He said that the spacecraft "in all probability" will have an international crew.

Czech Agricultural Aircraft Designed for Good Visibility

First photo of the prototype Czechoslovakian Cmelak XZ-37 Big Bee agricultural aircraft (AW Sept. 23, p. 23) shows the cockpit placed forward and high for good over-the-nose visibility. Spray hopper is behind the cockpit, which places the pilot between it and the engine, a Soviet-built Ivchenko reciprocating engine with a multi-bladed cooling fan in front of the cowling. Engine, cowling and variable-pitch propeller layout is similar to that of the Russian Yak-12 general purpose aircraft. Gross weight of the aircraft is 3,748 lb., of which the chemical payload accounts for about 30%. Note large flap area. Spray bars and dust spreader apparently have not yet been attached. For a detailed report on the market for agricultural aircraft, see p. 116.

Controversial Australian Order For F-111 to Total $125 Million

By Herbert J. Coleman

Canberra—Australian purchase of 27 USAF/General Dynamics F-111A (TFX) tactical fighter bombers (AW Oct. 28, p. 21), which has become a controversial issue in the Nov. 30 elections, will total $125.4 million.

Defense Minister Athil Townley timed an announcement of the purchase price to counter opposition party demands that the TFX deal should be reviewed. Potential overseas sales of Great Britain's TSR.2 strike reconnaissance aircraft have been hurt by Australia's order for the TFX (AW Nov. 4, p. 32).

Townley said the purchase was the best deal the Royal Australian Air Force ever made. Negotiations with U.S. Defense Secretary Robert S. McNamara started after an RAAF team evaluated the TFX and TSR.2.

The U.S. price was about 40% less than the cost of 27 TSR.2s, according to Townley. His agreement, he said, included provision of spare parts, such as engines, for a year, plus the training of RAAF crews in the U.S.

First payment of 10% will be made immediately, Townley said. The rest will be spread over a number of years.

Meanwhile, the first three of 30 surplus Boeing B-47Es, leased by the RAAF without charge from the U.S. Strategic Air Command, have left Guam for Darwin to begin RAAF familiarization operations. The B-47Es will be used as interim replacements for Australia's Canberras. They were accompanied by a Boeing KC-135 jet tanker.

Arthur Calwell, leader of Australia's opposition Labor Party, attacked the TFX purchase as "a decision taken in less time than the average family needs to decide on the purchase of a new car."

He said the deal was made in a few days "for a bomber still in the development stage and one in which development difficulties posed by its design have not yet been overcome."

Calwell's party is given a 50-50 chance to take power from Prime Minister Robert Menzies, whose Liberal Party enters the Nov. 30 election with a two-seat majority.

Other negotiations have begun at the Woomera rocket range for use of its instrumented site for development flying of the TSR.2.

Correction

Electronic Communications, Inc., will provide electronic systems integration in a second generation of Strategic Air Command airborne command post aircraft using turbofan-powered KC-135Bs.

Award of a $1,091,400 contract from Aeronautical Systems Div. of USAF Systems Command calls for Electronic Communications to function as associate contractor with Boeing Co., builder of the aircraft. AVIATION WEEK & SPACE TECHNOLOGY erroneously identified International Electric Corp., a subsidiary of International Telephone and Telegraph, as the prospective recipient of the contract (AW Nov. 4, p. 23).

Electronic Communications is prime communications contractor for SAC airborne command post aircraft now operational.

Hydroxyl in Space

Washington—Massachusetts Institute of Technology scientists have detected and measured hydrogen combined with oxygen in emissions from interstellar space using the Millstone Hill radiotelescope.

The oxygen-hydrogen radical, called hydroxyl, was noted between Oct. 15 and Oct. 29 using the constellation Cassiopeia A as the radio source. Energy absorptions were recorded in the frequencies of 1,667.35 and 1,665.40 mc.

Astronomers have predicted the existence of the radical for some years. The MIT experiments, conducted by the Electronics and Lincoln laboratories, were the first actual detections and measurements.

Worldwide Comsat Frequencies Allocated

By Cecil Brownlow

Geneva—Frequency allocations marginally sufficient for operation of a world-wide communications satellite system were hammered through an extraordinary conference of the International Telecommunications Union here, despite early signs of Soviet foot dragging and evidence that Cuba may try to interfere with U.S. space communications efforts.

At the conclusion of the grinding, five-week session of ITU's Extraordinary Space Radiocommunications Conference earlier this month, the delegates agreed to allocate a total of 8,200 mc. to space communications—including 2,000 of the 2,725 mc. requested by the U.S., plus Russian proposals which indicate that the Soviet Union may be planning a synchronous satellite system of its own.

The conference made available a total of approximately 15% of the frequency spectrum to space research activities, compared with the 1% agreed upon at the ITU radio conference of 1959. The final protocol was signed by all delegates present, although almost every allocation is burdened by footnotes containing disclaimers and waivers on the part of one or more of the signatories. Implementation date for the new and revised allocations is Jan. 1, 1965.

While the conference gingerly avoided a number of anticipated political pitfalls, the most jarring note so far as the U.S. is concerned was Cuba's consistent refusal to agree to the new frequency allotments and a formal warning that the island country generally is unwilling to cooperate.

Should it refuse to adopt the new frequencies, as it has indicated that it will, Cuba's transmissions could play hob with at least a portion of the American space communications effort, particularly transmission and reception from stations located in the southern U.S. and in close proximity to the island.

Charging that the principles guaranteeing equitable participation by all countries have not been adopted and some of the clauses contained in the procedure for frequency notification and co-ordination do not satisfy the interests of Cuba, the country said it "formally reserves its complete freedom of action and the right to reject those provisions . . . which would be prejudicial to the interests of Cuba."

Allocations requiring the signatories to abandon already-established conventional uses over the frequency bands concerned almost inevitably carry with them a footnote disclaimer on the part of Cuba.

As an example, the delegates agreed to allocate the 136-137 mc. band to space research, primarily telemetry and tracking, with the individual countries gradually phasing out the current conventional services over this portion of the spectrum. The allocation, however, is followed by this typical footnote:

"In Region 2 (the Americas), the band 136-137 mc. is also allocated to the fixed and mobile services until Jan. 1, 1969. Thereafter, in Cuba, the band will continue to be allocated also to the fixed and mobile services."

The 1969 cutoff date mentioned here and in a number of other instances within the protocol was established primarily to ease the transition pains for countries that already have expensive equipment built to operate on these frequencies for more-conventional uses. Other waivers appear to be based primarily on practical and understandable reasons.

Desire aside, Cuba's ability to jam or interfere with U.S. space communications will depend largely upon the attitude of the Soviet Union and its willingness or unwillingness to supply its Western satellite with the necessary equipment. "They [the Cubans] could cause some damage," a U.S. official concedes, "if somebody gives them the equipment."

Cuba's demurrer was met by a strong objection from the U.S. and, to a lesser extent, Canada.

Noting Cuba's decision to disassociate itself from the decisions of other delegations from Region 2 with respect to certain frequency allocations, a U.S. protest declared that the U.S. "cannot accept . . . any obligation to observe the exceptions claimed by Cuba."

While Cuba rejected allocations, Russia quietly backpedaled from its initial stand that establishment of communications satellite frequencies should be delayed until 1965 or 1966 (AW Oct. 14, p. 35) or, at the very least, that any agreements reached at the Geneva conference should be provisional pending further studies of the problem.

At the same time, the Russian delegation headed by vice minister of communications A. Badalov requested and gained a communications satellite frequency band that a number of Western delegates interpret as a sign that the Soviet Union plans to establish a synchronous satellite system.

The band, 5,725-to-5,850 mc., could be employed effectively only over Region 1 (Europe, Africa and the Middle East) since these frequencies will continue to be employed for other purposes, including ham radio activities, in Region 2 and Region 3 (Asia and Australasia).

Under these conditions, a multi-satellite, low-orbit communications system ostensibly would have to be turned off while over the areas of Regions 2 and 3 where, in any event, reception would be marginal at best. This fact is a primary

Syncom Voice Quality Cited

Washington—Quality of voice transmission via Syncom synchronous orbit communication satellite has equaled that of either Telstar or Relay, according to Leonard Jaffee, director of the communication and navigation programs division of National Aeronautics and Space Administration.

Jaffee made his statement following the world's first international press conference via communication satellite on Nov. 8. Newsmen interviewed U.S. representatives to the meeting of the International Telecommunications Union in Geneva (see story) via Syncom. During the half-hour session, excellent reception was marred only by slight static at the outset. The time delay in communication was imperceptible. For a detailed report on Syncom 2's performance see p. 75.

At the time of the conference, Syncom was headed toward the north of its figure-eight orbit 22,000 mi. above the equator over mid-Brazil. The Geneva-Washington connection involved 1,100 mi. of conventional telephone line—from Geneva to the USNS Kingsport, stationed at Rota, Spain, and from the U.S. point of reception from Syncom at Lakehurst, N.J., to Washington.

Jaffee reported that the conference was over a four-wire connection to avoid the echo problem artificially. This meant that the telephone speaker in Geneva was directly connected to the earphone, and vice versa, the speaker in Washington was directly connected with the earphone. This device to avoid echo is not adaptable to an operational system. However, Jaffee was optimistic that echo suppression "can be effectively achieved" in an operational equatorial orbit system.

point behind the reasoning that plans for a stationary-orbit system led to the Soviet request.

Aside from such a system's propaganda potential in the prime target areas of Africa and the Middle East, one U.S. official here says that the Soviet Union's present internal communications network is readily adaptable to a Syncom-type operation and that, with the large land mass it must serve, the Russian government may be thinking largely in terms of improving the country's own national capabilities in this area.

A supplementary channel which also had Soviet backing—5,850-to-5,925 mc.—will be available for Regions 1 and 3 but not for the Americas.

Reasons behind the Soviet switch in agreeing to accept the Geneva decision as final and to allow the U.S. requests to pass with a minimum of fuss are still being debated by U.S. delegates, as is the over-all worth of the conference itself.

Formally and informally, the outcome is being termed by U.S. officials as satisfactory and adequate, although one spokesman admits that, "with all these footnotes to consider, it will probably be months before anyone can figure out how much real progress has been made."

The U.S., however, did gain a substantial portion of its requests, including most of its communication satellite proposals. In its initial presentation, the U.S. had proposed that the bands 3,700-4,200 mc. and 7,250-7,750 mc. be designated for satellite-to-earth transmissions and 5,925-6,425 mc. and 7,900-8,400 mc. for earth-to-satellite transmissions.

In slightly varied form, 3,400-4,200 mc. was approved for satellite-to-earth transmissions as was 7,250-7,750 mc. The band 7,900-8,400 mc. also generally was approved for earth-to-satellite communications, although in bits, and no action was taken on the 5,925-6,425 mc. request. Broken down, this is how the over-all allocations were made for direct communications satellite use:

- **3,400-4,200 mc.,** satellite-to-earth, but it must be shared with other users.
- **5,725-5,850 mc.,** earth-to-satellite, can be used only in Region 1 and must be shared.
- **5,850-5,925 mc.,** earth-to-satellite, can be used in Regions 1 and 3 only and must be shared.
- **5,925-6,425 mc.,** earth-to-satellite, for all regions, but must be shared.
- **7,250-7,300 mc.,** satellite-to-earth, for all regions on an exclusive basis.
- **7,300-7,750 mc.,** satellite-to-earth, must be shared with other users.
- **7,900-7,975 mc.,** earth-to-satellite, on a shared basis.
- **7,975-8,025 mc.,** earth-to-satellite, but on an exclusive basis.
- **8,025-8,400 mc.,** earth-to-satellite and shared.

Major non-political reversal in the U.S. effort was its failure to gain exclusive satellite rights to a wider range of the spectrum involved, primarily because other countries refused to abandon the bands completely to space since, in some instances, a substantial redeployment of conventional frequencies would have been necessary.

Both exclusive bands—one for earth-to-satellite and one for satellite-to-earth use—are fairly narrow in margin, one spokesman says. "We will use them as long as they are adequate and then, when they get over-crowded, we'll have to go to the shared bands where we may run into interference."

Other officials hope that, before this becomes necessary, a greater exclusivity may have been gained.

For a really world-wide system, one says "this arrangement is marginal at best. We need much more standardization."

An attempt to gain this and to cut down on the number of shared bands undoubtedly will be made during a scheduled followup ITU study group meeting in 1965 and still another plenary session sometime in 1966.

One possible answer to the problem of gaining additional exclusive communications satellite frequency rights may come from the adoption of little-used millimetric-wave bands within a rough range of between 31 and 35 gc. (kmc.) for this purpose. For the moment, these bands are virtually unused.

The ITU delegates, however, agreed to allocate a number of these bands for space research work in reply to overlapping requests from both the U.S. and the Soviet Union. At least insofar as the U.S. is concerned, a major portion of this work will involve attempts to improve reception and transmission capabilities for potential communications satellite use.

Approved space research bands in this area include 31-31.3 gc. (kmc.); 31.5-31.8 gc. (kmc.), shared in Regions 1 and 3 and exclusive in Region 2; 31.8-32.3 gc. (kmc.), and 34.2-35.2 gc. (kmc.). The bands 31.3-31.5 and 33-33.49 gc. (kmc.) have been reserved for radio astronomy applications.

Other primary space research bands agreed upon by the conference delegates include:

- **15,762-15,768** and 18,030-18,036 kc., both in response to Soviet requests.
- **30.005-30.010 mc.,** another Soviet request.
- **136-137 mc.,** shared in Regions 1 and 3 and exclusive in Region 2.
- **143.6-143.65 mc,** primarily for telemetry and tracking. This was a Soviet request.
- **267-273 mc.,** a Soviet telemetry request.
- **401-402 mc.,** a U.S. telemetry request.
- **1,427-1,429 mc.,** a U.S. telecommand request.
- **1,525-1,535** and 1,535-1,540 mc., U.S. telemetry requests.
- **1,700-1,710 mc.,** U.S. telemetry and tracking request.
- **2,290-2,300 mc.,** another U.S. telemetry and tracking request.
- **5,250-5,255 mc.**
- **5,670-5,725 mc.,** designated specifically for deep space probes.
- **8,400-8,500 mc.,** reflecting both Soviet and U.S. requests semi-exclusive in Region 2 and shared in Regions 1 and 3.

Anti-Satellite Briefing

Defense Dept. Research & Engineering (DDR&E) has been briefed by military technical planners and an Advanced Research Projects Agency-Columbia University team on various approaches for anti-satellite systems. Military presentations early this month involved these highlights:

- **Air Force favors a terminal homing stage lofted by a booster which would not be selected until Phase 1 studies were completed.**
- **Army proposes a modified Zeus vehicle employing propulsion system exhaust gases fed through jet nozzles for control purposes.**
- **Navy would use a sea-based Polaris missile to boost an intercept mechanism.**

The ARPA-Columbia presentation consisted of an analysis, without specific recommendations, of approaches for anti-satellite schemes being studied by various industry companies under contract to ARPA. These companies recently briefed ARPA on details of their various approaches (AW Oct. 14, p. 30). Columbia is assisting ARPA in the coordination of the study results.

Titan Vibration Fix

Air Force-Martin Titan 2 launched Nov. 1 was flown without measurable "pogo" effect—longitudinal vibrations—according to flight data analyzed last week. The vehicle in the 23rd development flight contained an accumulator-standpipe device designed to damp surges which cause oscillations in the oxidizer and fuel lines.

National Aeronautics and Space Administration placed a limit of ±0.25 on the resultant gravity peak (AW Nov. 11, p. 32) to qualify the vehicle for manned Gemini launches. USAF and Martin have been modifying test vehicles to reduce the gravity load.

The 24th test vehicle, scheduled for launch within the next few weeks, also will include the accumulator modification.

French May Alter Strike Forces By Including Strategic Missiles

Paris—French government is considering development of a surface-to-surface strategic ballistic missile for operational use in the late 1960s.

Originally, the French had planned their nuclear strike force in two steps (AW Mar. 11, p. 280). First, the force would be based on Dassault twin-jet Mirage 4 supersonic bombers armed with free-falling nuclear bombs. Secondly, this aircraft nuclear strike force was to be replaced in the late 1960s by a fleet of three to five nuclear submarines armed with Polaris-type missiles (AW Aug. 21, 1961, p. 32).

French officials now seem to judge that the nuclear submarine system won't be available until 1972, perhaps not until 1975. At the same time, there is a growing conviction that the Mirage 4 bomber, deliveries of which begin in January, will be less valid in the late 1960s as a strategic weapons system.

The possibility of this "weapons systems gap" has been recognized by French officials for some time. Some have favored extending the life of the Mirage 4 weapons system by development of a Blue Steel-type of standoff air-to-ground bomb.

Others have pushed instead for the development of a ground-to-ground ballistic weapons system.

Defense Minister Pierre Messmer, despite the revelations by informed deputies concerning the middle-stage nuclear strike force, made no reference to the project in his intervention in the military debate. Messmer did say that French technicians had solved, or were about to solve, ballistic missile problems of propulsion, guidance and reentry. He made no comment on French studies concerning miniaturization of nuclear warheads for such missiles.

Deputies sitting on the Assembly Defense Committee, however, were more revealing in their statements during the military debate. Gaullist Deputy Joel Le Theule, reporting for the Defense Committee, told the Assembly it appeared the government had abandoned the possibility of arming the Mirage 4 with a stand-off missile and was instead moving ahead on a ground-to-ground strategic missile. "The Mirage 4," he said, "without doubt will be the last strategic aircraft France builds."

Deputy Pierre Clostermann, one of the more outspoken advocates of arming the Mirage 4 with an air-to-ground stand-off weapon, also admitted the government had moved away from this solution.

Other remarks by deputies who had been briefed on government thinking indicated the French ground-to-ground strategic missile would be similar to the U.S. Polaris A-2 missile and probably would be deployed in France at hardened sites rather than mounted on mobile carriers.

Other military details revealed in the budget debate were:

Actual payments in the 1964 budget for development of France's nuclear armament totaled $737 million. This total breaks down into $516 million for studies dealing with nuclear weapons and missiles, $105 million for Mirage 4 bombers and Boeing KC-135 tankers, $23 million for propulsion studies, $88 million for test operations and $5 million for studies on nuclear submarines.

These 1964 credits earmarked for nuclear armament account for 40% of the military budget and 3.9% of the overall budget. From 1960 through 1964, the French have paid out $1.6 billion for nuclear armament. This figure, however, does not include the country's isotope separation plant at Pierrelatte which will supply France with weapon grade, enriched uranium in the late 1960s. To date, Pierrelatte has cost $1 billion.

Deliveries on the Mirage 4 production aircraft will get under way in January and 20 of the 50 aircraft on order will be delivered to the French Air Force in 1964. The government also disclosed it intends to order an additional 12 Mirage 4 bombers, probably with more powerful engines. This will bring the total Mirage 4 bomber fleet to 62 production aircraft.

Deliveries of the 12 Boeing KC-135 tankers will also begin in January and will be completed by the end of 1964.

French VTOL Plans

Paris—Dassault Mirage 3V fighter, currently in the prototype stage, will cost about $8 million per aircraft, according to French Defense Minister Pierre Messmer. He noted that this unit cost figure is six times greater than the Mirage 3F strike fighter, the latest Mirage version.

"Therefore we won't be building many of these," Messmer said. The defense minister added that such an expensive aircraft would be meaningless militarily if it weren't armed with nuclear weapons. "This is our intention," he told the French Assembly.

The Defense Minister didn't elaborate on the philosophy of using such a short-range aircraft for nuclear missions, nor was his statement commented on in the long Assembly debate that followed.

News Digest

Navy completed evaluation of bids on its interim light attack aircraft on Nov. 14 and forwarded recommendations to Defense Secretary Robert S. McNamara. Douglas, Grumman, Chance Vought and North American are bidding on the aircraft (AW Aug. 12, p. 26).

Fredrick B. Ayer & Assocs., Inc., aircraft dealers, has bought General Dynamics/Convair's last new 990A jet transport for $6.5 million. The aircraft, built to fill a Swissair order which was cancelled, has been modified to carry 119 passengers. It will be leased to Aerolineas Peruanas (APSA) over a seven-year period during which the airline has an option to buy it outright (AW Oct. 7, p. 128). Beginning Dec. 1, APSA will inaugurate jet service between Miami, Mexico City and Buenos Aires via Lima.

Philco, Ling-Temco-Vought and RCA have been selected from 216 firms for a final competition in which NASA will select a prime contractor to provide administrative and management services for the Merritt Island Launch Area. One-year contract, which may be renewed for an additional two years, will be worth about $2.5 million.

Dr. Donald F. Hornig, a physical chemist, will succeed Dr. Jerome B. Wiesner as special assistant to President Kennedy for science and technology. Wiesner will return to the Massachusetts Institute of Technology as dean of the School of Science.

Edward J. Williams, Rockwell-Standard Corp. vice president, is directing operations of Rockwell's Aero Commander Div., succeeding Thomas J. Harris, former aero commander vice president-general manager, who resigned last week to seek the Republican nomination for senator from Oklahoma.

Uncontrolled 12,000-ft. dive by an Eastern Air Lines DC-8, which lost an engine during pull-out, was under intensive investigation by the Civil Aeronautics Board last week. Six of 128 persons aboard were injured when the aircraft, 8 min. after departure from Houston, Tex., suddenly plunged from 18,000 ft. while in an area of extreme turbulence. Abruptness of the recovery at 6,000 ft. tore the number three engine and pylon from the wing. CAB investigators said examination of the aircraft after it made an emergency landing at Barksdale AFB, La., disclosed that rivets were loosened on two of the aircraft's remaining three engines.

Pan American Is Awarded Tahiti Route

Board skirts basic issues; action in three cases is viewed as move toward regional type competition.

By L. L. Doty

Washington—Civil Aeronautics Board decisions in the Transpacific Route Case released last week, which give Pan American World Airways traffic rights in Tahiti but shelve all other phases of the case, are being viewed here as another Board move toward the concept of regional competition.

Three decisions, involving international and domestic operations in the Pacific area as well as the U.S.-Tahiti route, were issued separately but are closely interlocked.

The orders were adopted by the Board Aug. 7 and signed by President Kennedy Nov. 7. The decisions leave open for future settlement the basic issues in the case—addition of a third carrier on the transpacific route, and certification of Western Air Lines into Hawaii. But there is a strong hint that division of competition between U.S. carriers will be a guideline to any further decisions.

Key to the pending U.S.-South American and Transatlantic Route Cases is the announced aim of curtailing or eliminating duplication of competition in the major markets of these areas (AW May 28, 1962, p. 38). In this connection, the Board earlier this month proposed separation of competition on the intra-island Hawaiian routes between Hawaiian Airlines and Aloha Airlines.

The case has become clouded by a sharp split over the issues at stake between Board members, along with a lack of firm understanding of the White House position in the case. The President has approved the decisions in the international phases, but has no jurisdiction over the domestic phase of the case.

In 1959, former President Eisenhower directed that proceedings be undertaken in the Transpacific Case to provide "greater competition among U.S. flag carriers in the Pacific." In January, 1961, he reversed his stand and told the Board that he was persuaded that "our foreign relations would be adversely affected were we at this time to add second carriers on our major routes to the Orient" (AW Jan. 30, 1961, p. 38).

The stand of the present Administration on this issue with respect to the Pacific area is still unknown, although there have been repeated implications it would not tolerate air route adjustments that curtail competition as a general principle. President Kennedy's approval of the decisions in the Transpacific Case suggest that the Administration believes foreign policy considerations in this area take precedence over competitive factors.

This lends support to the Board's current drive to implement the concept of regional competition.

Split vote in the Transpacific Case indicates that the road to a division of competition will not be smooth. Chairman Alan S. Boyd and Member Chan Gurney voted to certificate Western Air Lines into Hawaii, while Members G. Joseph Minetti and Whitney Gillilland voted against certification.

Vice Chairman Robert Murphy did not participate in the case but, to break the deadlock, familiarized himself with the record to qualify to vote. He joined Minetti and Gillilland. Similarly, he entered the international phase of the decisions to break a tie on some issues in this opinion.

Pan American was awarded a certificate to provide single-plane service between the U.S. mainland and Tahiti and to serve Tahiti on its transpacific route between the U.S. and New Zealand-Australia. It will be the first time that competition has been offered the French carrier TAI, which was recently merged with UAT to form UTA (AW Nov. 11, p. 46).

Pan American was selected over South Pacific Airlines, which now operates between Hawaii and Tahiti. Minetti concurred and then dissented in the case, holding that South Pacific routes should be extended to the mainland. However, Pan American has an application on file with the Board to purchase the South Pacific Honolulu-Papeete certificate.

Last week, a South Pacific spokesman told AVIATION WEEK & SPACE TECHNOLOGY that the airline has fully accepted the fact that, once Board approval of the application is granted, South Pacific will be completely absorbed by Pan American. South Pacific inaugurated the Hawaii-Tahiti service in April, 1960.

In the majority decision, the Board held that the proposed extension of South Pacific's route to the mainland would be "immensely" unprofitable and would result in either a request for subsidy or in the carrier's "early demise."

The Board concluded that the award of the Tahiti route to Pan American would strengthen the U.S. flag carrier position in the South Pacific in these two ways:

First, it would enable Pan American to tap a new source of traffic. Second, inclusion of Tahiti as an intermediate point on Pan American's South Pacific route would allow the carrier to operate a more efficient and attractive pattern of service in competition with foreign flag carriers.

In this connection, Qantas Empire Airways of Australia and Canadian Pacific Airlines operate the route only via Honolulu without the right to carry local traffic between Honolulu and the U.S. Australia once argued that its bilateral agreement with the U.S. included Tahiti as an intermediate point on its route, but later dropped this position when the U.S. dissented.

TAI serves both Tahiti and Honolulu but serves only Los Angeles in the U.S. where it connects with Air France to give France an around-the-world operation.

A major advantage of the Tahiti stop to Pan American is that it provides the carrier with a Great Circle course between Los Angeles and New Zealand. Interior Dept. had urged the Board to restrict Pan American to a pattern that would include American Samoa on the route but the Board rejected this recommendation on grounds that the proposal is "not part of the evidentiary record in this case."

In its ruling on the international phase, the Board stated that the Transatlantic Route Renewal Case could have a substantial bearing upon the redefining of the Pacific route structure. It added:

"In our opinion, it would not be timely to institute a re-examination of the American-flag route pattern in the Pacific until additional experience with jet operations in that area by both domestic and foreign-flag carriers has been accumulated and there has been an opportunity to assess such experience in the context of the related developments" in air transportation.

In this statement, the Board indicates that it now appreciates the full effect of jet operations on world-wide operations, that it no longer is feasible to analyze international route patterns on a provincial basis, and that the various markets of the world are indirectly related as a result of the range and speed of the jet aircraft.

The statement also suggests that the Board's views on the regional concept of competition, documented in the Transatlantic Route Renewal Case, may well be applied to the Pacific and that its current decision in the Transpacific Case is not final.

In the domestic phase of the case, the Board apparently has received no guidelines from President Kennedy, since it still adheres to the advice handed down by Eisenhower early in 1961. Admitting that he had no domestic jurisdiction, Eisenhower expressed the hope that the new carrier granted authority to serve Hawaii would be one "customarily engaged in international commercial aviation in the Pacific . . ."

Governments Discuss Atlantic Fares

Washington—North Atlantic fare dispute last week moved into the hands of governments despite optimism expressed by a special airline working group meeting in New York that a compromise solution was in sight.

Lead in the drive to settle the rate differences was taken by the U.S. last week when a delegation led by Alan S. Boyd, Civil Aeronautics Board chairman, went to Europe to discuss the issues with governments of Ireland, Britain, Italy, Germany, France and the Scandinavian nations. Meanwhile, the special working group named by International Air Transport Assn. traffic conference at Salzburg (AW Nov. 4, p. 45) to attempt to reach an agreement on fares reported progress on its mission in New York.

Earlier this month, Boyd talked with Canadian government officials in Ottawa and returned with the report that Canada may be willing to ease its original firm stand for an extremely low fare level on North Atlantic routes. Trans-Canada Air Lines' drive for a new tariff structure was one of the reasons that the Salzburg traffic conferences were terminated in deadlock (AW Oct. 7, p. 27).

Accompanying Boyd on the European trip are Robert Murphy, Board vice chairman; Albert Stout, who was CAB observer at the conferences, and Allen Fergusen of State Dept.

Mockup Shows DC-9 Cockpit Arrangement

Cockpit mockup of Douglas Aircraft Co.'s DC-9 short-haul jet transport shows two-man arrangement which has been approved by Federal Aviation Agency pending flight demonstration (AW Oct. 21, p. 37). The cockpit features a master caution and warning light system for both crewmen. These lights (mounted atop the glare shield) indicate an abnormality in any system. The malfunction can then be located by referring to a warning and caution light panel located on the overhead console between the pilots. Standard-dial flight instruments are used, with engine instruments grouped in the center of the forward console and flight instruments in front of each pilot. Note the clipboards attached to the control columns for attachment of charts and other data.

TWA Orders Eight More SSTs

New York—Trans World Airlines has ordered eight more supersonic transports, raising its total on order to 14, with a downpayment investment of $1,750,000.

Four of the latest order are for the Anglo-French Concorde, with TWA receiving delivery positions 22, 32, 34 and 38 (AW Nov. 4, p. 41). It paid $750,000 to Sud Aviation and the British Aircraft Corp. to firm the positions.

The other four orders, involving a $400,000 down payment to the Federal Aviation Agency, are for the proposed U.S.-built transport. Six of these were ordered earlier by TWA with a $600,000 deposit (AW Oct. 21, p. 38).

The Concorde order was made despite TWA's expressed dissatisfaction with the delivery schedule offered by the European manufacturers. Charles C. Tillinghast, Jr., TWA president, had told a Senate Subcommittee that TWA was denied deliveries comparable to those granted Pan American.

This was denied by Gen. Andre Puget, head of the joint French-British Concorde project. He said TWA's scattered delivery positions were the result only of the carrier's delay in picking up a more advantageous arrangement offered earlier for six aircraft.

TWA's Concorde order was influenced largely by concern over giving Pan American too great a lead time in supersonic introduction. Pan American has ordered six Concordes and 15 of the U.S. model.

The longer the U.S. program drags, TWA officials said, the less chance there is that a U.S. product can be built by the time Concorde is ready for service. TWA can't risk Pan American's getting an advantage with the Concorde in a market as competitive as that across the Atlantic, they said.

Northeast Leases Jet Equipment, Plans 18 Daily Flights to Florida

New York—Northeast Airlines is leasing jet equipment from Trans World Airlines to capture a larger share of the winter tourist flow to Florida.

The lease will enable Northeast to schedule 18 daily jet flights, three times the number currently operated with its four Convair 880s. Expanded service, which starts Dec. 18, will include nine New York-Miami nonstops daily.

TWA is providing a Boeing 707-320B for one round-trip three days a week between Dec. 20 and Apr. 30. The aircraft is in 159-seat Military Air Transport Service configuration with three-abreast seating throughout.

A TWA Convair, starting Dec. 15, will fly from New York to Miami four nights a week. The Convair will be replaced by a Boeing from Jan. 15 to Mar. 15, the end of the lease term.

The aircraft will retain their TWA markings but will be flown by Northeast crews, some of whom were qualified on Boeings in 1959 in an earlier lease arrangement with TWA. Flights will be mostly "tail end time," with the Florida service consuming time that otherwise would go to nightly layovers.

Northeast's action erased the possibility that National Airlines and Eastern Air Lines would have the New York-Florida route virtually to themselves this winter. With their greater capacity, the two carriers could have provided a service pattern which Northeast would find difficult to match with only four 880s.

Observers interpret the lease as another attempt to prove to the Civil Aeronautics Board that Northeast has a rightful place on the Florida route. Most sources, however, feel it will have no effect in swaying the Board from its order that Northeast quit the market.

Northeast is still on the route only because it took the CAB's order (AW Aug. 5, p. 42) into the U.S. Court of Appeals at Boston. The court ruled that Northeast could continue through the winter while the matter was in litigation, and the CAB did not object.

Most observers also feel that the Hughes Tool Co., which owns 80% of Northeast's stock, is again lending financial assistance to the carrier. The tool company stopped underwriting the airline's daily operating expenses after the CAB decision (AW Aug. 12, p. 41). Reference to Hughes Tool's continued support was made by M. Willson Offutt, vice president of traffic and sales for Northeast, in announcing the lease.

"This stepped-up winter schedule on the Miami route has been made possible by steadily increasing public demand and by the continuing support of Northeast's principal stockholder, the Hughes Tool Co.," Offutt said.

Persons familiar with the Hughes Tool-Northeast relationship say the tool company is probably guaranteeing the lease payments for the TWA aircraft. The tool company can also be expected to finance Northeast's advertising through the winter season, they said.

Hughes Tool's influence in Northeast was further evidenced last week when seven new members were added to the airline's board of directors, bringing its total membership to 16.

Elected were Raymond M. Holliday, executive vice president of Hughes Tool; Maynard E. Montrose, vice president of Hughes Tool and president of its Oil Tool Div.; F. William Gay, a Hughes Tool vice president; Chester C. Davis, Raymond A. Cook and Gregson Bautzer, legal representatives for the tool company, and Robert E. Montgomery, vice president of marketing for Hughes Dynamics.

Montgomery only recently resigned his position as sales vice president for TWA's international division with offices in Paris.

India Landing Fees

Indian government has approved a proposal made earlier this year that landing fees at the country's airports be increased to almost twice the current level (AW Feb. 4, p. 40).

The new cost for landing aircraft of the Boeing 707 and DC-8 class will be $294. The previous cost of $157.50 was among the lowest in the world. Revenues resulting from the increase should double the $52,500 currently received in landing and parking revenues at Bombay's Santa Cruz airport.

Air Union Meeting

Paris—Four European governments involved in the creation of the proposed Air Union—France, West Germany, Belgium and Italy—are planning a top-level conference in February in a new attempt to overcome obstacles blocking creation of the union.

Several previous meetings between representatives of Air France, Lufthansa, Sabena and Alitalia have failed to settle disputes over a revenue-splitting quota. The top-level governmental conference, which probably will be held in Brussels, was decided on recently by Common Market ministers meeting in the Belgian capital.

Senate Unit Approves SST Funds

Washington—Senate Appropriations Committee last week approved $60 million for initial phases of the Federal Aviation Agency's supersonic transport program. The committee also restored more than one-third of the money cut earlier by the House from the FAA and Civil Aeronautics Board Fiscal 1964 budget requests (AW Nov. 4, p. 43).

Approval of the supersonic transport funds was the sole point on which the Senate and House subcommittees agreed, opening the way for FAA's proposal to select and finance detailed design studies on the aircraft next year (AW Oct. 14, p. 39).

House attempts to reduce sharply both local service airline and helicopter subsidies met resistance from the Senate subcommittee, which restored $6.7 million of an $8.7-million slash in the CAB budget voted by the House. FAA also regained $20 million of a total $64.5-million reduction imposed by the House.

Senate floor action on the appropriations is expected this week, and the final totals for both agencies will be worked out by House-Senate conferees.

Total CAB appropriation recommended by the Senate committee was $92.1 million, compared with House approval of $85 million. Of this total, the House reduced the Board's projected subsidy needs to $75 million, with a strong recommendation that the industry's three subsidized helicopter operations be limited to $1 million each, compared with the previous year's budget of $5.7 million. The Senate committee voted to raise the helicopter funds to $5 million and gave CAB all but $2 million of its requested $83-million subsidy need.

FAA recaptured part of its appropriations loss, but did not fare as well as CAB. The Senate committee approved a $770.2-million budget for the agency, restoring $20 million of a House cut, but leaving FAA $45 million short of its requested $815-million budget request. An estimated $9.2 million of the restored funds were for air traffic control and other facilities, with the Senate committee voting $525 million, compared with a House figure of $515.7 million. FAA had requested $545 million for this purpose.

The Senate committee also restored $10 million of a $15-million House cut in research and development funds. Under the Senate report, FAA will receive $45 million of the $50 million FAA sought for this purpose.

AIR-INDIA INTERNATIONAL is now flying its six Boeing 707s an average of 11 hr. daily, a top mark among aircraft powered by Rolls-Royce Conway engines. Maintenance work on engines is performed at Air-India's overhaul facility that opened this year.

Air-India Pushes Route, Fleet Expansion

By James R. Ashlock

Bombay—Air-India International, self-sufficient in the maintenance and operation of its six Boeing jet transports, is proceeding toward route expansions and doubling its all-jet fleet by 1970 (AW Sept. 30, p. 47).

The airline has $24 million in foreign exchange reserves, from which the government has authorized the acquisition of one new Boeing per year through 1969. The first of these, equipped with Pratt & Whitney JT3D-3 powerplants, is scheduled for delivery next spring.

Air-India is now expected to make a strong bid to become a round-the-world operation. Japan's easing of currency restrictions on pleasure travel has revived interest in activating the Tokyo-U.S. route (AW Jan. 16, 1961, p. 40), which Air-India can fly under existing bilateral rights.

However, the carrier's management sees little economic value in this route without authorization to link either Los Angeles or San Francisco with its service from New York. Negotiations on crossing the U.S. may be requested next year, Air-India officials said.

Sydney Route

The airline is considering an extension of its Sydney route to New Zealand and Fiji. B. R. Patel, general manager of the airline, said Fiji offers a prime revenue potential from the concentration of Indian nationals who settled there years ago. It is also a regular stopover point for much of the growing tourist flow to Tahiti.

Making the homeland accessible to Indians abroad is also the reason Air-India hopes for routes into West Africa. This area contains Indians like those who spread throughout the British Empire in quest of better fortunes. West Africa would be reached by extending the route which now terminates at Nairobi, Air-India's only service point south of Cairo.

If Air-India does move into West Africa, Patel said, the next conceivable step would be across the South Atlantic into South America, and perhaps on into the Caribbean. But this, he admitted, is very long-range planning and doesn't fit into the more immediate picture.

The airline must first, management sources said, bring existing service to a more competitive level. Paramount in this drive is initiation of daily, year-round service between New York and London. Four flights a week are currently flown on this segment. The New Delhi-Moscow frequency may be increased to two a week, although Air-India sees little economic reason to activate the Moscow-London route at this time.

Its new Boeings will help Air-India attain better service frequency. The airline is already making a profit with its six jets—$7,257,000 in the year ending Mar. 31—and its officials foresee even better returns in coming years due to a general stabilization of costs.

Air-India's operating revenues rose to $51,527,000 in Fiscal 1963, up almost $6 million. But its operating expenses, excluding interest on loans, increased by less than $1 million to $44,270,000.

Of $20,430,000 borrowed from U.S. commercial banks and the World Bank for equipment, Air-India has repaid $10,320,000 and expects to retire the balance by 1966. The latest loan of $11,040,000 for new equipment will be repaid in five years, with payment commencing in late 1964.

The airline is in a good position for effective cost control, its officials said. Its aircraft are all Boeings and are flown an average of 11 hr. daily. No increase in maintenance or engineering forces is needed for planned fleet expansion. And the carrier is now performing all functions with its own personnel.

Before its $1,050,000 engine overhaul facility was opened at Santa Cruz airport this year, Air-India was shipping its Mk. 508 Conway engines back to Rolls-Royce at Derby, England, for overhaul. The time-between-overhaul (TBO) was 2,500 hr., and the higher English labor costs and practice of using new components to replace worn ones was costing $28 per TBO hour.

Reduced TBO Costs

With its own plant, where mechanics earn an average of $70 a month, Air-India can do the same work for about $7 per TBO hour, and the Conways are up to 3,500 hr. Because of foreign exchange restrictions, Air-India's parts stockpile is held to a minimum. Consequently, many components that would be discarded elsewhere and replaced are instead repaired and used again, saving more funds.

K. G. Appusamy, engineering manager, stressed that Air-India is not cutting corners on maintenance despite its economy practices. For instance, the airline's 800 mechanics are supported by 200 inspectors, an unusually high ratio.

"We believe in 100% quality control," Appusamy said. "We leave nothing to a mechanic's final judgment."

The $70 monthly income for mechanics, and $200 for inspectors, appears low by Western standards. But it is good money in India where the average annual income per capita is $64.

Mechanics are drawn primarily from

the Indian Air Force, and must have five years of experience before Air-India will accept them. They receive a year of schooling from the airline before attaining full mechanic status. The inspectors are mostly professional engineers who began training with Air-India while still undergraduates in Indian universities. The 30-man engineering force consists of graduate engineers, who received a three-year post-graduate course at the airline.

The overhaul facility reflects Air-India's emphasis on cleanliness. All equipment looks new. Because of dust problems in the dry season, buildings are air conditioned and a large cleaning force scours floors and machinery repeatedly. When an engine is dismantled, all parts are scrubbed before inspection.

When Air-India sent its Boeings back to Seattle for tail section modifications two years ago, William M. Allen, president of Boeing, wrote Patel complimenting him on the cleanliness and over-all good condition of the aircraft.

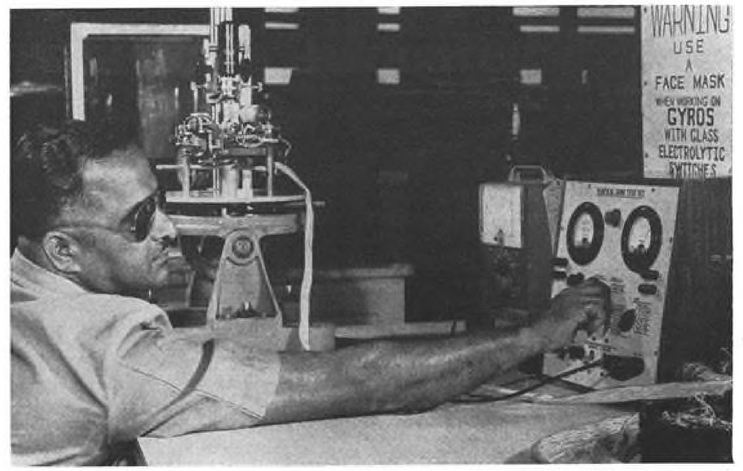
The maintenance base adheres to the standards of India's Director General of Civil Aviation, which patterns its criteria on the British Air Registration Board. The airline went a step further and gained Federal Aviation Agency endorsement of its plant, the first granted to such a unit in the Far East. An FAA inspector from Beirut visits the facility every three months.

Appusamy said that with only six aircraft and 38 engines to maintain, approximately 40% of the maintenance force's time is idle. Only three engine overhauls a month are performed by a staff capable of handling twice that volume. Some of the margin is taken up by maintenance of the Air Force's eight Constellations and C-119 transports, but there is still idle time.

Consequently, the present force is adequate to handle the proposed fleet expansion, plus the engine overhaul for the three Caravelles that will go into service this January on India's domestic carrier, Indian Airlines Corp.

Air-India is making trial TBO runs on its Conways up to 3,900 hr., Appusamy said, and will soon ask for clearance to advance the overhaul cycle to this level. He feels the Conway TBO will stabilize at about 4,000 hr. Only one premature engine removal is being encountered in each 8,000 hr. of engine operation at present.

Seven of the 14 spare engines are kept as "insurance powerplants" at London, New York, Sydney, Tokyo, Nairobi, Moscow and Rome line stations. Spares at Hong Kong and Singapore are Air-India's contribution to an engine pool with British Overseas Airways Corp. and Qantas. The airline also maintains spares at six stations for the parts pool set up by a number of international carriers.



INSTRUMENT OVERHAUL at Air-India is performed with test stands built on the premises. Foreign exchange restrictions discouraged purchase of completed units, so the airline bought blueprints and components. Completed units are encased in wooden stands like the one shown in above photo.

Boeing airframes are block overhauled each 3,000 hr., which falls due each eight months since they average 4,000 hr. of utilization a year. Overhaul requires 10,000 mechanic manhours during a two-week period. Air-India is asking that the airframe TBO be advanced to 4,000 hr.

The JT3D-3 engine on the Boeing due next year marks Air-India's first departure from Rolls-Royce turbojets. The American engines will power all of the aircraft Air-India plans to order, since they provide the longer range which the airline feels it will need as routes are extended. Conways will be retained on aircraft flying shorter routes.

"We particularly need the capability to overfly the Middle East," Appusamy said. "Uprisings there result too often in airports being closed temporarily, disrupting our service. With the Pratt & Whitney engines, we can reach India non-stop from Europe."

Air-India uses four-man cockpit crews —two pilots, a flight engineer and navigator. Doppler radar may be installed as a navigation aid, but operations officials said the navigator would still be retained to operate it.

"We're not interested in raising the work load of pilots to the extent of them doing their own long-range navigation," said Capt. K. Vishvanath, operations manager. "And if the navigator saves us a few minutes of fuel on every flight, he is paying for himself."

All members of Air-India's 40 cockpit crews are Indians, a condition long required by the airline's chairman, J. R. D. Tata. Pilots are drawn mainly from the air force and Indian Airlines Corp., and many received their initial training in government-subsidized flying clubs. The average monthly flight time for Air-India pilots is approximately 60 hr.

Pilot candidates must have 4,000 hr. of flight time, of which 1,500 must be in command of multi-engine aircraft. An instrument rating is also required before Air-India will consider an applicant.

First officer students undergo six weeks of ground school and 25-30 hr. of training on a Boeing simulator built for Air-India by Curtiss-Wright Corp. Flight training involves 10-15 hr. of local flying, then 100 hr. of route supervision. Refresher checks are performed each six months.

Captain candidates, selected by seniority from among the first officers, undergo the "command course." Two weeks of ground school is followed by 25 hr. in the simulator and 20 hr. aloft. Route supervision takes up another 300 hr., and then the candidate returns to Santa Cruz for 5 hr. of "polishing up."

The first time a new Air-India captain takes a Boeing aloft unsupervised is confined to local flying, in which he practices command procedures without a check pilot aboard. Even after he is a captain, he must undergo a check ride on any route he hasn't flown in six months if he has won a bid to fly it.

Eight first officers have failed to pass Air-India's "command course," and Vishvanath has even demoted two captains for landing at airports when weather conditions were below minimums. This has caused some reaction from the Indian Pilots Guild, to which all Air-India pilots belong. But Vishvanath has been upheld by the pilots.

Vishvanath allows only captains to make landings on scheduled runs, stressing that smooth touchdowns promote passenger confidence. In 3½ years of jet operation, Air-India has not had an accident.

SHORTLINES

► **Allegheny Airlines** reported net earnings of $82,227 for the third quarter of 1963, compared with $321,929 in the same period last year. The carrier said that results in the 1962 third quarter were inflated because of the Eastern Air Lines strike.

► **Civil Aeronautics Board,** Interstate Commerce Commission and Federal Maritime Commission staff members have met with the chairmen of these agencies to report on the progress of current studies of regulatory problems affecting over-all transportation systems. The joint study was undertaken in response to President Kennedy's request last year that some action be taken to improve the regulatory process.

► **Continental Air Lines** operated an estimated 103 million revenue passenger miles in October, a 27% gain over the volume flown in the same month last year.

► **Ethiopian Airlines** has increased its Madrid-Addis Ababa flights from two to three weekly. Flights presently are operated with Boeing 720B fan jet transports.

► **Federal Aviation Agency** will begin moving into its new headquarters next weekend. The new building, located at 800 Independence Ave., S. W. in Washington, will house headquarter office personnel under one roof for the first time. Agency now maintains units in nine different locations in Washington and Virginia.

► **Irish International Airlines** is introducing a deferred payment plan for regular or group fares at an interest rate of 4.25%, which, the carrier claims, is the lowest available in the airline industry. The plan, called the Shamrock Thriftair, calls for a 10% down payment with the balance to be paid over two years.

► **Northeast Airlines'** centralized reservations system, using the automatic call distributing system, has been placed into operation. The centralized reservations office, located in Boston, receives calls that have been dialed locally from 23 cities. System was developed by Bell Telephone Laboratories.

► **Pacific Southwest Airlines** reported net earnings of $1.6 million for the first nine months of 1963, a 62% increase over the same period last year. Revenues rose 27% during the comparative periods.

AIRLINE OBSERVER

► Alitalia agreement to purchase three U. S. supersonic transports has not inspired the rash of foreign orders for the aircraft anticipated by aviation officials although Australia, Holland and Japan are known to be interested (AW Nov. 4, p. 43). Feeling is that most nations are waiting for more comparative details of configuration, cost and performance of the U. S. supersonic transport and the French-British Concorde before making any cash commitments, even at the risk of losing early delivery positions. Alitalia, which placed a $300,000 down payment with the Federal Aviation Agency for delivery positions, will not order the Concorde.

► **Report of a breach between Civil Aeronautics Board and Federal Aviation Agency was bolstered when FAA failed to include CAB in the special working group developing technical details of a U. S.-Russian bilateral air transport agreement (AW Nov. 11, p. 45). Board will issue the foreign air carrier permit to Aeroflot when and if the agreement is signed, but has not attended the two meetings of the group consisting of Coast Guard, Pan American World Airways and State, Commerce and Defense departments.**

► Pratt & Whitney Research Center studies on supersonic transport engine noise involve a hypothetical aircraft of 380,000 lb. gross weight, which could take off in ¾ mi. and reach 3,000 ft. at 3 mi. from brake release, minimizing the noise on the ground. Such performance would require four engines exceeding 40,000-lb. thrust each.

► **Thai International Airlines will return two Convair 990 transports to Scandinavian Airlines System in January when it receives the two Sud Caravelles it will lease from SAS. Technical problems of the 990s, plus the necessity for sending them to Stockholm for maintenance and overhaul, hampered Thai's operation of the Convairs. SAS will place the returned aircraft on its routes to Africa and South America.**

► Japan has rejected a Pakistani bid for landing rights in Tokyo on the Pakistan Airlines route from Karachi to Tokyo via Red China. Despite Pakistani confidence that the route would be inaugurated next spring (AW Oct. 21, p. 43), the Japanese move was expected by Western observers because of Japan's fears of straining its trade relations with the U. S. Pakistan Airlines will operate the first segment of the route as planned, however, terminating flights at either Peking or Canton.

► **United Arab Airlines took a major step forward in its route expansion program last week with the signing of a bilateral air transport agreement between Egypt and France. Major provision, in addition to the right to serve Paris, is the grant of rights for the airline from Paris to New York. Bilateral also represents an easing of tension between the two countries inspired by France's close ties with Israel, and would pave the way for free transit of passengers between Arab nations and Israel.**

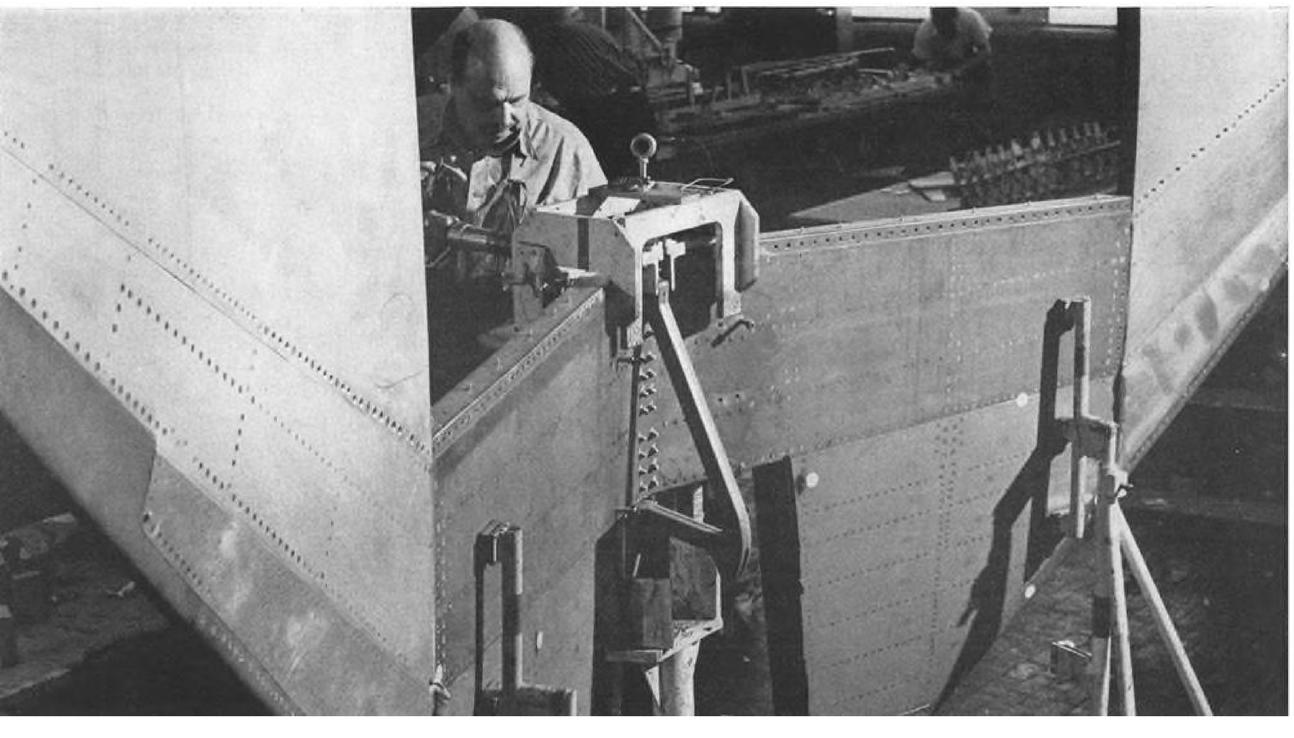
► National Airlines has signed an agreement to purchase seven Boeing 727 turbofan transports with an option for an additional three. Purchase price of $30 million for the seven aircraft will not require additional equity financing by National. Carrier now operates 13 Douglas DC-8 turbojet transports and 17 Lockheed Electra turboprops.

► **Russia's Aeroflot has inaugurated the Tu-124 turbojet transport on international routes. Flights will be operated from Moscow to Vienna, Stockholm and Helsinki. Aircraft have been in domestic service for about one year.**

► Federal Aviation Agency has warned pilots to be on the alert for the annual migration of Whistling Swans during mid-November. Migrating flocks, which consist of 50-100 birds at altitudes below 10,000 ft., follow southeast flyways from the Great Lakes to Chesapeake Bay where they concentrate between the Potomac and Susquehanna rivers. Collision with a Whistling Swan was blamed for the November 23, 1962, crash of United Air Lines Viscount near Ellicott City, Md. (AW Apr. 8, p. 106).

Phantom aft fuselage section *(above)* and stabilator *(below)* being assembled at Republic Aviation Corp., under subcontract for McDonnell, are 25% titanium, must withstand jet wake heat.

Titanium SST concepts get rugged test on fabulous Phantom



Tomorrow's design problems being solved by today's Navy-Marine-Air Force Fighter

Hidden in the tail section of the McDonnell F4B/F4C Phantom, back where the hot jet wake sets the thermal pace, are titanium structures. Like a buried treasure-map, they carry directions to tomorrow's Mach 3, high-performance aircraft.

A total of 531 pounds of titanium is used in the aft fuselage section alone—more than 25% of its weight. It is used in key areas . . . where titanium's qualities of strength and low weight, toughness, stiffness, and resistance to fatigue, thermal stress, corrosion are needed to stand up under high loadings at intermediate heat ranges up to 900F, with blasts even higher, vibration, aerodynamic buffeting, cyclic loads.

In short, titanium has the properties needed to make the supersonic transport a practical reality!

More than 100,000 hours of flight, selection by three services, scores of speed records have probed and tested these vital titanium structures: the stabilator torque box and inboard sections, and the tail cone, which thrive in the searing ambience of the jet wake; the access doors that surround the tail pipes, and the 18-foot stiffened web in the keel beam between the engines, plus many other titanium parts.

For more than a decade, McDonnell, which is noted for the thoroughness of its materials testing, has continued to use more and more titanium in its aircraft. The F4B/F4C uses twice as much titanium as the F101, 10 times as much as the F3. It can be said of titanium that no other metal except aluminum has been so thoroughly tested and tried, proved in flight, and found so reliable.

A whole spectrum of fabrication and titanium mill products goes into the making of a Phantom. Titanium Metals Corporation of America supplies much of the titanium; a network of fabricators spread across the U.S.A. supplies a multitude of skills. This capacity and technology is available now . . . today . . . to help solve tomorrow's Mach 3 problems.

Declining cost of titanium. In the decade since the Phantom first appeared on the drawing board, the price of titanium has dropped to less than a third. The trend should continue to grow as volume and know-how advance.

Write for titanium data sheet on the Phantom. Or for information on titanium applications...fabrication... fabricators . . . write Technical Service Department, Titanium Metals Corporation of America.

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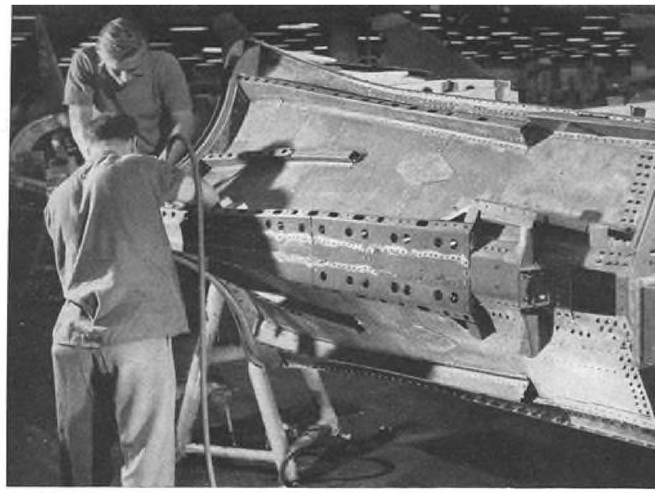
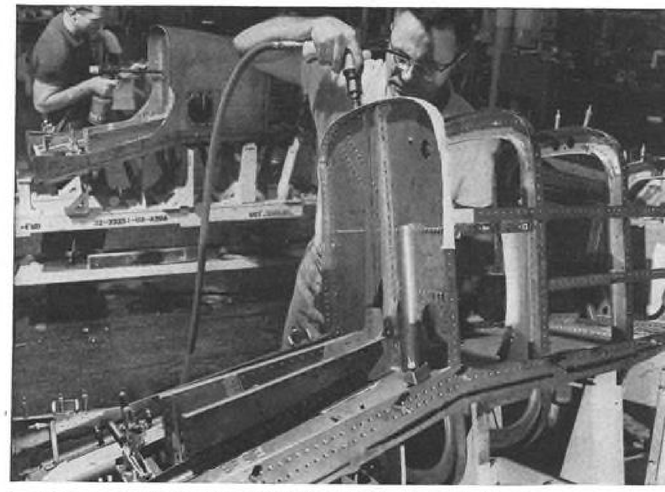
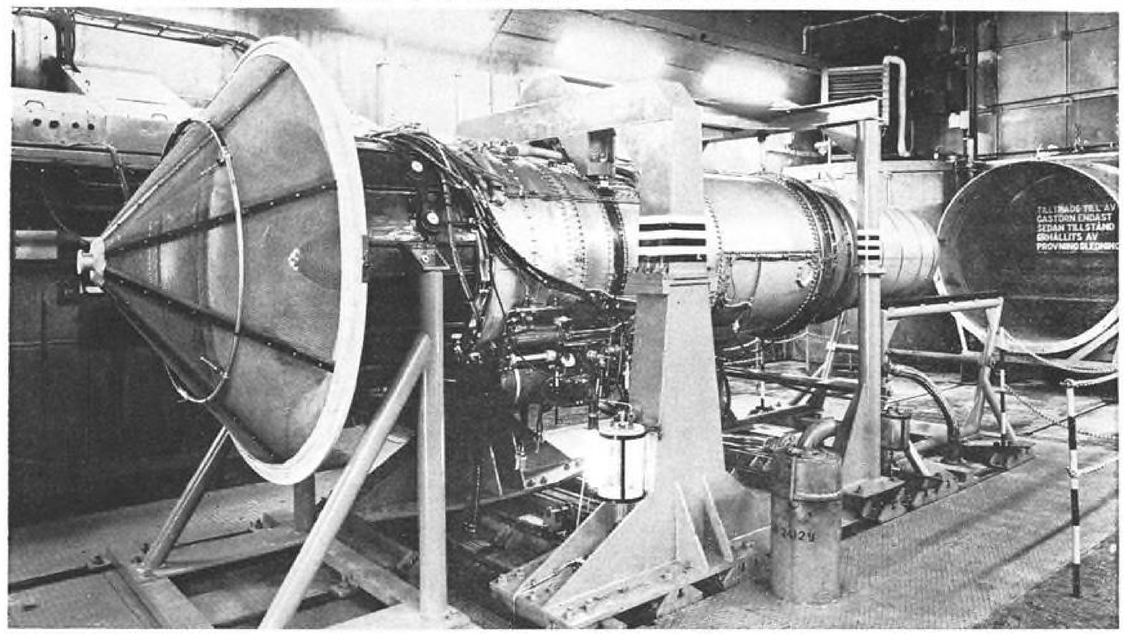


Stiffness, Strength characterize the titanium underside of the aft fuselage section. Area is directly adjacent to jet blast. Despite heat shields, operating temperatures reach 700F. Frame and skin material is 0.032″ Ti-8Mn; longeron is 0.190″ Ti-6Al-4V.



Hot forming is used extensively in producing parts for the all-titanium tail cone. Frames are 0.025″ titanium alloy (Ti-8Mn); skin is 0.032″.

Resistance to fatigue and thermal stress, make titanium major choice for skin, ribs, and spars in key areas of stabilator. Torque box, with its 0.350″ Ti-6Al-4V skin, must withstand cyclic loading plus aerodynamic buffeting, at temperatures of from 650 to 1000F.



PRATT & WHITNEY JT8D-1 commercial turbofan engine is being tested by Svenska Flygmotor AB in preparation for modifications which will transform it into the supersonic RM-8, slated to power Sweden's next manned weapons system, the multipurpose Saab 37 Viggen.

RM-8 Detail Design Pushed by Flygmotor

By Warren C. Wetmore

Trollhattan, Sweden—Detail design work is now well under way here on Svenska Flygmotor AB's RM-8 engine, which is slated to power Sweden's next manned weapons system, the multipurpose Saab 37 Viggen. An outgrowth of the Pratt & Whitney JT8D-1, the engine bears the U.S. designation JT8D-22 and probably will be the first supersonic turbofan to fly (AW Oct. 21, p. 57).

Swedish Air Board selected the American powerplant over such other contenders as the Bristol-Siddeley Olympus and the Rolls-Royce Conway after an exhaustive evaluation of several years revealed that it had a higher growth potential.

Pratt & Whitney has supplied a sample JT8D-1 commercial engine to Flygmotor, which is putting it through thorough testing preliminary to the first modifications next year. All alterations will be made to the basic design layout furnished by Pratt & Whitney.

No specific problems are anticipated in converting from a subsonic commercial engine to a supersonic military version, according to Flygmotor. No major changes, such as the addition of extra compressor stages to the present 13, are expected.

Higher intake stagnation conditions accompanying supersonic flight will be met in part by the use of higher temperature alloys in the compressor blades. Possibly the configuration of the blades will be changed to increase the compression ratio from the now-existing 15.8:1 or to alter the JT8D-1's bypass ratio of 1.06.

A sophisticated fuel and control system will be developed, with particular attention to the fully-modulated afterburner. For a description of the basic JT8D-1, see AVIATION WEEK & SPACE TECHNOLOGY, Oct. 14, p. 52.

RM-8 will be in the 24,000-lb. thrust class. The afterburner will increase this by about 70%. This seemingly large boost is because afterburning augments the turbofan engine thrust by approximately twice that of a straight turbojet, according to Flygmotor. The greater than one-to-one bypass ratio allows more air to pass through the fan duct than into the combustion chamber. Full-length fan duct conveys the bypass air into the afterburner, and gives a ramjet-like effect.

RM-6C POWERPLANT for the Swedish Air Force's J35D Draken interceptor is a modified Rolls-Royce Avon 300 turbojet developing 17,600 lb. thrust with a Swedish-designed afterburner. Middle section is length adapter connecting engine with afterburner.

Specific fuel consumption will be essentially, the same in the military version, or about 0.585 lb./lb. thrust/hr. at takeoff without afterburner. With afterburner, it will be slightly higher.

Thrust reverser is considered to be a part of the airframe and is therefore Saab's responsibility, as are the air intakes. Flygmotor is testing several of Saab's intake designs in its supersonic wind tunnel.

Preliminary work on the engine began last autumn, but the licensing contract with Pratt & Whitney was not signed until January. Probably none of the RM-8s will be built in the U.S., although a reciprocal clause gives each firm rights to the other's developments.

This is not the first instance of Flygmotor's cooperation with Pratt & Whitney. During World War 2, Flygmotor engineers made Chinese copies of several damaged P&W Twin Wasp 1,200-hp. radial engines from downed aircraft which were placed at their disposition. Duplicated engine was designated the STW-C3 and flew in the Swedish B-17 and B-18 bombers. It was produced until the end of the war, when Sweden was able to make a settlement with Pratt & Whitney.

Founded in 1930

Since its founding in 1930 as Nohab Flygmotor Fabriker AB, the company has built all of its large-scale production engines under license, including:

- **My (Bristol Pegasus),** which went through six mutations and increased in power from 600 to 980 hp. It enjoyed the longest production run, from 1930 to 1942, of any Flygmotor engine to date and flew in the Gloster Gladiator.
- **DB-605 (Daimler-Benz)** was produced from 1945 to 1948, and powered the G-21 twin-boom pusher-propeller fighter. It was rated at 1,475 hp.
- **RM-1A (de Havilland Goblin),** Flygmotor's first jet engine, was produced in small numbers for the G-21R. This stop-gap aircraft was a G-21, retrofitted for jet power. RM-1A was rated at 3,300 lb. thrust and was produced from 1949 to 1952.
- **RM-2 (de Havilland Ghost)** was manufactured in quantity for the Saab 29 Flying Barrel and delivered in the years 1951-1955. Engine developed a thrust of 5,100 lb.
- **RM-5 (Rolls-Royce Avon)** powers the Saab 32 Lansen and generates a thrust of 6,600 lb. Swedish afterburner yields a 30% increase in thrust. Engine was produced from 1955 to 1958.

Currently under production at Flygmotor is the RM-6C turbojet, a variant of the Rolls-Royce Avon 300. Engine is rated at 17,600 lb. with afterburner, permitting a speed of Mach 2.2 for the J35D Draken. Unit was derived from the RM-6B by the addition of a zero-stage compressor for increased airflow. A later version of the Draken, the J35F, will also use the RM-6C engine, which is slated for production through 1968 after which it will be replaced on the lines by the RM-8.

To cope with the additional loads imposed by the modification and production of the new engine, Flygmotor is increasing its technical staff and erecting a new engineering building, which is to be completed by the end of the year.

Two test buildings are also under construction. One of these will be used for equipment for the RM-8. The other will house two test cells capable of accommodating engines of up to 55,000 lb. thrust. To test the thrust reversers, one of the cells will be equipped with large blowers to force the diverted exhaust gases up the vent tower and prevent recirculation.

An overhead suspension system for measuring the thrust will be used, rather than the conventional floorborne arrangement.

Cells are to be completed by September of next year at a cost of about $1 million.

To supply air to the high-speed wind tunnels and ram-thrust jet test cells, Flygmotor designed a unique subterranean compressed air magazine, which was blasted out of solid rock in a cruciform shape 280 ft. below ground level. Capacity is 390,000 cu. ft. or 130 metric tons of air, which can be exhausted at a rate of 440 lb./sec. Untreated rock of the magazine has an estimated leak rate of one charge per month.

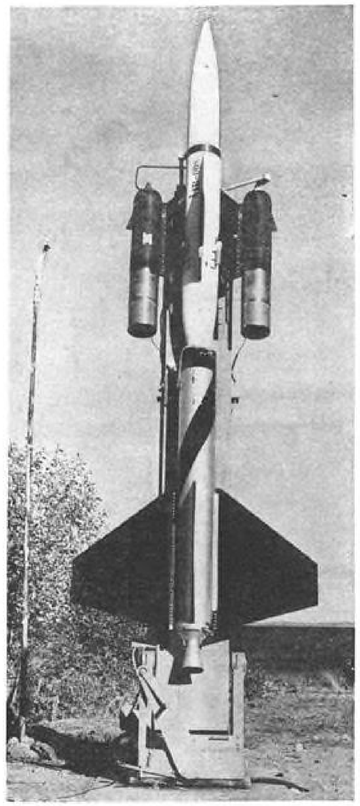
Magazine Charge

Advantage of this technique, Flygmotor says, is that the magazine can be charged at low power—a 2,000-hp. compressor is used—and yet have a high output of about 80,000 hp. for a duration of nearly 7 min.

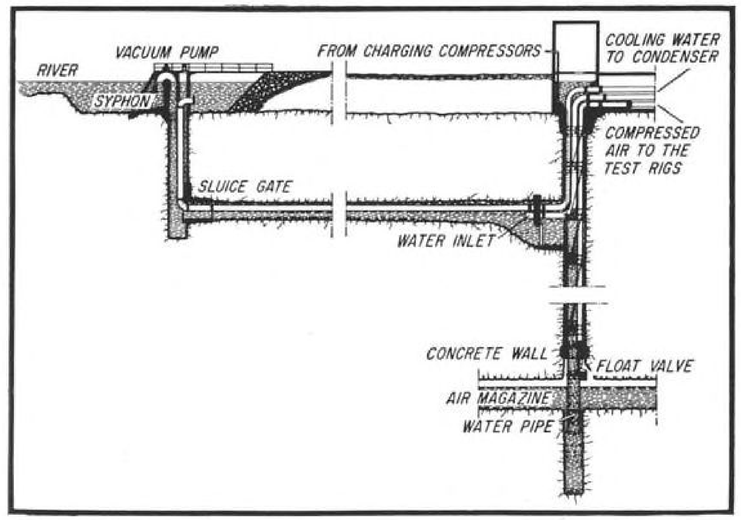
Siphon arrangement connects the air magazine to the nearby Goeta River so that a 280-ft. head of water maintains air pressure nearly constant during discharge.

Recharge time is now about 6 hr. A new compressor, rated at 15,000 hp., is scheduled for installation next year so that the magazine can be refilled with 130 tons of air in less than 1 hr. That change was needed because the RM-8, being a turbofan engine, consumes more air than a conventional turbojet of the same rating—about 550 lb./sec. at low-level transonic speed. The new compressor will operate simultaneously with the air magazine in order to meet this demand.

A free turbine—which removes energy from the air-streams and thus lowers its temperature to —70C—can be shunted



RB.322 TEST VEHICLE is shown, above, on launcher near Kiruna in northern Sweden. Vehicle reached Mach 3 speed and 75,000 ft. altitude in test series. **RRX-1** ramjet, below, is for Mach 5 speed ranges.



RESERVOIR FOR FLYGMOTOR's ram-thrust jet stands has subterranean cruciform air magazine blasted out of solid rock at depth of 280 ft. Maximum discharge rate is 440 lb./sec.

into the system for cold-weather simulation tests.

Since Sweden's most important contributions to flight propulsion technology have been in the area of simple, highly-efficient afterburners and their control systems, it is not surprising that there has been a considerable amount of interest in ramjet research. Flygmotor has been engaged in this field for 10 years, most recently in cooperation with Bristol-Siddeley of Great Britain.

The majority of these efforts have been directed toward the 2,700-lb.-thrust RR-2 engine, which in pairs powered the experimental Rb.322 vehicle in a series of fully-instrumented flight tests which ended about one year ago. Speed ranges were from Mach 2.2 to Mach 3 at altitudes of 75,000 ft.

The company is now investigating higher Mach numbers where the theoretical maximum efficiency of the ramjet lies. Its RRX-1 integrated ramjet project, funded by the Air Board, is designed to achieve a vertical burnout speed in the region of Mach 5-6.

Originally intended for use as an anti-aircraft missile, the kerosene-fueled RRX-1 carries a 33-lb. payload and has a launch weight of 165 lb. Its over-all length is 6 ft. 10 in. with a diameter of 7.5 in.

The vehicle is boosted to ram speed by a small solid-propellant rocket.

Primary application now foreseen for the RRX-1 is as a sounding vehicle capable of reaching an altitude of 65 mi. Swedish space authorities have expressed an interest in the vehicle operating in this capacity, the company said.

Although no detailed study of the RRX-1 compared to that of a rocket propelled sounding vehicle has been made, the company believes that it would be more economical. Propellant costs would be lower, and the mechanical parts might be more or less expensive depending on the type of rocket. Over-all weight would be less for the RRX-1 since it is air-breathing and does not carry along its oxidizer as a rocket must.

Flygmotor's ultimate goal in its ramjet research is the development of a missile system, since ramjet-powered missiles are said to be very attractive in applications where long range combined with light weight is important. The company has studied a number of ramjet schemes and has found them to be quite competitive with rocket power.

Flygmotor also envisions the use of ramjets as powerplants for Mach 3-plus manned aircraft. Probably a ramjet in tandem with a turbojet would be used. After the turbojet had accelerated the aircraft to ram speed it would be bypassed and the ramjet ignited.

A rocket motor, designated the VR-3, was developed to be used as an assist pack for the Draken. It develops 5,735 lb. of thrust at 66,000 ft. and weighs about 165 lb. Its length is 40 in.

Burning a hypergolic combination of 85% hydrogen peroxide and kerosene, VR-3 features thrust modulation ranging from 40 to 100% of full thrust and multiple restart capability. Controls are completely hydraulic — no electrical power is required.

The unit is said to be powerful enough for use in the second stage of a three-stage satellite launch vehicle, and was considered for proposal to the European Launcher Development Organization.

The project was finally shelved due to difficulties in obtaining hydrogen peroxide in sufficient quantity.

At right, Dr. David Atlas, Chief of the Weather Radar Branch, Air Force Cambridge Research Laboratories. At left, Mr. Harold Belcher of The Budd Company Electronics Division's Marketing Dept.

USAF-LOCKHEED U-2s monitor Cape missile launches, gathering infrared data on exhausts. U-2 above has black paint protection.

U-2s Gathering Data on Missile Exhausts

Cape Canaveral – USAF-Lockheed U-2s have monitored launches from here over the last three years in a program designed to gather data on the infrared characteristics of the exhausts of ballistic missiles.

Program, sponsored by Aeronautical Systems Div. of Air Force Systems Command, is called Smokey Joe and is closely coordinated with Advanced Research Projects Agency's Project Tabstone, which includes as subprojects Project Lookout, also staged from here with Royal Canadian Air Force CF-100s, and Project RAMP (Radiation Air Borne Measurement Program). All programs employ aircraft.

Data obtained on the launches through the U-2 flights are distributed to those government agencies concerned with ballistic missile defense (AW Sept. 25, 1961, p. 243).

Detached Aircraft

The two two-seat U-2s used in Smokey Joe are assigned to Special Projects Branch of the Air Force Flight Test Center, Edwards AFB, Calif., but are more or less permanently detached for duty here at the Atlantic Missile Range.

One of the U-2s carries an infrared spectrometer and the other an infrared radiometer. Each instrument is mounted in the second, or aft, seat of the aircraft. Radiation is focused on the instruments through an intricate mirror system which extends up and through the canopy. External part of the mirror system is covered with an aluminum housing, called the "pickel barrel" by pilots, with a circular aperture on the forward side to admit radiation to the lens.

The pickel barrel has a fastback-type fairing immediately behind it to reduce aerodynamic turbulence – which frequently has caused the aircraft to be mistaken locally for a HASP (High Altitude Sampling Plane) version of the U-2 (AW Aug. 12, p. 72).

The radiometer and the spectrometer weigh about 400 lb. each and were developed for the program by Baird-Atomic, Inc., Cambridge, Mass. Lockheed-California Co., performs most of the data reduction.

U-2s are programed to cover every launch–weather, aircraft and equipment permitting. Since the program began in March, 1960, at least 80% of missile launches from here have been monitored by one or both U-2s. (For a report on other U-2 operations relating to Cape Canaveral, see AW Nov. 11, p. 78.)

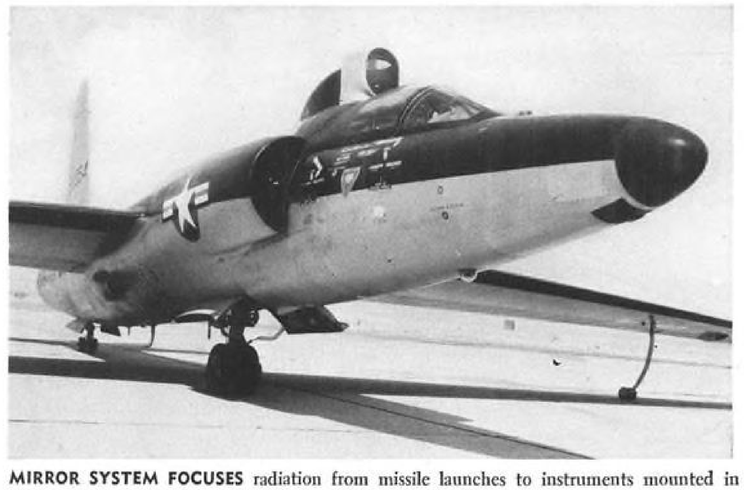
On a normal mission, both aircraft are dispatched approximately 1-1½ hr. before the scheduled launch. They fly to an altitude of about 60,000 ft. and take up a heading in line with the planned launch azimuth of the missile. For some launches, both aircraft might be positioned uprange of the launch stand; for other missions one might be positioned downrange under the missile's trajectory.

Usually, there is at least one U-2 located uprange.

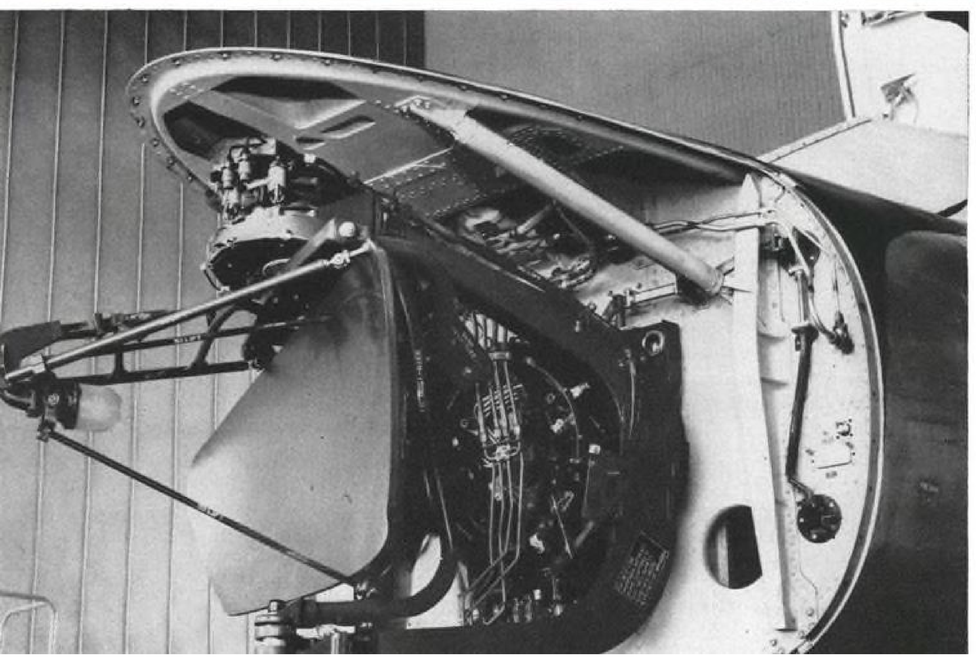
200-300 mi. Run

Horizontal scan angle of the infrared devices is greater than 180 deg. and is several degrees in the vertical plane. Look angle can be constantly adjusted by the navigator/equipment operator to follow the ascending missile, to a limit of about 30 deg. Aircraft is held stable during the time of the scan operation.

U-2 pilots receive vector instructions from ground radars here and usually try to begin a run from about 200-300 mi. out at the moment of launch. Aircraft



MIRROR SYSTEM FOCUSES radiation from missile launches to instruments mounted in rear seat of monitoring U-2. "Pickel barrel" covers external parts and it has a fastback-type fairing located directly behind it to reduce aerodynamic turbulence.



Conceptual illustrations of: (Top left) Airborne surveillance-and-command system. (Top right) Integrated mapping, terrain-following, and airborne target-detection radar.

Left: B-58 bombing/navigation radar — an example of Raytheon's proven capability in the development and production of precision radars.

NEW AVIONIC CONCEPTS
for Advanced Weapon Systems-from Raytheon

At Raytheon, radical new solutions to problems of multi-mode antenna design, ground clutter elimination, electromagnetic penetration, and optimized digital data techniques, are making important contributions to advanced weapon systems technology.

Backed by more than 15 years of successful ECM, guided missile, radar and avionics experience, Raytheon is applying new techniques to a wide range of advanced avionic systems. Typical examples include: an integrated mapping, terrain-following, and airborne target-detection radar for light attack aircraft — an airborne surveillance-and-command system featuring a long-range sensor to detect a variety of small targets "buried" in ground clutter — and a precision radar for accurate navigation, weather detection at jet altitudes, and approach monitoring.

For more information about these and other new Raytheon avionic developments, write: *Neil A. Montone, Director of Marketing, Raytheon Company, Space and Information Systems Division, Bedford, Massachusetts.*

RAYTHEON

53 U-2s Produced

Two groups of Lockheed U-2 high altitude aircraft were built in 1956 and 1957. The first model was one-place and most were powered by the Pratt & Whitney J57-P-37A (JT3). This engine was a special modification of the twin-spool J57 to permit very high altitude operations without compressor blade stall. Several one-place versions, like the one flown by Francis Gary Powers over the Soviet Union, were powered by P&W J75s.

A total of 48 aircraft were produced in the first version, with serial numbers from 56-6675 to 56-6722.

The second model was two-place and was powered by a modified Pratt & Whitney J75, a larger twin-spool engine. Five aircraft were in this group, with serial numbers 56-6951 to 56-6955.

seldom come closer than 35 mi. to the Cape reservation, and are aloft on an average of 2 hr. in support of each launch. All launches—from the Army's solid-propellant Pershing battlefield missile to NASA's Saturn space booster—are monitored by the U-2s.

U-2s are painted black on the upper half of the fuselage, from about the trailing edge of the wings forward to the nose, to prevent reflected infrared radiation from entering the equipment and causing erroneous readings.

Pilots and navigators are assigned by the Flight Test Center at Edwards and are detached for temporary duty to here usually for 30-day periods to fly the missions. AMR operations are directed by J. Dixon Parker, ASD civilian, aided by personnel from the various contractors.

Speed Records Claimed

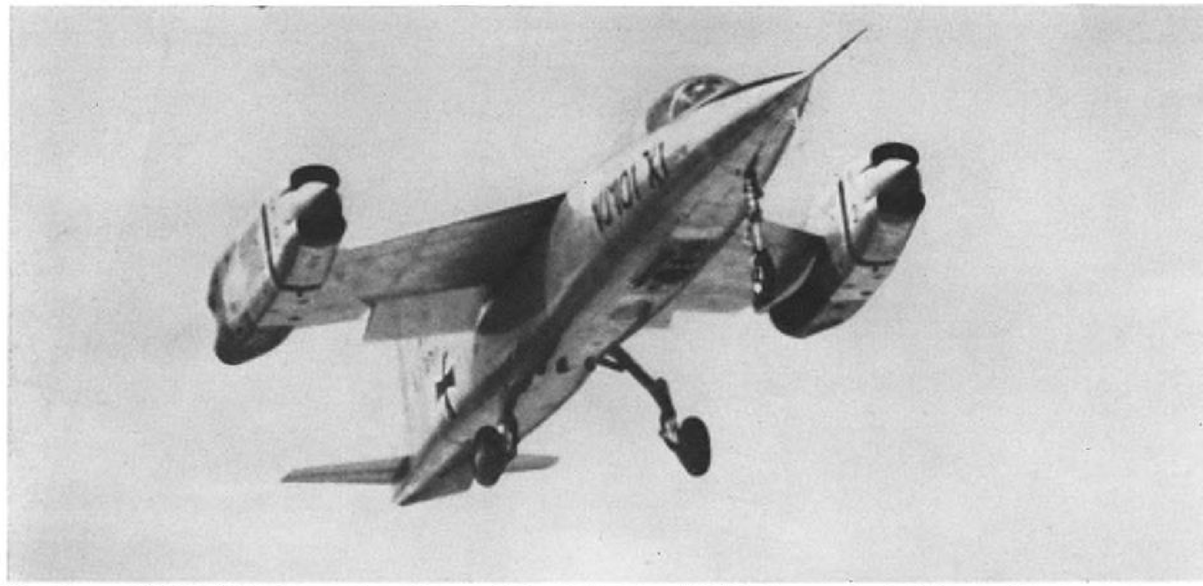
Washington—Six speed records have been claimed for an Army-Hiller OH-23G helicopter. Record runs were made at Edwards AFB, Calif., and completed Oct. 30.

In Class E-1B for helicopters grossing between 1,102 and 2,204 lb., a speed of 123.67 mph. was attained on a 3-km. straight course and a speed of 123.58 mph. on a 15-25 km. straight course. Neither record has been claimed before.

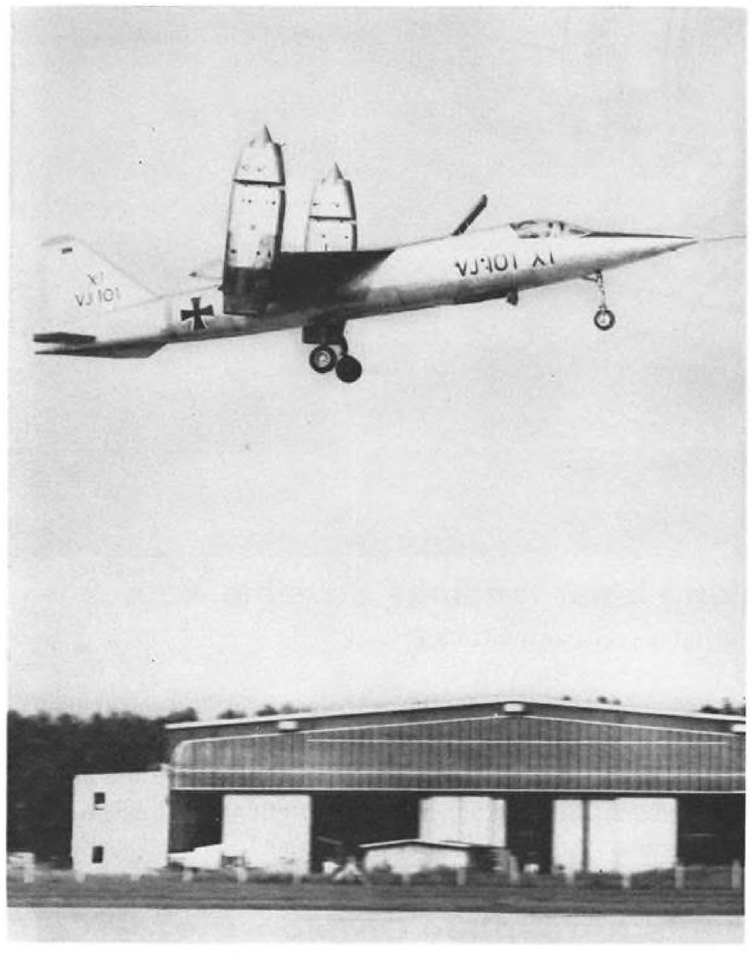
In the same class, a speed of 119.81 mph. over a 100-km. closed course was claimed. The existing record of 104.613 mph. was set in a Bell 47J-2 in 1961.

In Class E-1C for helicopters grossing between 2,204 and 3,858 lb., a speed of 123.44 mph. over the 3-km. course was claimed, and a speed of 123.77 mph. was claimed over the 15-25 km. course. Neither record has been claimed before.

Over the 100-km. closed course in the same class, a speed of 121.7 mph. was claimed. The existing record was held by a Bell 47J-2, which flew 107.081 mph. in January, 1961.



West German VJ-101C VTOL fighter is shown (above and below, left) in first full flight demonstration, including transition from vertical to horizontal flight. Photo above shows the aircraft accelerating into forward flight after the transition phase.



VJ-101C Shown In Transition Demonstration

West German EWR Sud VJ-101C fighter recently made its first transition from vertical to horizontal flight after a series of hover tests in a design program started four years ago (AW July 1, p. 69; June 10, p. 154; May 27, p. 70). The VTOL aircraft was built by a consortium owned by Boelkow, Heinkel and Messerschmitt. Flight was made at Manching field north of Munich.

Slot running around Rolls-Royce RB.145 engine pod containing two of VJ-101C's six engines is opened by moving entire intake section forward. RB.145s have 2,750 lb. thrust each.

Ames Study Supports Mars Life Theory

By Harold D. Watkins

Moffett Field, Calif.—Experiments demonstrating adaptability of earth organisms to the hostile Martian environment lend support here to a belief in the possibility of life on Mars.

Researchers hedge their conclusions cautiously, partly because of a lack of precise knowledge of Martian conditions. But work on the Martian environment at the exobiology division of the National Aeronautics and Space Administration's Ames Research Center has shown that under temperature conditions approximating those believed to exist on Mars, certain earth organisms not only survive, but will grow.

Extreme temperature changes detected on Mars have led some scientists to believe that the chance of earth organisms surviving the planet's environment and subsequently contaminating it, is slight.

Ames researchers, however, feel their preliminary findings and other NASA supported research tend to dispute that theory and strengthen arguments for sterilizing spacecraft.

'Open Mind'

Dr. Richard S. Young, chief of the division urged caution in evaluating conclusions but said:

"Experiments of this type point out the need to maintain at least an open mind on the possibility of Martian or extraterrestrial life, by demonstrating the incredible adaptability of our own microorganisms to environments approaching that of Mars."

Young, who is directing the work, said the experiments first simulated temperature extremes of an equatorial Martian summer day and night. Earth organisms spent only 4¼ hr. above freezing out of 24, with a maximum temperature of only 25C. Growth was observed even when the "daytime" was reduced to as little as 15 min. above freezing.

Experiments assumed the presence of water and a nutritional medium. No attempt was made to control atmospheric pressure, since preliminary experiments indicated pressure had no effect on microorganism growth.

Other studies are being conducted at Ames to demonstrate how water might be available for such microbial growth, although observations indicate the Martian atmosphere contains only about 1% of the earth's atmospheric moisture content.

Survival of earth organisms in simulated extraterrestrial environments is not directly related only to the question of spacecraft sterilization. It also allows scientists to examine the response of familiar organisms to such conditions.

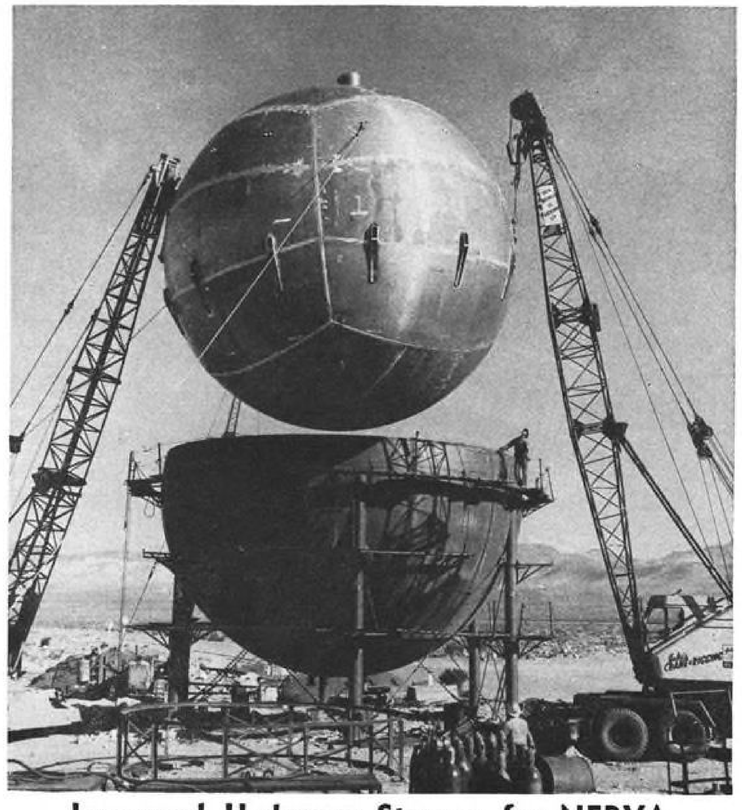
Assuming that Martian life has characteristics similar to life on earth—such as a carbon-based chemistry—experiments may provide meaningful data from which generalities can be derived about possible life on Mars, according to Young.

Experiments tackling such fundamental questions are of the type which Ames hopes will establish its life sciences directorate as a basic research center in the field of extraterrestrial environments. The exobiology division is one of three under the directorate.

Scientists are now attempting to determine the minimum nutritional and water requirements, in addition to the shortest growth period necessary, for earth organisms to maintain themselves under simulated Martian temperature conditions.

To demonstrate sources of life-supporting moisture not detectable from earth at present, Young and scientists in the biochemical evolution division have constructed a "Martian model" in which temperature and pressure are controlled to simulate environmental conditions with some degree of confidence.

Moisture content in the Mars model is reduced to levels considered analog



Increased Hydrogen Storage for NERVA

Liquid hydrogen for the Atomic Energy Commission-National Aeronautics and Space Administration nuclear engine for rocket vehicle application (NERVA) program will be stored in this 100,000-gal. capacity Dewar installed by the Chicago Bridge and Iron Co. at the AEC's Nevada test site. The outer sphere, 36.6 ft. in dia., is separated from the inner hydrogen tank by a 3-ft. partial vacuum.

The nuclear-powered ballistic missile submarine, Alexander Hamilton, surfaces on a quiet evening sea.

The sea doesn't change: The subs do.

The United States Navy's first submarine, the Holland, could cruise underwater for 40 miles.

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The first submarine changed naval warfare tactics. The nuclear submarine created a whole new dimension in defense.
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The Electric Boat division of General Dynamics delivered the Holland in 1900.

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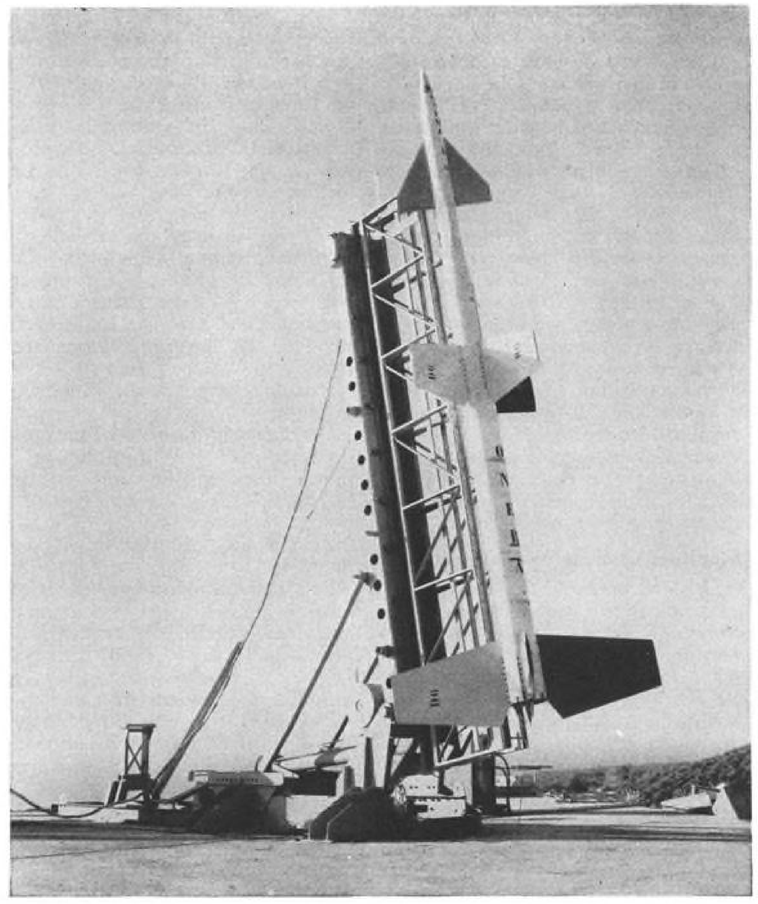


French SST Flight-Test Model Flown

Flight-test model of a supersonic transport has been flown several times recently at the French Naval Mediterranean missile test center as third stage of rocket developed by Office National d'Etudes et de Recherches Aerospatiales (ONERA) (AW Aug. 12, p. 52). First and second stages, both solid fueled, push model to test velocity. Model, identical to wind-tunnel configurations, has 440 lb. thrust Icarus motor for 20 sec. of powered flight.

ous to Mars by drying chamber air in a liquid nitrogen cold trap. The end point of the experiment is determined when a light frost is present at the "north pole"—proportionately comparable to what can be seen on Mars—and the chamber is opened. The sub-surface layer of ice comes to the surface at the pole and is farthest from the surface at the "equator."

Young acknowledged that the climatology of a planet cannot be precisely simulated in a closed box, and that the significance of these observations is difficult to evaluate.

"Whether such an ice layer does now exist, or has ever existed on Mars, remains to be seen, but it certainly seems possible, and may be used to hypothesize a source of water on the planet," Young said.

Young suggested that it might be possible for Martian summer heat to cause some of the sub-surface ice to melt and rise to the surface as moisture.

Another speculation is that geothermal activity might produce springs or pools of moisture in which microorganisms could grow.

Young said that while astronomers generally believe that water passes directly from a solid to a gaseous state on Mars because of low atmospheric pressure, Ames researchers have detected liquid moisture at the base of the ice cap in their model, indicating some melting does occur.

Such a sub-surface source of moisture could help explain the "wave of darkening" which is observed on the surface of Mars. This phenomenon proceeds in a seasonal fashion from the pole through the equator—the reverse of spring on earth—and has been interpreted by some to indicate a spring-

like process due to some living organism.

Even if an acceptable theory for the source of moisture could be developed, however, Young pointed out it still must be explained how life could exist in the sub-freezing temperatures existing year-round on most of the Martian surface.

Observable temperatures never rise above zero C. except at the Martian equator and a few degrees north and south of it. One possibility offered by Young is that Martian surface temperatures reported by astronomers may actually be measurements of the atmosphere, and that the surface could be warmer than now believed.

Studies into the adaptability of earth organisms, and other efforts to obtain meaningful information about possible Martian life are expected to aid the work being done in the life detection systems branch of exobiology.

Monitors Outside Work

Oriented primarily to Mars at present, the group is monitoring the work of some half-dozen outside researchers who are developing life detection devices. Life detection branch scientists are also studying concepts that could lead to improved techniques involving gas chromatography, thermal analysis and wet chemicals.

Cell biology, the third exobiology branch, is a pure science undertaking devoted to learning as much as possible about cells in support of other exobiology programs.

Of 50 in-house research projects under way at Ames life sciences, 21 are in the exobiology division. Research in this group aims at providing the basic information that will enable more meaningful data to be obtained about life on Mars and other space bodies. Answers are being sought to such fundamental questions as how to define life and how to measure it.

Scientists in the biochemical evolution branch, for example, have succeeded in producing synthetically a number of important organic molecules.

In one of the most recent of these experiments, Dr. Cyril Ponnamperuma produced the adenosine triphosphate molecule, or ATP. It was the first time ATP had been produced in the laboratory, according to NASA.

The complex molecule was produced by shining ultra-violet light on a solution of compounds thought to resemble the composition of the earth's primitive oceans of about four billion years ago. ATP supplies most of the energy for chemical processes in all earth organisms. Animals make it by breaking down food and plants through photosynthesis.

This experiment illustrates the intricacies of the exobiology field. "Prior to Dr. Ponnamperuma's discovery we thought that such chemicals were peculiar to living organisms, and, therefore, if we found them on other planets we could assume the existence of life. Now we know that such an assumption is incorrect," explained Dr. Harold P. Klein, acting assistant director at Ames for life sciences.

Projects in biotechnology and environmental biology, the two other life sciences divisions at Ames, include studies into effects of unusual environments on man, how these changes can be monitored and how man and machines can best be integrated during space travel.

Among projects in these fields are the following:

• **Development of a sensitive measuring** device to assay trace quantities in the human blood of vasopressin, an alerting hormone. Such a device could be utilized to provide warnings of impending emotional disturbances in space pilots.

• **Rats are being spun** in centrifuges at forces of from 2 to 3gs. to determine if any physiological changes occur during such conditions. Clues to date point to changes in carbohydrate metabolism, including the way fats are produced.

• **Psychologists are attempting** to define the variables of a man's behavior in a confined environment such as a spaceship.

Keep Room Germ-Free

Among other subjects which Klein hopes to come under the scrutiny of Ames life scientists is a study of the type of facility needed to handle and examine extraterrestrial samples expected to be brought back from the moon and later from Mars.

The room must be germ-free to prevent contamination of samples by earth organisms, and it must ensure that the earth won't be contaminated by extraterrestrial organisms.

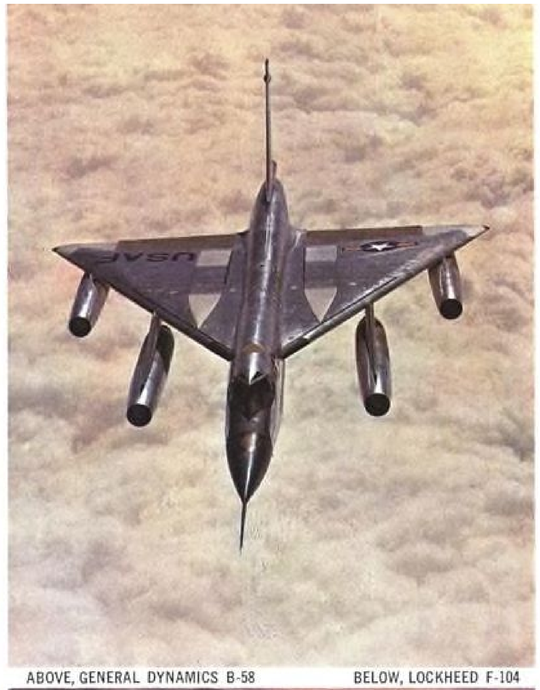
Ames hopes that such experiments and others will help establish its new life sciences group as a basic research center into the extraterrestrial environment. Recognition as such is sought as one answer to congressional criticism of independent NASA life sciences capabilities. There have been doubts, for example, of the justification for work at Ames when other NASA centers have similar facilities.

Klein said that without such recognition "we won't amount to much or get much support."

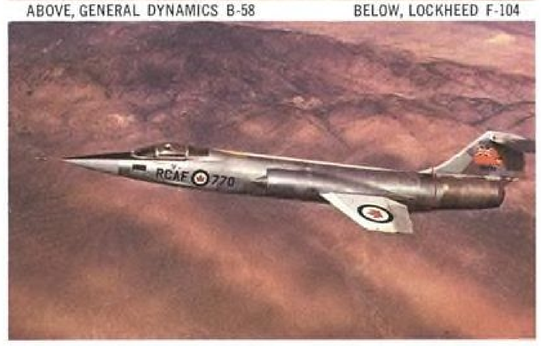
Klein, who formerly was head of the exobiology division, said that it was "well on its way" to gaining that sort of recognition. The field, a new one in which there is relatively little competition, deals with the detection and study of possible forms of life in extraterrestrial environments and the even more

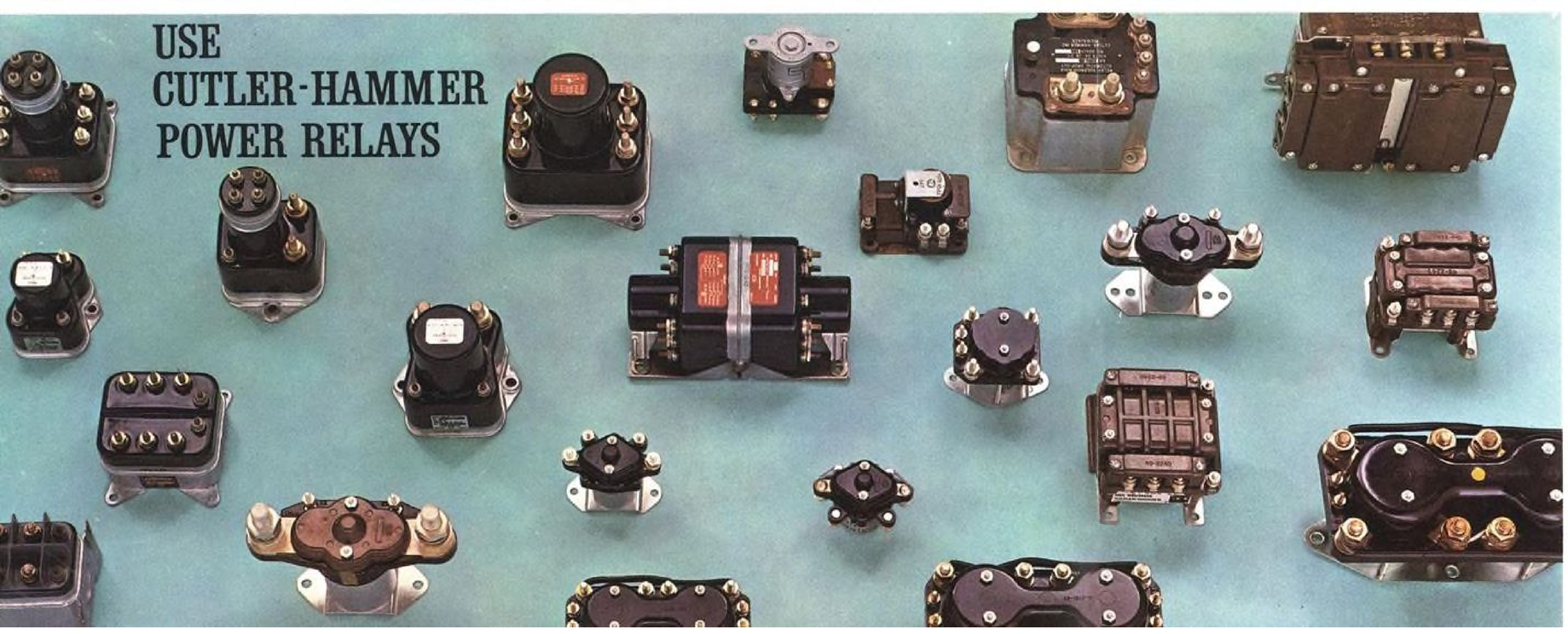
LEFT, MARTIN TITAN I — ABOVE, RYAN Q-2C FIREBEE

ABOVE, FAIRCHILD F-27F — BELOW, LING-TEMCO-VOUGHT F-8E CRUSADER



ABOVE, GENERAL DYNAMICS B-58 — BELOW, LOCKHEED F-104





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CONTROL

profound areas of life origins and biochemical evolution.

Klein said that the environmental biology and biotechnology divisions, face rougher going because there is so much activity in each at other NASA centers and at Department of Defense facilities.

This emphasis on non-applied research at Ames was outlined recently for a House of Representatives subcommittee by NASA deputy Administrator Hugh L. Dryden, in explaining the distinction between life science work here and that being carried on at NASA's Manned Spacecraft Center at Houston.

"The difference between Ames and Houston is the difference between science and engineering, or the difference between biology and medicine. Biology is a science and the doctor is the engineer who applies the science," he said.

LTV Developing Space Repair Guide for NASA

Dallas—Space repair and maintenance design manual is being prepared for National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, by Ling-Temco-Vought under an initial 12-month study contract funded at $73,000.

The design guide of human engineering criteria for maintenance and repair of advanced space systems will attempt to define for designers of future space systems what man can or cannot do in space and what is needed to repair and service his vehicle in the course of long-duration missions.

Tasks covered will range from simple plug-in parts replacement inside a spacecraft to relatively complex external repairs.

The study will include space suit assessment to include man's mobility, visual range, reach distances, and ability to apply forces while using various tethering and lock-on devices and while working under space lighting conditions. Tools and other hardware will be evaluated for replacing surfaces or parts, repairing punctures, refueling, transferring liquids and other tasks.

The study is being conducted because spacecraft design will be related to in-flight maintenance and repair operations, NASA believes.

LTV has suggested to NASA that future study phases of the program embrace lunar base construction and planetary operations, including maintenance of roving surface vehicles, crew shelter, construction equipment, power and communications systems and other equipment. Evaluation of man's ability to use small, remotely controlled manipulators or robot repair tugs for servicing or repairing nuclear-powered spacecraft is also being proposed.

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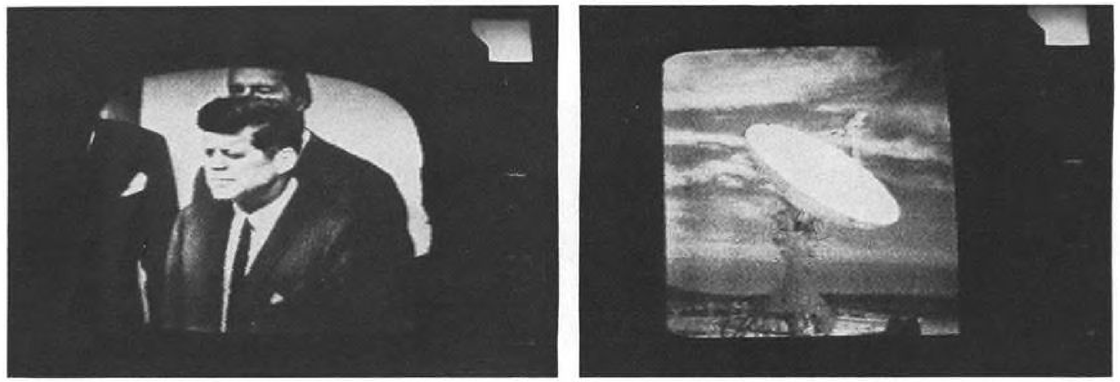


RELAY OF TELEVISION pictures via Syncom 2 satellite from Ft. Dix, N. J., to Andover, Me., is one of the more unusual experiments conducted recently with National Aeronautics and Space Administration's synchronous communications satellite. Syncom's narrow-band transponders were intended to relay a single two-way voice channel only, not broad-band television. Clarity of these pictures is degraded from what appeared on the Andover monitor, due to several reproduction steps subsequent to their initial display.

Syncom 2 Transponders Exceed Objective

By Barry Miller

El Segundo, Calif.—Recent communications experiments using the Syncom 2 satellite as a relay have produced surprising results which exceed the generally anticipated performance of the satellite's limited-capability communications transponders. Notable among these experiments was the relay of live television between Ft. Dix, N. J., and the Bell Telephone Laboratories station at Andover, Me.

The relay of television by communications satellite, a feat first performed by Telstar and repeated by Relay, is no longer unusual. What is unusual about Syncom doing this is that its transponders were designed to handle only a single two-way telephone conversation, not the reception and retransmission of broadband video.

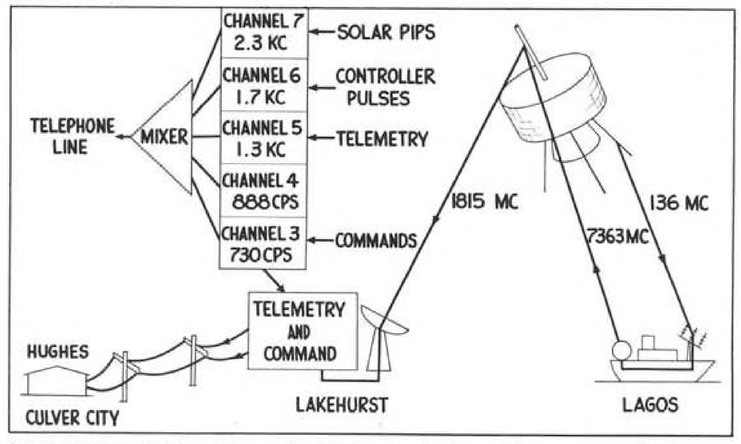
Syncom's mission objectives were to demonstrate a synchronous orbit and the ability of the spacecraft's controls to orient and position the satellite. These objectives were met in what may be one of the major accomplishments in this nation's space activities. Eugene F. O'Neill, director of Bell Telephone Laboratories' Telstar project, has called the Syncom success a "remarkable achievement" at so early a stage in space technology.

Syncom 2 was conceived and developed by Hughes Aircraft Co. under funding from the National Aeronautics and Space Administration and was launched on July 26 (AW Aug. 5, p. 75) into what is believed to be the first synchronous orbit achieved by a man-made satellite.

A synchronous orbit is one in which the orbital period of the satellite is the same as that of a sidereal day (23 hr., 56 min., 4.09 sec.). It occurs at an altitude 22,300 stat. mi. above the average equator altitude. An important advantage of a satellite in such an orbit is that it can provide continuous communications with sites that remain in its view for 24-hr. periods.

Demonstrations of the communications capability of Syncom 2 were of secondary importance and a direct consequence of the ability of the satellite to achieve its synchronous orbit. Because of its light weight (85.5 lb. after burnout of its onboard solid-propellant apogee rocket), the need for onboard orbital controls and the apogee boost rocket, the communications capacity in this experimental system of necessity had to be restricted. A larger, later generation, advanced Syncom, elements of which Hughes has developed for NASA, will be capable of carrying four multiple-access transponders, each able to relay 600 two-way voice conversations to many ground stations (AW June 10, p. 108).

Live and taped television signals were relayed through Syncom's narrow band



TELEMETRY DATA from Syncom 2 satellite was relayed over its own communications system to ground station at Lakehurst, N. J., after being sent to USNS Kingsport at Lagos, Nigeria. On the ship, telemetry subcarrier oscillator signal modulated the communications transmitter, whose output was sent back to the satellite and relayed in turn to New Jersey. At Lakehurst, telemetry was pulled out and sent with other signals over regular telephone lines to Culver City, Calif., for real-time calculations. Total delay from initial satellite telemetry transmission to receipt at Culver City was less than 0.5 sec.

transponder, which has only 5 mc. of IF bandwidth, compared to 25-mc. RF bandwidth for the broadband transponders on Telstar and Relay. In the Syncom experiments, the relay of television was partly made possible by deviating the carrier frequency well beyond 2.5 mc. from the center frequency in the band so that operation extended to the band skirts. The large aperture antenna and low-noise receiving system at Andover were indispensable in the success of the experiment.

The live TV was picked up from a commercial Philadelphia television channel and demodulated down to its baseband, which was used in turn to modulate a transmitter at Ft. Dix. This was sent to the satellite, frequency translated (from 7,363 to 1,815 mc.) and rebroadcast.

The nature of the pictures appearing on the TV monitor at Andover was described by a Bell Labs engineer present during the experiments as being of "motel quality"—distinguishable, but of inferior quality to what would be displayed on a good consumer receiver. This can be inferred from accompanying pictures, reproduced from enlarged positives of 35-mm film exposures of the Andover monitor. The resolution of these photos was degraded somewhat in the chain of reproduction, so that the actual quality of TV would be slightly better than it appears here.

Quality of the picture might be enhanced, however, making it more like commercial-grade television, by adjusting a filter in each of the dual transponders of the next satellite of this type, scheduled for launch this spring, to provide broader bandwidth.

U. S. Army Satellite Communications (Sat Com) Agency at Ft. Monmouth, N. J., is responsible for conducting and evaluating the communications experiments. Tests were conducted using low through high modulation indexes and seven different so-called modem codes. The wide-narrow/FM with feedback

1½ Nav/Com System

New nav/com 1½ system, released to production at Bendix Radio Div., includes a 360-channel transmitter/receiver, a 100-channel VOR/LOC unit, VOR/ILS crosspointer with transistor omni converter circuitry, and optional transistor marker receiver and transistor/nuvistor glide slope receiver. Transmitter output is rated at 12 w. Weight of complete system is 21.5 lb.

Relay of Olympics Via Syncom Suggested

El Segundo, Calif.—Engineers at Hughes Aircraft Co. are suggesting the possibility of relaying via a Syncom satellite live television pictures of a major sports event, the 1964 Olympic games in Japan, as a dramatic demonstration to the American public of the value of satellite communications.

NASA plans to launch from Cape Canaveral the third and last shot in the current Syncom series early next year (AW Oct. 7, p. 23) and this satellite could be brought to and held in position over the Pacific. If a suitable transmitting terminal were located in Japan, real time pictures could be returned to the West Coast of the United States via Syncom and distributed through commercial channels.

If necessary, Syncom 2 might be suitable for this purpose. It retains sufficient control fuel to permit it to be moved from its longitudinal position over the Atlantic to the Pacific. As a result of degradation in the output of its solar panels due to space radiation, however, available power is expected to decline to 60% of design level at the end of the first year in orbit (July, 1964), permitting only intermittent use of the satellite's transponders beyond that time.

The quality of any relayed television pictures might be better if Syncom 3 did the job, because the bandwidth of its transponders could be enlarged by making filter adjustments prior to the launch next year (see story, p. 75).

code, having a peak deviation of 40 kc. and a baseband of 4 kc., had the highest output signal-plus-noise to noise ratio for a given signal of any of the codes. Both ordinary FM and FM with feedback receivers were employed on the ground.

Other Syncom 2 communications tests included:

• **Real Time Telemetry**—Satellite telemetry data were transmitted on 136 mc. from the vehicle's telemetry antenna to the U.S.N.S. Kingsport, one of three key surface stations, located in the harbor of Lagos, Nigeria. A 14.5-kc. subcarrier oscillator signal was pulled out and used to modulate the ship's communications transmitter which then beamed its signal to the satellite on the 7,363 mc. communications uplink. Once received at the satellite, the signal was treated like any other communications—frequency translated and rebroadcast. The second ground station, at Lakehurst, N. J., picked up the 1,815 mc. satellite transmission, demodulated it and pulled off the channels which were then used to frequency modulate a 1.3 kc. oscillator preparatory to being sent over commercial telephone lines to Culver City, Calif., for real time calculations.

Total time delay from initial transmission of telemetry data from the satellite to its receipt via telephone from Lakehurst was less than ½ sec. The value of such an arrangement is that it permits immediate operation on telemetry data far away from the location where telemetry is received. The experiment, repeated again in late October, also demonstrates that Syncom has the bandwidth capability in its communications for handling telemetry. Use of a Syncom satellite for real time relay of telemetry from the Atlantic Missile Range is a possible application. The telemetry mixed with four other channels of satellite reference data accounted for about 2.5 kc. of usable bandwidth in the phone transmission.

• **Simultaneous Voice and Teletype**—Teletype was superimposed on a voice channel and sent simultaneously in a narrow mode (4 kc. baseband). This was done by filtering a 250-cps. slot out of the center of the 3.1 kc. band in which an FM modulated Teletype signal is inserted. At the receiving end, the Teletype circuit rejects the voice portion of the signal; the voice circuit accepting only voice and filtering out Teletype. No more power was required to transmit both than voice alone in this manner, according to Hughes engineer Al Owens.

• **Duplex Voice**—The Kingsport and Lakehurst stations simultaneously talked to one another over separate channels (duplex), an exercise of the original communications capability of the satellite (when linked by 30-ft. ground antennas). In addition, the equivalent of four voice channels were simultaneously multiplexed by each of two stations on a separate RF carrier, giving the equivalent of 8 two-way conversations. Only one voice signal was transmitted, but the three remaining channels carried noise to simulate the full four-channel complement. Voice quality was good, Owens says. In fact, voice quality signal to noise ratio was better than the direct record capability of most tape recorders, according to Hughes. Transmission was in wide medium mode (50 kc. peak deviation, 20 kc. baseband).

• **Facsimile**—Two stations simultaneously transmitted a photo to one another, each using a separate voice channel. Each photo required a 5-min. scan.

• **Teletype**—Sixteen Teletype channels were transmitted duplex in a single voice channel in a wide narrow mode (40 kc. peak deviation, 4 kc. baseband).

• **Range and Range Rate**—Seven tones

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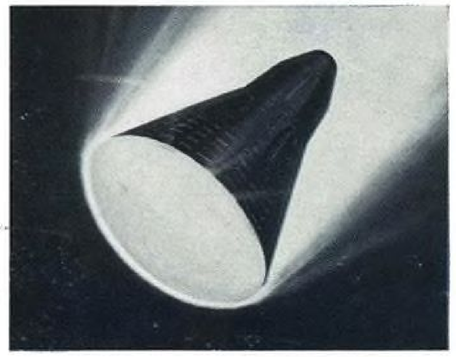

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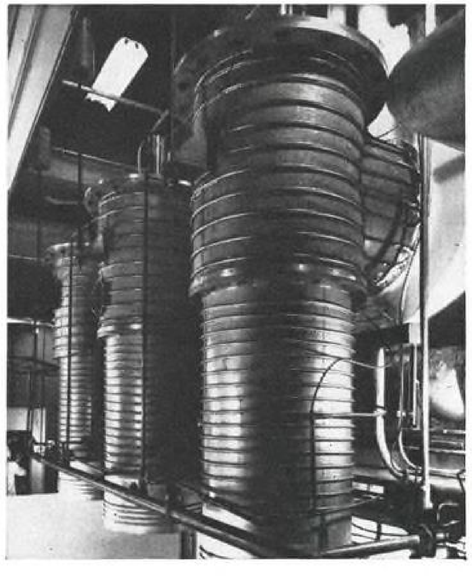
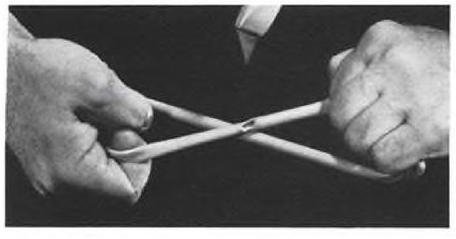


Silicones help simulate space ...

Fairchild Camera and Instrument Corporation's Defense Products Division has a 3,000 cubic foot test chamber at Syosset, Long Island. It is used to simulate the environmental pressure at altitudes of 380 miles . . . vacua in the range of 4×10^{-9} mm Hg.

Dow Corning® diffusion pump fluid is used in the six 32-inch diffusion pumps to achieve the desired test chamber pressure level. Silicone diffusion pump fluid offers superior resistance to oxidation; will not decompose or lose pumping properties; recovers 15 to 20 times faster than conventional fluids after exposure to air; eliminates the need to cool pumps before releasing vacuum; is chemically inert.

Dow Corning also produces a line of coolants for space chambers and other test facilities. Some resist radiation.



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Silastic® 950U rubber is a silicone stock designed for applications in aircraft, space vehicles and ground support equipment. This 50-durometer silicone rubber provides high tensile strength, 1400 psi minimum; tear strength of 175 psi or better; a brittle point of —178 F; good heat stability at 500 F. This stock shows all the properties typical of silicone rubber and is designed to meet the requirements of the following military and commercial specifications: MIL-R-5847D, Class III, Grade 50; MIL-STD 417, TA 510 and TA 512; AMS 3345; and SAE-ASTM TA 510 and TA 512. Parts made from this material are available from many companies fabricating rubber parts to meet the specialized requirements of aerospace applications.

For further information about materials mentioned here . . . or our capability to provide you with tailor-made materials designed specifically to meet your requirements, write Dept. 0923, or call Aerospace Materials Department, Dow Corning, Midland, Mich.

Dow Corning

were transmitted simultaneously to the satellite which returned them shifted due to Doppler effect. From this, range rate is calculated. Range was computed from propagation time and the constant for the velocity of light.

• **Voice to Small Ground Station**—Good quality voice was received at a small antenna mounted atop the Hughes Aerospace building here. This dish is only 10 ft. in diameter, compared to the 30-ft. dia. communications dishes at the three Syncom ground stations.

Owens says he thinks Syncom 2 in future experiments will be able to transmit simultaneously 240 duplex voice channels using the full IF bandwidth, allowing about 1.92 mc. for the 240 8-kc. channels.

Telemetry Acquisition

Satellite signal strength has been sufficiently strong to enable telemetry antennas to acquire their signals when the satellite is 1.5 deg. beyond the horizon and ground stations lock onto the satellite beacon when it appears at 0.5 deg. elevation.

A total of eight maneuvers were made by the onboard propulsion and control systems to place the satellite at approximately 55.6 West Longitude on October 18, within 0.1 deg. of its position, predicted a month earlier. The satellite is inclined 33 deg. with respect to the equator so that in the course of a single day it traces out a figure eight pattern on the ground.

The maneuvers included firing the apogee boost rocket and performing seven corrections with the onboard nitrogen (vernier) and hydrogen peroxide (coarse) control systems. (For a detailed description of these systems, see AW Aug. 20, 1962, p. 80.)

The necessary corrections consumed less than 210 of the 368-ft./sec. velocity increments available to the satellite for orientation and positioning changes, leaving about seven or eight years of station keeping capability. This is longer than the probable lifetime of the satellite's power system.

Decaying Spin

As a result of a leak in the satellite's nitrogen control system, Syncom's spin rate is decaying at the rate of about 6 rpm. per month. The nitrogen system is expected to be exhausted at least for control purposes by December, but the spin rate of the satellite is not expected to drop below a tolerable 70 rpm. level. Much below this instability could develop.

The loss of nitrogen will not degrade future control capability of the satellite, according to Roger W. Cole, Project Syncom orbital analyst, because the nitrogen system accounted for only a small portion (48 fps.) of the 368 fps. orbital control capability and much of this was deliberately used in corrections when the leak was discovered. After the nitrogen is exhausted, the decay rate becomes fractional.

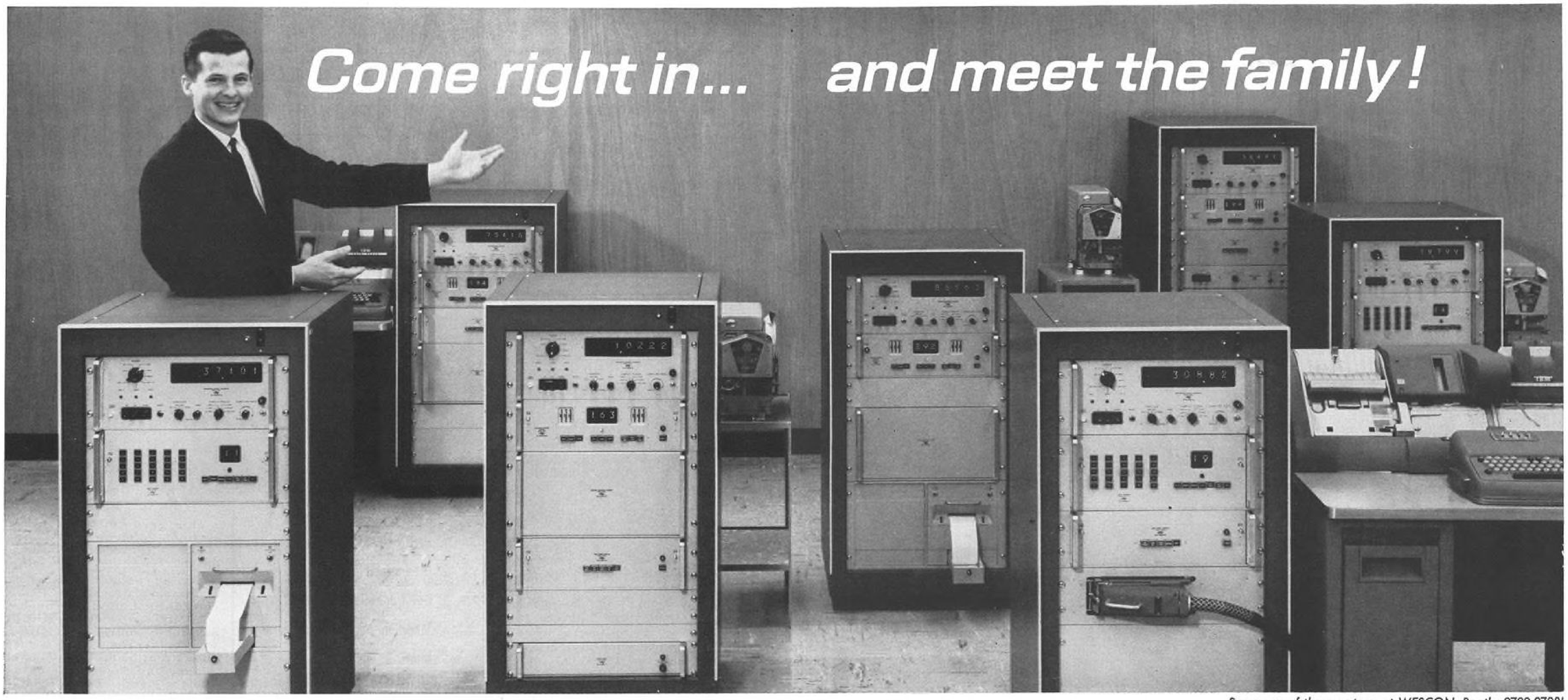
All maneuvers performed by the satellite were directionally correct and were nearly correct in magnitude, according to Cole.

The following correction sequence illustrates this:

• **Apogee Motor Firing**—Spacecraft's apogee motor fired by command of onboard timer for 20 sec., placing the satellite in a near synchronous orbit on July 26, with a speed, relative to synchronous velocity, of 70 fps. within ⅔ of the predicted one sigma accuracy. The satellite was drifting eastward at a rate of about 7 deg./orbit.

• **Westward Drift**—To nudge the satellite westward to its station over the Atlantic, the hydrogen peroxide axial jet was fired on July 27, imparting a 109 fps. increment (one third of the hydrogen peroxide fuel system) to change Syncom's relative velocity such that its drift was westward 4.5 deg., compared with 6.25-deg. rate predicted for the maneuver.

• **Reorientation**—To reorient the spacecraft so that 24-hr. communications could be achieved before the satellite reached station and to make the sun's



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Systems are described briefly in the table. The DY-2010G, not listed, is identical to the 2010D with the addition of a guarded amplifier that makes it ideal for use in measurements of thermocouples, strain gages and similar low-level devices (price, $14,250). Check the table for the system that fits your requirements, then call your Hewlett-Packard/Dymec field engineer for full information . . . and for fast delivery on the system you need.

	DY-2010A	DY-2010B	DY-2010E	DY-2010C	DY-2010D	DY-2010F
Scanner Input	Up to 25 3-wire signal sources; to 100 channels with slave scanners; programming capability permits measurement of mixed types and levels of signals			Up to 200 guarded 3-wire inputs; 300 2-wire; to 600 non-guarded 1-wire inputs		
Voltage Ranges	100 mv to 1000 v full scale; overranging to ±300% of full scale on four most sensitive ranges; 0.01% stability on four highest ranges					
Frequency Ranges	10 cps to 300 kc; sample period 0.01, 0.1 or 1 sec ; accuracy ± 1 digit ± time base accuracy					
Display	5 digits of data, range, function (polarity), channel number, all included in front-panel readout, logged on output recording device					
Measurement Speed	5 channels/sec	10 channels/sec	1 channel/sec	5 channels/sec	10 channels/sec	1 channel/sec
Effective Common Mode Rejection	105 db	105 db	105 db	130 db	130 db	130 db
Output	Printed paper tape	Perforated tape	Punched card (on IBM 526)	Printed paper tape	Perforated tape	Punched card (on IBM 526)
Price	$8675	$10,800	$9885	$10,965	$12,850	$12,175
Options	Time of day information, ac voltage and resistance measurements, 10 mv full-scale sensitivity, cabinet					

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rays more incident to the solar panels, another maneuver was executed on July 31. Until this time, the spacecraft's spin axis was in the orbital plane, inclined 33 deg. with respect to the earth's equator. This maneuver, using the hydrogen peroxide jet in a pulsed mode, caused the satellite to precess so that its axis was nearly normal to the orbital plane. As a result drift rate increased to over 6.8 deg. per orbit westward and precession left the satellite short of its desired perpendicularity by 6.5 deg.

• **First Velocity Correction**—On Aug. 11, as Syncom approached the desired longitude, the hydrogen peroxide lateral jet (thrust through the satellite's center of gravity) was fired in the pulse mode to slow the westward drift so that three orbits later the satellite might be synchronized properly near 55 West Longitude.

This correction slowed the satellite to 2.7 deg. orbit, 0.7 deg. higher than intended.

• **Second Velocity Correction**—On Aug. 12, the lateral nitrogen jet was fired in the pulsed mode to further slow the westward drift rate to 1.89 deg. The result was 1.3 deg./orbit drift. The satellite was left in this orbit for three cycles so that it would overshoot the 55 deg. longitude goal and would then be corrected for eastward drift.

• **Third Velocity Correction**—On Aug. 15, the lateral nitrogen jet was fired again to reverse the drift sense to 0.05 deg. east. This was expected to be damped out by triaxiality effects so that the satellite would drift slightly east and return west again to the desired longitude 40 days later. The correction was excessive, producing instead a 0.16-deg. eastward drift.

• **Fourth Velocity Correction**—On Aug. 16, to correct the previous overcorrection, the nitrogen lateral jet was fired in the pulse mode to reduce the eastward drift to 0.03 deg./orbit, the actual value achieved being 0.09 east. This raised the cycle time to roughly 60 days.

This degree of synchronization was regarded as satisfactory considering uncertainties in orbital data, triaxiality, radiation pressures, various perturbations, etc.

• **Attitude Touch Up**—On Aug. 18, the axial nitrogen jet was fired to adjust the satellite's attitude such that its axis would be normal to the orbital plane. This came within 1 deg.

Fuel required to make the last six corrections was about equal to that of the first control correction for westward drift alone.

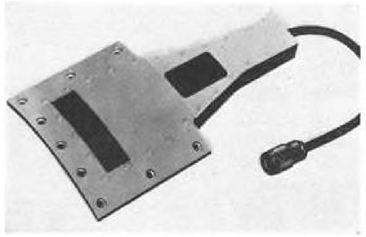
The satellite has now remained within about 0.5 deg. of 55 deg. West Longitude for a period of nearly three months without need for making any corrections.

NEW AVIONIC PRODUCTS

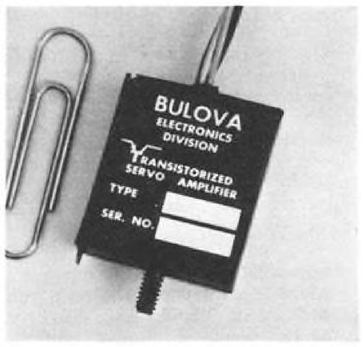
• **Pulse-code modulation simulator,** Model PTS-3A, with extendable programming drawer providing decimal switches for easy PCM format selection, employs oscillator whose initial frequency can be selected to 0.1% by means of three decimal thumbwheel switches. Stability of internal clock is maintained to within 0.05% over temperature range of 0-55C. Simulator can generate a serial bit train with main frame synchronizing word, two variable words, main frame common word, identification word and up to nine sub-commutation synchronizing syllables, at bit rates from 1 cps. to 1 mc. Operator can control jitter, rise time as well as format and output code. Manufacturer: Defense Electronics, Inc., 5455 Randolph Road, Rockville, Md.

• **Miniature long-wavelength infrared detector,** Model QKN-1227, sensitive in the 2-15 micron region, has time constant of less than 1 microsec. Device measures 1.19 in. in diameter by 0.39 in. thick. Manufacturer: Raytheon Co., Special Microwave Devices Operation, 130 Second Ave., Waltham, Mass.

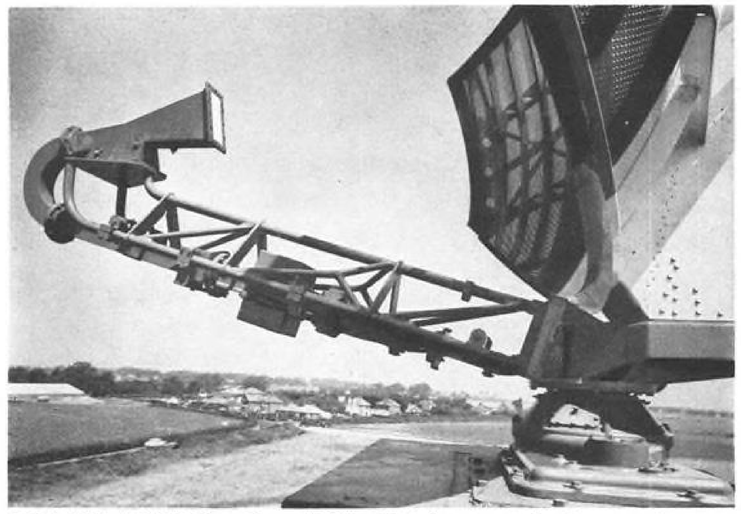
• **Lightweight beacon antenna** for X-band use with missiles and re-entry vehicles, Model DM-AQ2 uses leaky wave endfire fed aperture widened to two wavelengths in the H-plane, to provide 4½ db. gain over an open-end waveguide. Antenna is tunable over frequency range of 9-12 gc. (kmc.), has bandwidth of 75 mc. within fixed tuning range and a VSWR of 1.5:1. Antenna is curved to fit conic or cylindrical vehicles and can be used singly or in pairs with a matched power splitter. Manufacturer: Dorne & Margolin, Inc., 29 New York Ave., Westbury, N.Y.



• **Miniature servo amplifier,** Type 165, for size 11 servo motors, delivers 3.5 watts, operates over temperature range of −55C to 125C from 28 v.d.c. with up to 80 v.d.c. transients. Encapsulated amplifier, designed to environmental requirements of MIL-E-5272C, measures ⅛ x ⅛ x ⅛ in. and weighs ½ oz. Manufacturer: Bulova Watch Co., Electronics Div., 40-01 61st St., Woodside 77, N.Y.



• **Microwave varactor diode,** Model MD100, silicon planar epitaxial diode, exhibits 60% efficiency when operated with input of 1.5 gc. (kmc.), output of 3.0 gc. and output power level of 2 watts. Cutoff frequency at zero volts is 70 gc. and capacitance is 2.0 picofarads, according to manufacturer. Fairchild Semiconductor, 545 Whisman Road, Mountain View, Calif.



BOOM ARM ASSEMBLY on Decca Radar's AR-1 airport control system mounts components for remote-control variable polarization and circular polarization. Feed horn has a fin-loaded aperture to provide equal beamwidths for the two orthogonal polarizations. Antenna is a single reflector horn-fed unit of cosecant squared pattern, with an antenna gain of 31 db. Horizontal aperture is 16 ft. and vertical aperture is 6.5 ft.

Surveillance, Approach Functions Combined in Traffic Control Radar

London—Decca Radar, Ltd., has developed an AR-1 airport control system in which a single radar carries out all normal air traffic control functions from very close range to a 75-mi. limit. First orders for AR-1 were placed recently by Royal Air Force, which said it will obtain a "substantial number," probably about 20 units.

The system is now in initial production at new Decca Radar plant on the Isle of Wight. Present capacity is for about 20 units per year but Group Capt. Edward Fennessy, managing director, said capacity can be doubled if necessary.

Sale to Royal Air Force, made through British Ministry of Aviation, was the opener in what Fennessy called an international sales drive aimed at small airports with limited budgets for air traffic control. Installed, the AR-1 system will cost about $186,000. This price includes a prefabricated building to house transmitters, an optional item.

AR-1 comprises a single beam 10-cm. (S-band) radar which Decca says gives unbroken coverage to a range of 75 naut. mi. and to heights in excess of 40,000 ft. Equipment consists of the antenna, a standard tower, one or two transmitter cabinets, a log/lin receiver housed in an ancillaries rack, control unit and two displays, which may be of either fixed coil or rotating coil type.

The airport uses embodied in the single radar system are the following:

- **Surveillance of holding** and approach patterns and radar sequencing of approach traffic.
- **Surveillance radar element of** a ground controlled approach (GCA) system. Decca says AR-1 meets all performance and specification requirements of ICAO Annex 10 for this feature.
- **Plan position indicator** (PPI) approach. During company and RAF evaluation, aircraft were controlled to within one-third of a mile from the antenna down to a height of 200 ft.
- **Parallel runway approach** surveillance and low level surveillance with no degradation of moving target performance. Target renewal is once every four seconds.

Another feature, and one which was an important factor in RAF acceptance, was early aircraft identification on takeoff. During operational trials, high performance fighters (English Electric Lightnings) were followed in combat climbs initiated within one-quarter mile of the radar head. Systems also will be used for fighter recovery. Decca says there are no blind speeds below 560 kt.

AR-1 aerial is a single reflector horn-fed unit of cosecant² pattern with an antenna gain of 31 db. Horizontal aperture is 16 ft. and vertical aperture is 6.5 ft. Spot frequency is in the 2,750-2,900 mc. or 2,850-3,050 mc. bands. Horizontal beam width is 1.5 deg., an-

"Microwave tube research at Varian isn't always directed toward major technical breakthroughs. Many company-funded programs are aimed at less glamorous goals, such as increased tube reliability. To develop more reliable tubes, our R&D people must identify, understand and eliminate the causes of tube failure. Right now, we're doing promising work on field emission points, in hopes of eliminating high-voltage breakdown in high-power tubes. ❀ Work of this kind sometimes has very beneficial side effects. A research program on reliable cathodes led to a major breakthrough in vacuum technology, the invention of the VacIon® pump. We use these pumps extensively in our manufacturing operations, and they have substantially increased the reliability of our tubes. This was, after all, the basic objective of the research program." *Dr. Theodore Moreno (left), Manager, Palo Alto Tube Division. Dr. Moreno is shown here conferring with Varian research scientists, Dr. Ivor Brodie (standing) and Dr. Daniel Dow (right).*

TUBE DIVISION, *Palo Alto, California* | BOMAC DIVISION, *Beverly, Massachusetts* | VARIAN ASSOCIATES OF CANADA, LTD., *Georgetown, Ontario* | SEMICON ASSOCIATES, INC., *Lexington, Kentucky* | S-F-D LABORATORIES, INC., *Union, New Jersey*
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tenna rotates at 15 rpm. and is stressed for operation in wind speeds up to 70 kt.

The 650-kw. transmitter has a low noise traveling wave tube preamplifier giving a noise factor better than 6 db. over all. A stable local oscillator (stalo) is housed in RF section. This is a modified triode cavity oscillator with AFC servo systems.

Transistorized receiver has logarithmic characteristic to provide additional block clutter reduction coupled with good target-to-background contrast.

FILTER CENTER

▶ **New Microcircuit Companies**—A new company to specialize in semiconductor microcircuits has been set up in the San Francisco Bay region and another one may follow shortly. Stewart-Warner Inc., a subsidiary of Stewart-Warner Corp., will be located in Sunnyvale, Calif., and headed by Don Potter, vice president and general manager of Stewart-Warner's Electronics Div. Dual executive vice presidents will be Bill Hugle, formerly with Siliconix, and Ken Brunsman of Stewart-Warner. This company raises to nine the number of semiconductor organizations in the Bay area, seven of them formed in the past three years. In addition, Union Carbide has been surveying the possibility of entering the semiconductor microcircuit business, probably in this area.

▶ **Tactical Laser Weapons**—Possible use of intense, high-energy beams of optical masers in tactical weapons is under serious review by industry and the military. This is in addition to the more ambitious and more remote possibility of their use against aircraft and missiles, under Dept. of Defense funded study for nearly two years (AW Mar. 26, 1962, p. 41). Among the proposed tactical weapon applications are as countermeasures against heat seeking air-to-air missiles like Sidewinder. Also proposed is a high repetition rate battlefield personnel blinder. Laser beams can damage or destroy infrared sensors and can permanently impair human vision. Such weapons may be within the foreseeable reach of laser technology.

▶ **Micro Computer for Maneuvering Re-entry Vehicle**—A microminiature digital guidance computer intended for use in a maneuverable re-entry vehicle is being developed by the Univac Div. of Sperry Rand under contract from USAF's Ballistic Systems Div. Like comparable units slated for the guidance system of the Medium Mobile Range Ballistic Missile, the new computer is derived from the semiconductor microcircuit computing machine made by Univac last year (AW Dec. 24, p. 43). It will

mate with an inertial platform under development at Massachusetts Institute of Technology and probably is slated for ultimate application in the maneuverable ballistic re-entry vehicle (MBRV), a highly advanced ballistic system capable of making preprogrammed evasive action to avoid interception after re-entry (AW Sept 16, p. 23). MBRV is being designed by General Electric.

► **Radiation Resistant Solar Cells**—A multi-company program aimed at further developing the drift field solar cell, a device which shows promise of being more resistant to nuclear particle irradiation in space than available N-on-P solar cells (AW Mar. 4, p. 88), was begun recently by National Aeronautics and Space Administration's Goddard Space Flight Center. Participating companies and the dollar values of their contracts are Electro-Optical Systems, $47,130; Heliotek Div. of Textron Electronics, Inc., $51,567; and Texas Instruments, $40,031. Working under an earlier NASA contract, Electro-Optical developed the drift field cell, in which a drift field is built into the silicon cell's base region.

► **Superconducting Nuclear Detectors**—Nuclear particle detectors, using thin superconducting films, of materials such as tin, which might prove to be unusually sensitive to alpha particles, are being investigated by Atomics International Div. of North American Aviation.

► **Government Funds More Laser Research**—Among recent contracts for laser research and development awarded by military agencies to industry are:

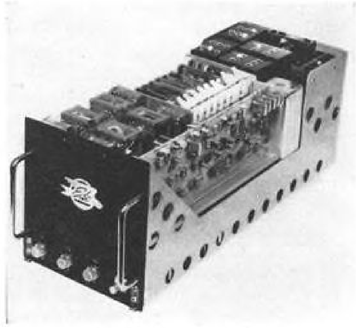
• **North American Aviation's** Los Angeles Div. will explore the spectral emissivity of chemical reactions in a search for high energy pumping sources for lasers under a $94,670 contract from the Office of Naval Research. The study is similar to one funded by ONR at Aeronutronic (AW Sept. 23, p. 95).

• **Varian Associates** will conduct experiments to determine the feasibility of an infrared maser using excited molecular states under a $50,000 ONR contract.

• **American Optical Co.** will pursue possibility of obtaining useful laser action from a neodymium glass laser pumped by solar energy, a continuation of two years of research sponsored by Air Force Aeronautical Systems Div. (AW Apr. 22, p. 69).

• **Mithras, Inc.**, Cambridge, Mass., will examine fluorescent ions in various crystals under a $39,960 contract from ONR.

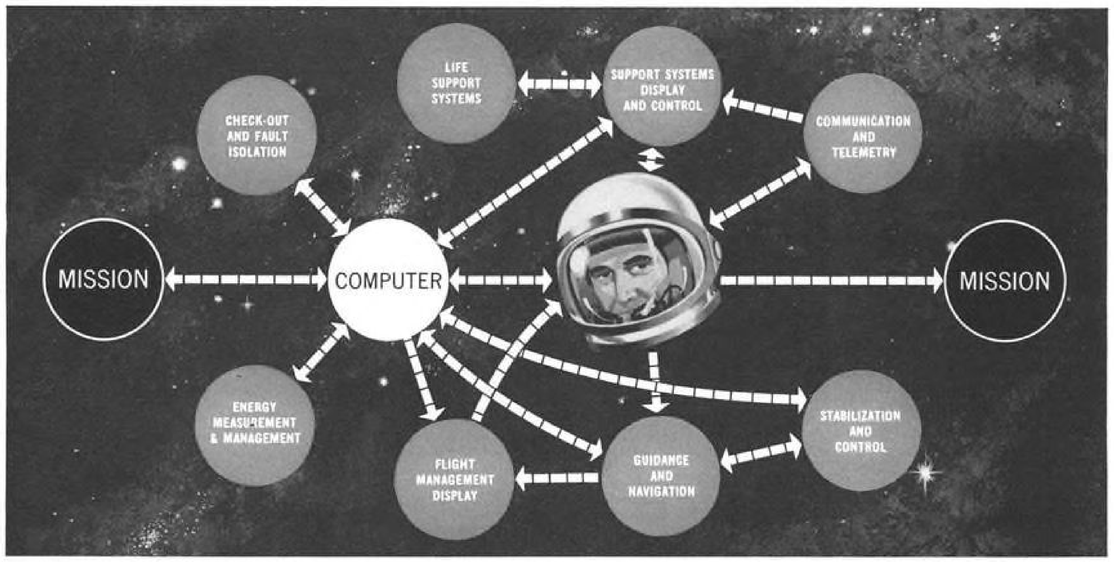
► **Upside-Down Diode Improves Performance**—Technique which reportedly reduces the leakage current of alloyed junction diodes by as much as 1,000:1 has been discovered by two researchers at Purdue University. Instead of placing pellet of antimony on top of a thin germanium wafer prior to heating, the pellet is placed underneath the crystal. This produces a much smoother junction which slashes leakage current by factor



Solid State Loran

Solid state airborne receiver, Model 600T, combines Loran A and Loran C capability in a package that weighs less than 30 lb., according to Edo Commercial Corp., White Plains, N. Y. Design eliminates electromechanical devices by using photo-conductive selector switch modules. Power consumption of system is 100 w.

How can Pilot/Managers be integrated into future aerospace missions?



MAN-MANAGEABLE SYSTEMS INTEGRATION for an aerospace vehicle produces a flexible man/machine team for managing a flight successfully. This single-system development for wide application brings together Honeywell's full-spectrum capabilities and experience in a variety of subsystem areas. Honeywell has proven its management experience in each of these areas (and related areas) to provide man-manageable systems.

Automatic systems must be designed to bring man's management capabilities into play

Completely automated systems, *when performing their functions reliably*, are such that it may be possible for man to complete an aerospace mission and return safely —without ever making a single decision affecting the mission.

However, the inevitability of system performance deviation—as well as the additional weight of subsystems to do tasks that are simple for man—require that future vehicle systems provide for man to play an active role. Consequently, Honeywell systems are designed so that *man can manage the mission* throughout all its phases. This design approach results in what we call a "man-manageable system"—one that has the flexibility to be adapted to changing conditions in the course of a mission.

Exactly what is a man-manageable system? It is one that puts man in complete charge of the mission, able to allocate tasks and subtasks to the various subsystems —or to himself—during the flight. For example, during a space ferry mission the astronaut may want his system to automatically handle both guidance computation and control. Or he may only want the system to display solutions to alternative guidance problems which he poses. *But the decisions are his.* A man-manageable system does not take over the decision-making and action-initiating functions of man (see illustration at left).

Of course, man can't possibly direct all subtasks constantly during a space flight. Limits of space and time do not allow having a separate display for every information element. In fact, displays must be integrated and compatible with the astronaut's capabilities and with the system. From these displays man must comprehend the information and be able to act upon it quickly—and in some cases reflexively.

Information comes to the man from a computer which collects, assimilates and processes the vast amount of data provided by the various subsystems. A balanced allocation of tasks and information between man and the computer produces a flexible team for managing the flight and accomplishing the mission.

Such a man-manageable system is made up of interdependent subsystems that may be unified upon command. For instance, the guidance, control, stabilization, energy control and life support subsystems must be planned and built with an understanding of both the subsystem's peculiarities and its role in the man-managed mission. As a result, man and all other subsystems are properly interfaced so they function integrally to perform the required operations. Together they form a closed loop system.

This systems philosophy is a basic element in producing man-manageable systems. System management goals can then be translated into a plan of task sequences and task allocations, which results in a compatible group of major subsystems that can be planned down to the smallest engineering and production detail.

Due to the range of technologies required, from mission analysis through production, a man-manageable system requires that a contractor be highly experienced and knowledgeable in each subsystem area. Through active participation in every type of U.S. military and space program, Honeywell has developed a high percentage of total resources required to fulfill the role of man-manageable systems integrator.

We invite management level discussions on Honeywell's unique capabilities in producing man-manageable systems and their integration and application to next generation aerospace systems. Write Honeywell, Dept. 671A, 2600 Ridgway Road, Minneapolis 40, Minn.

Honeywell investigates high-speed sighting

Tactical air warfare missions of the future may be flown at high speeds and as low as 50 feet above the ground.

A new concept in quick-reaction bore-sighting will permit pilots of the future to track and fire on targets within seconds after locating them.

Honeywell's concept requires the pilot on a tactical air warfare mission to merely look at the target through an eyepiece mounted on his helmet and press a "fire" button. Sensing devices mounted in the helmet will automatically locate the target with reference to the aircraft and feed the information into a centralized computer.

The computer, by knowing the aircraft's attitude, position and speed, computes the required trajectory and fires the missile at the optimum time.

EVALUATION MODEL of helmet-mounted target sighting device is used in human factors studies at Honeywell probing search behavior and predicting the performance level of the human eye while a pilot is flying a low-altitude tactical mission.

ENGINEERS AND SCIENTISTS: Explore new professional opportunities. Write Mr. Fred A. Laing, Honeywell, Minneapolis, Minnesota 55408. An Equal Opportunity Employer.

Sustenance for spacemen: What are minimums?

Since the volume and weight of supplies to sustain a five or six-man crew in a space station for a year would reach unwieldy proportions, Honeywell is studying the problem of biologistic tasks for rendezvous vehicles.

In constructing a realistic mission for a six-man crew in a space station that requires resupply every 30 days for a period of two to three years, the Incremental Life Support Operations (ILSO) must consider many factors: oxygen provision, removal of carbon dioxide, water provisioning and recovery, and waste management. In addition, the amount of room and living environment of the station and how ILSO affects them are also being considered.

For example, 1,200 pounds of water (including two-week emergency rations) will be required at launch to maintain the crew for 30 days—if metabolic waters of respiration and perspiration are reclaimed. However, before any conclusions can be reached on water supply versus reclamation, Honeywell scientists and human factors engineers are considering both the psychological and physiological factors and reclamation equipment required. The study is one of a series that Honeywell is conducting on man-machine relationships, how to support man in space, and the adaptability of the human body to space station conditions.

Some of these current Honeywell-supported studies include the investigation and analysis of respiratory and circulatory physiology aimed at understanding the causes and prevention of oxygen toxicity and contamination.

Honeywell considers life support a major subsystem in an aerospace vehicle. The company's staff of highly trained human factors engineers are thoroughly familiar with the psychological and physiological aspects of operating and living in space stations and aerospace vehicles. These efforts are extending Honeywell's overall system capability to assure that Honeywell aerospace systems are compatible with man and will support his mission.

Technical paper on "Biologistic Tasks for Rendezvous Vehicles" is yours free of charge. Write Honeywell, Dept. 671A, 2600 Ridgway Road, Minneapolis, Minn. 55440.

ADVANTAGES of Honeywell's Man-Manageable Systems

1. Man's capabilities are used to the fullest extent in an optimized man-machine relationship. Man-manageable controls extend man's capabilities in accomplishing the mission.

2. Tradeoffs among subsystems and man's capabilities are determined from a mission standpoint.

3. Test and maintenance can be introduced so that checks can be made upon subsystem performance, and corrective maintenance of components, modules and subsystems can be made in flight.

4. Circuits and components are standardized, subsystems are man-related and optimum redundancy or back-up is achieved.

5. Operational reliability and increased mission flexibility are attained. Fewer on-board subsystems and back-up units are needed.

Honeywell

of 100:1, according to Purdue's Yuan Feng Chang and H. W. Thompson, Jr. When same technique was used to fabricate silicon diodes, a 1,000:1 reduction in leakage current was achieved.

► **Infrared Air-To-Ground Missile Guidance**—Breadboard hardware of an infrared terminal guidance system for an air-to-ground missile is being developed by Chrysler Corp. for the Air Force's Air Proving Ground Center, Eglin AFB. Infrared guidance is employed in Sidewinder air-to-air missiles, is being developed for the Redeye surface-to-air and Shillelagh anti-tank missiles, but now used in air-to-surface missiles.

► **Major Vortac Procurement Soon**—Federal Aviation Agency's last major procurement of Vortac ground stations to complete presently planned airway network, will be made during next several months. Contract is expected to total about $20 million. Twelve prospective qualified bidders recently met with FAA officials in Washington to discuss possible changes in design from previous Vortac procurements.

► **Telstar 2 Defies Diagnosis**—The five-week outage of Telstar 2, followed by a return to normal operation, is still unexplained despite the best sleuthing efforts of Bell Telephone Laboratories scientists. Current conjecture is that one or more of eight electro-mechanical relays in the command circuitry may have "hung-up" or otherwise gotten into a "forbidden configuration," blocking proper operation of the command system, according to Eugene F. O'Neill, Telstar program director.

► **Electron Beam Measures Radar Power**—Measurement of radar pulse power by means of the reflection of an electron beam from the potential barriers within a waveguide has been reported by Soviet scientists. Electron gun and collector are placed on opposite sides of a vacuum section of a waveguide channel. Power measurement is reported to be accurate to within 5% at power levels of 200 kw. using a calorimeter as a standard. Soviet work is reported in Pribory i tekhnika epsperimenta, No. 3, 1963, p. 108-112.

► **Radar Used to Test Solid Propellants**—Atlantic Research Corp. reports that focused microwave energy, like ultrasonics, can be used for non-destructive inspection and testing of solid-propellant rocket motors. Microwave absorption or reflection by the propellant can be used to detect undercuring, improper formulation of propellant and adhesive systems and bonding failures between the inhibitor and propellant.

► **NBS to Publish Radio Journal**—National Bureau of Standards publication, "Radio Propagation," will change its name to "Radio Science," and broaden its scope effective Jan. 1 and publish on a monthly schedule. C. G. Little, chief of NBS' Central Radio Propagation Laboratory at Boulder, Colo., has been named editor. Subscription price will be $9.00 per year, $11.50 for foreign distribution.

► **Explosion-Proof Tests Devised**—Technique for testing equipment which must operate in and near flight vehicles using high-octane fuel has been developed by Air Force Systems Command. It is described in report entitled "Explosion-Proof Testing Technique," AD-400-483, available for 75 cents from Office of Technical Services, Commerce Dept., Washington, D. C. 20230.

► **New Cryogenic Effect Discovered**—Discovery that at least some metal crystals, when cooled to cryogenic temperatures, experience an oscillating change in length when exposed to a gradually changing magnetic field has been reported by two physicists of Western Reserve University. The discovery confirms the theoretical prediction made only six weeks earlier by one of the scientists, Dr. B. S. Chandrasekhar. The fact that magnetic materials experience a change in dimensions when exposed to an oscillating magnetic field, known as the magnetostrictive effect, has been known since 1842. But the new discovery, that a gradual variation in field causes the metal to alternately shrink and expand is an outgrowth of theory developed by Soviet Nobel Prize winner Lev Landau who calculated change in energy of electrons in a metal when magnetic field is applied. In recent experiments, Dr. Chandrasekhar and Dr. Benjamin A. Green, Jr. used a single crystal of bismuth exposed to a superconducting magnet producing more than 30,000 gauss and cooled to temperature of liquid helium.

► **Anglo-French Avionics Consortium**—The (British) Marconi Co. and Compagnie Francaise Thomson-Houston have formed a technical consortium to produce jointly a new secondary radar interrogator system, to be known as Secar. The fully transistorized system will be compatible with military and civil traffic control beacon requirements.

► **ITT to Build Microcircuit Facility**—International Telephone & Telegraph Corp. will build a $3 million, 135,000-sq.-ft. facility in West Palm Beach, Fla., to manufacture microcircuitry and other semiconductor devices. Facility, known as ITT Semi-Conductors, Inc., is expected to be completed in February and eventually to employ 500 people.

► **Microwave Transistors Reported**—Gallium-arsenide transistors, fabricated by new process, have exhibited a gain-bandwidth product of 1.4 gc. (kmc.), indicating an alpha cut-off frequency of higher than 2 gc., H. L. Henneke, Texas Instruments Inc., reported at the recent Electron Devices Meeting in Washington. Using an alloy of tin and indium to form the emitter provides higher injection efficiency and therefore higher betas, Henneke reported. Low melting point of this alloy presently restricts the transistor to operation below 200C temperature but minor changes in fabrication technique should permit operation at temperatures above 350C, he predicted.

► **Electron Beam Duplexer Reported**—Experimental broadband duplexer, which makes use of slow-wave and fast space-charge wave coupling to an electron beam, capable of handling 10-kw. peak and 200-watt average power at C-band and S-band while protecting receiver against signal power greater than 10 milliwatts, was reported by Irving Itzkan, Sperry Gyroscope Co., at the recent Electron Devices Meeting. Maximum noise figure for the experimental electron beam duplexer is 6 db., according to the report. Paper was co-authored by Karl Knudsen and Albert Brandenstein.

► **Microminiature Magnetometer**—Magnetometer weighing only 0.004 grams but capable of producing an output of 1 volt per gauss of field, can be fabricated using 3-5 compound semiconductor and the Hall Effect, according to a paper by Neal P. Milligan and James P. Burgess of Ohio Semiconductor Div., Tecumseh Products Co., Columbus, Ohio, delivered at the Electron Devices Meeting.

► **Signed On The Dotted Line**—Major contract awards to avionics manufacturers include the following:

• **Ion Physics Corp.**, Burlington, Mass., will investigate effects of a two million volt electron bombardment on materials, using a 2 mev. Van de Graaff generator, under Air Force contract. In-

itial tests will use aluminum, tungsten and quartz as target materials.

• **Laboratory for Electronics, Inc.**, Boston, will investigate high-frequency parametric amplifiers using low-frequency pump sources under $95,000 contract from USAF's Aeronautical Systems Div.

• **United Aircraft Corp.**, Hamilton Standard Div., will design and build pilot production line to demonstrate use of electron beam welding to interconnect semiconductor microcircuit wafers and to hermetically seal new "Enhanced Micro Modules" under contract from Army Electronics Materiel Agency. (The Enhanced Micro Module is a new version of RCA-Army Micro Module designed for microcircuit use with many more riser wires to provide additional interconnections needed between individual wafers.) Company also reports a $630,000 award from USAF's Research and Technology Div. to develop a thin-film microcircuit fabrication facility. The integrated facility will be designed to fabricate, analyze and test microcircuits without removing them from vacuum chamber.

• **General Precision** GPL Div., Pleasantville, N. Y., will produce Doppler radar navigators for Navy anti-submarine, attack and early warning aircraft under $1.6-million contract from Bureau of Naval Weapons.

• **Sylvania Electric Products**, Waltham, Mass., will conduct basic research on error-correcting codes designed to eliminate errors in high-speed digital communications under an $80,000 contract from Air Force Cambridge Research Laboratories.

• **Bendix Radio Div.**, Towson, Md., will design and manufacture a mobile all-weather missile range safety system under $1-million contract from Navy. System will be used to monitor early phase of missiles launched from Pacific Missile Range, providing missile position and velocity data for range-safety computers during first 10,000 ft. of missile flight.

• **Sperry Gyroscope Co.**, Great Neck, N. Y., will produce ship's inertial navigation systems (SINS) for attack submarines, aircraft carriers and a missile tracking ship, a total of 21 vessels, under $14.2-million contract from Navy.

• **Chicago Aerial Industries, Inc.**, Barrington, Ill., will develop manufacturing techniques and equipment for mass production of high-quality fiber optic plates under $297,000 contract from Army. The fiber optic plates will operate in the visible and near-infrared part of the spectrum.

• **Stewart-Warner Electronics**, Chicago, reports two production contracts totalling more than $4 million from Navy and Air Force for radar altimeters to be used by RF4-C and ARN-52 Tacan navigation equipments.

Flying Tiger Line technicians at the line's main base of operations in Los Angeles, Calif., inspect the fuselage break area of one of their famous swingtail air freighters

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MANAGEMENT

Costs and Schedules Stressed Under New Marshall Structure

By George Alexander

Huntsville, Ala.—Marshall Space Flight Center's reorganized management structure (AW Sept. 9, p. 25) will focus more attention on schedules and costs—areas that formerly were overshadowed by pressing technical requirements of the Saturn program.

Recasting of the management structure of this major National Aeronautics and Space Administration center reflects growing concern with rising costs of the manned lunar landing program.

Wernher von Braun, director of the center, said: "Technically, we are quite satisfied with the hardware we are buying. But we are not so happy with the schedules and costs of hardware. We hope to be in a better position to control slippages in the future."

Externally, the reorganization has been a regrouping of the many-elemented old structure into two large blocs:

- **Research and development operations,** which includes nine technical divisions now called laboratories, and four special offices.
- **Industrial operations, which includes** the project offices of the old structure, part of one old division and two field installations.

Internally, and less tangibly, the reorganization has reduced the impact of "working groups" in different Saturn programs and increased project office powers.

Formerly, when the center's primary effort was on development of detailed hardware designs, project offices relied heavily upon those groups for technical direction. The groups (AW July 2, 1962, p. 100) were composed of specialist personnel from the technical divisions, from the project office and, upon occasion, from contractor firms.

Members hammered out, among other things, the framework of a Saturn stage's electrical system, mechanical design, checkout and test requirements. The groups also provided the project office which they served with all the data needed by the project manager to issue appropriate directives to the contractor concerned. The groups also monitored the work done by the contractor.

It was through the working groups that the Marshall center sought to apply its engineering skills and experience to technical problems. The groups are credited by von Braun, by all Marshall management levels and by industry, as having been key instruments in the progress made to date in Saturn development. "Without their penetration," one center official said, "we wouldn't be as far advanced as we are today with Saturn systems."

But with the designs of the Saturn 1, 1B and 5 either complete or nearly free of major development bugs, the need for daily, fine-grain support from the working groups has largely evaporated. The center's primary task today is the supervision of a large-scale, nation-wide manufacturing and test effort, and the shepherding of many Saturn parts so that they come together at the right time in the right place.

To do this required a re-adjustment of the relative strengths of the working groups and project offices. Under the

Program Definition

Huntsville, Ala.—Industry can expect the Marshall Space Flight Center here to adapt a stringent version of Defense Dept.'s program-definition technique in all future major system procurements.

Wernher von Braun said that practically all technical, schedule and cost problems encountered in the development of Saturn systems to date could be attributed to "a lack of proper definition" before the programs got under way. He said that a well thought-out pre-program definition phase, similar to that used by the DOD in the evolution of the mobile medium-range ballistic missile (MMRBM) would prevent recurrence of the schedule slippages, design changes and cost over-runs experienced so far by Marshall.

"It is important to have a better handle on a project," he added, "before the contract is signed."

Von Braun said that present bidding procedures essentially are "leaning-out-the-window contests, with contracts going to the company which can lean the farthest without falling."

Marshall must share part of the blame for this situation, von Braun said, since "we were so eager to get going [with the various Saturn programs]." In the future the Marshall director said, the center will take more time to carefully identify—perhaps with contractors' aid—all the essential technical, schedule and cost details of a new system before the inauguration of competitive hardware procurement.

'Paternalism' Challenged

Huntsville, Ala.—Appointment of Robert B. Young as director of industrial operations for Marshall Space Flight Center is expected to reduce or eliminate reported friction with Saturn project contractors.

Officials here denied any knowledge of dissension, but from industry there have been numerous complaints about the "paternalistic" attitude taken by Marshall in dealing with contractors.

Selection of Young (AW Sept. 9, p. 25), a former vice president of Aerojet-General Corp., was welcomed by industry because his long experience should give him a better understanding than evidenced by Marshall officials in the past, according to contractors.

Complaints have been in three major categories:

- Marshall concerns itself with details of management which normally are left to contractors to resolve. "They don't give you credit for having a brain in your head," one private source said.
- Tendency to dismiss contractor-originated proposals and ideas with an 'if-it-wasn't-made-here-it-can't-be-any-good' attitude.
- Tendency to expect unquestioning obedience from contractors. Free discussion of an approach conflicting with one adopted by the center is frowned upon, according to several industrial sources.

Observers thought Young's appointment may answer the need, expressed by Wernher von Braun, for as great an awareness at Marshall of schedules and costs as there is within industry. Young, reputed to be a forceful personality, started work Nov. 1.

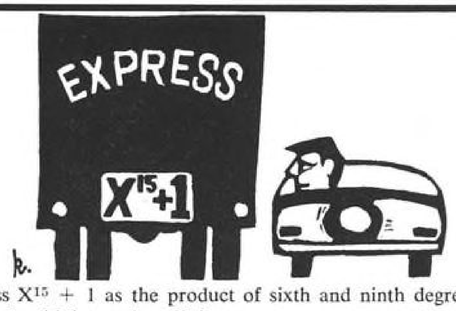
former organization, the groups dominated the project offices not only by virtue of their assigned responsibilities, but also frequently by sheer numbers. One particular working group had about 150 personnel, while the project office which it served could muster but five men.

"You can R-and-D [research and development] something to death," one observer said in reference to the old relationship. "Now it's time for management to take over and start pushing this hardware out through the hangar door."

Marshall engineers could be called "perfectionists' with some justification, von Braun said, since there was a strong tendency to go on "tinkering" with something "just to make it work a little bit better." He said the time for tinkering, is during the preliminary design phase and that time has long since passed and added:

"We must prevent great numbers of people from impinging on the program

PROBLEMATICAL RECREATIONS 197



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now," von Braun said, "since this can only lead to major scope changes in the program. And these changes will cost us in time and money. We can't afford that now."

Under the new organization, the personnel strength of the project offices has been increased an average of 20% to date and, in some instances, by almost 100%.

With new people drawn from within Marshall, from other NASA centers and from industry, project offices are in a better position to make decisions without relying wholly on the working groups.

Responses Improved

Although there will continue to be much informal discussion between the groups and the project offices on working levels, the formal channels for discussion now are up through division lines to the front office, across to the front office of the other division and then down to the appropriate project office or group. Working groups used to have available a number of lateral channels in which to operate.

In addition to more personnel, the project offices also have both procurement and facilities specialists working side-by-side with managerial personnel. According to Harry H. Gorman, Marshall deputy director for administration, this insertion of contracting officers into the middle of project offices significantly improves the center's ability to respond to day-to-day problems.

"Authority is now delegated to the level where the responsibility is located," Gorman said. This includes field offices at the different government and contractor plants in Louisiana and California, since these now are part of industrial operations.

Speed Change Orders

A Marshall plant representative may authorize a change order for hardware up to the limit of his responsibility and have his contracting officer write the appropriate order that day. The contractor conceivably could begin work on the change that day. Under the former system, the proposal was mailed back to Huntsville, reviewed there by the project office and working group, then forwarded to the procurement and contracts division which would write the order and finally mail it back to the plant—perhaps after several weeks had passed.

Under the new organization, industrial operations will consist of:

The Saturn 1/1B project office, under U. S. Army Col. Lee James; Saturn 5 project office, under Dr. Arthur Rudolph; engine project office (formerly part of the propulsion and vehicle engineering division), under Leland Belew; Michoud operations (Saturn manufac-

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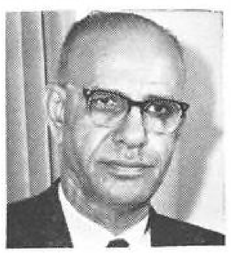

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Remote-Controlled Antenna Range Aids Design

Technicians at Space-General Corp. are shown installing a horn antenna on a three-axis mobile platform for radiation pattern testing at the company's completely remote-controlled antenna test range. The new installation permits remote control of both receiving and transmitting stations by technicians observing instruments recording antenna radiation patterns. This remote control capability keeps test personnel out of the electromagnetic field, where they might influence the signal. Although the antenna range covers less than 500 ft., it permits engineers to determine how a design will function in deep space. The three-axis platform permits tilting or rotating of the antenna to any desired position.

turing plant at New Orleans, La.), under Dr. George Constan; Mississippi test operation, under Navy Capt. William C. Fortune; and the four major offices of contracts, facilities projects, project logistics and resources management.

Research and development operations, under Director Hermann K. Weidner, will include the nine laboratories (formerly divisions) of the old structure – aero-astrodynamics (formerly aeroballistics), astrionics, computation, manufacturing engineering, research projects, propulsion and vehicle engineering, quality assurance and reliability (formerly quality assurance), test, and launch vehicle operations. This bloc also includes offices for future projects, special assignments, systems management and resources management.

The working groups will be coordinated by the systems management office, under Konrad Dannenburg, formerly deputy director of the Saturn systems office. The groups, said Dannenburg, will continue to be the center's means of "penetrating in depth" the problem areas encountered by Marshall but "financial problems will be emphasized more in the future" rather than technical problems.

Von Braun was emphatic that neither the laboratories nor the working groups –in which the center's in-house capability resides–would be allowed to decline, now that "industrial participation has increased sharply to over 90% of [Marshall's] total budget."

Not only would these organizational elements be used to support the project offices in supervising the contractors' efforts, he said, but there also will be enough development work in the future to keep them busy. He mentioned the areas of common bulkheads and sound suppression for test stands as two common examples where much work remains to be done.

AFOSR Awards

Air Force Office of Scientific Research recently awarded grants for almost $1.5 million to universities and research firms in the United States.

Grants:

Washington University, St. Louis, Mo.—$20,927 for the application of functional power series to nonlinear systems.

New York University, New York, N. Y.—$36,071 for research on investigations in systems theory; $26,928 for research on measurement of vocalic and tonal contexts.

Massachusetts Institute of Technology, Cambridge, Mass.—$73,000 for research in fluid dynamics.

Yeshiva University, New York, N. Y.—$105,720 for the study of statistical mechanics of transport properties in non-equilibrium and dissipative systems; $88,512 for the study of irreversible processes and general relativity.

Ohio State University, Columbus, Ohio—$10,782 for research on the spectrum of the G9 giant star Epsilon Virginis.

Duke University, Durham, N. C.—$249,200 for the study of microwave, millimeter wave and radio frequency spectroscopy.

University of Chicago, Chicago, Ill.—$26,549 for the study of quasi-elastic proton-proton scattering in light nuclei; $16,709 for research on the relational approach to biology.

University of Mississippi, University, Miss.—$4,800 for the study of spectrophotometric and non-spectrophotometric studies of solutions.

University of Pittsburgh, Pittsburgh, Pa.—$31,754 for the study of free-radical attack on trivalent phosphorous derivatives.

University of Utah, Salt Lake City, Utah—$27,056 for the study of laser temperature-jump studies of fast reactions.

University of Toronto, Toronto, Ont.—$17,528 for research on kinetics of ion formation during chemical reaction in shock waves.

University of Colorado, Boulder, Colo.—$24,945 for the study of methods of validation of judgments in decision-making.

Bureau of Social Sciences Research, Washington, D. C.—$3,924 for the study of human factor aspects of military operations in arid zones.

University of New Mexico, Albuquerque, N. M.—$33,382 to study the influence of campus environment on student commitment to a paramilitary organization.

University of Texas, Austin, Tex.—$35,000 for the study of the quantum aspects of electrical sciences.

University of Pennsylvania, Philadelphia, Pa.—$30,951 for the study of large-sample phonological and morphological studies with machine-generated tools; $10,800 for research on information system design for the information processing field.

Contracts:

University of Miami, Coral Gables, Fla.—$59,380 for the application of stochastic processes in a plasma.

Indiana University Foundation, Bloomington, Ind.—$64,584 for research on the spectrometric studies of fast reactions.

Cornell University, Ithaca, N. Y.—$10,350 for research on the chemistry advisory services.

Hughes Research Laboratories, Malibu, Calif.—$22,538 for the study of acid-base characteristics of phototropism.

Princeton University, Princeton, N. J.—$30,000 for research on perception of time-varying stimulus magnitudes.

University of Michigan, Ann Arbor, Mich.—$57,650 for the study of leadership, organizational effectiveness and human resources.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.—$94,962 for research on high frequency oscillatory combustion.

Columbia University, New York, N. Y.—$130,628 for research on hydromagnetic plasma.

IIT Research Institute, Chicago, Ill.—$51,307 for continuation of determination of the structure of O_3F_2.

PRODUCTION BRIEFING

Douglas Aircraft's Aircraft Div. has received a follow-on contract for $46.7 million from the U. S. Navy for continued production of the Douglas A-4E Skyhawk attack bomber through December, 1965. Contract is on a fixed price basis for the first time, replacing previous cost-plus-fixed-fee arrangements. Total procurement funds, including the most recent order, for this aircraft since initial development contract in June, 1952, now stand at $870 million. Total number of the A-4 series produced is nearing 1,500.

H. K. Porter, Inc., Ambridge, Pa. has been awarded a $1.6-million Army contract for M88 rocket motors and igniters for the Nike Hercules.

General Atomic Div. of General Dynamics Corp., San Diego, Calif., has received a $1.8 million cost-plus-fixed-fee Air Force contract for continuation of nuclear impulse propulsion research.

Follow-on contracts for T-37B jet trainers are being negotiated by USAF and Cessna Aircraft Co., Wichita, Kan. Cessna has received an initial $1.5-million order for additional trainers, which is expected to result in a total follow-on valued at approximately $5 million–allowing production to continue through December, 1965.

Contracts totaling $3.8 million for jet engine and accessory overhaul have been awarded to Southwest Airmotive Corp., Dallas, Tex. The Air Force contracts included the firm's first award to overhaul 164 General Electric J47 engines, at a cost of $1.2 million. Other awards include $432,861 for 103 Allison J35s and $2.1 million for 675 Allison J33s.

Radiation, Inc., Melbourne, Fla., will provide digital command systems for Project Gemini under a $1.6-million contract from NASA's Manned Spacecraft Center in Houston. Contract is for production and installation of two master digital command systems to be installed at Mission Control Center, Clearlake, Tex., and a data router and error detector to be placed in Mission Control Center, Cape Canaveral, Fla.

Mosler Safe Co., Hamilton, Ohio, will build supply valves for underground Minuteman ICBM launch control capsules under a $1.4-million contract from the Boeing Co.'s Aero-Space Div.

Douglas Aircraft Co. has granted a one-cent-an-hour cost of living pay hike to wages of 26,300 hourly employes under terms of union contracts. The increase will add $547,000 to Douglas' annual payroll.

Hawker Siddeley of Toronto, Canada, will develop a lightweight launcher to be used with the Army's new Lance missile system under a $1.5-million contract from the Canadian Department of Defense Production. Lance is being developed as a joint U. S.-Canadian program. Hawker Siddeley will be a subcontractor to Ling-Temco-Vought's Michigan Div., prime development contractor for the Lance.

FLEET OF 10 GRUMMAN AG-CATS is lined up before delivery to Guatemala. Grumman is re-certificating the Ag-Cat with a standard line of the Jacobs radial engine, which ranges in power from 245 hp. to 300 hp. Added power increases competitiveness of Ag-Cat.

Agricultural Aircraft—Part 1:

Market for Agricultural Aircraft Grows

By David A. Brown

Agricultural airplane manufacturers, currently enjoying a high sales volume created by the obsolescence of converted World War 2-era aircraft are counting on remaining predominant in the growing market through 1970, despite competition from helicopter manufacturers.

Helicopters took an appreciably larger share of the agricultural market last year. Rotary-wing manufacturers, sensing that the agricultural field might become a major market for them, have begun intensive research, development and sales efforts toward this goal.

Fixed-wing manufacturers, however, are counting on the undeniable advantages of lower initial cost and cheaper operating costs to keep the airplane predominant in this field. And they are finding their years of effort pleasing to both the agricultural aircraft operator and the farmer beginning to bear fruit.

This is partly because converted Stearman, N3N biplanes and other aircraft which were put into agricultural service are less economical to operate as replacement parts become more unobtainable. New equipment specifically designed for agricultural work, is considered so much better suited to the job to be done. Farmers, more knowledgeable about aerial application needs, are demanding the newer equipment more often.

Main reason that helicopters have begun to show up more in agricultural work during the past year is a reduction in operating costs which, helicopter manufacturers say, are beginning to make rotary-wing craft economically competitive with the fixed-wing agricultural aircraft.

Manufacturers of new fixed-wing agricultural aircraft, on the other hand, have within only the past 18 months marketed aircraft with sufficient engine power to make them competitive with older airplanes which have dominated the agricultural field since World War 2.

Exact figures on the number and types of fixed-wing aircraft in aerial application work are non-existent, but estimates by the National Aviation Trades Assn. indicate that there are almost 2,000 operators in the United States.

Applying a Federal Aviation Agency estimate of an average of 3.2 aircraft per operator, it would appear that there are slightly more than 6,000 agricultural aircraft operating today.

An agricultural aircraft market survey by Cessna Aircraft Co., in June, 1962, indicated there were about 5,000 agricultural aircraft in operation then. That would mean about a 20% increase in the number of active aircraft in 16 months.

Cessna's survey showed there were about 4,000 active agricultural pilots as of June, 1962. The difference between the number of aircraft and pilots was attributed to the aircraft being out of service at times for maintenance.

Of the 5,000 aircraft, 32.6% were converted World War 2 Stearman biplanes, 4.5% were converted N3Ns, 25% were Piper Pawnees and PA-18 Super Cubs, 3% were Grumman Ag-Cats and about 2% were Snow S-2 series aircraft. The remaining 32.9% were miscellaneous types.

Cessna estimated that of all the agricultural aircraft in operation, only about 13.5% were specifically designed for aerial application. This figure has increased, since the replacement of the older aircraft is increasing.

Of the operators, 54.05% are full-time aerial applicators with no other major aviation interest. Of the rest, 21.3% did the work as an adjunct to their own farming activities, 22% were fixed base operators who did aerial application work as a sideline, and 2% were aircraft dealers and distributors who did aerial application work.

This indicated that only about half of the persons engaged in aerial application wanted an aircraft only for that purpose. The rest probably wanted planes convertible to other uses.

Most of the specially designed agricultural aircraft have been available since 1958-59, when the Piper Pawnee, Grumman Ag-Cat and Snow S-2 series first became available. Within the past two years, however, both Piper and Grumman have increased the engine power available in their aircraft, indicating that operators favored more power.

Of all the companies producing specialized fixed-wing aircraft for agricultural use, Piper has been the most successful in selling its product to the agricultural operator.

More than 1,255 Pawnees had been sold from 1959 through Sept. 4 of this year, the latest figures available. Of these, 526 were the up-rated Pawnee 235 version. Earlier Pawnees were powered by 150-hp. Lycoming O-320-A2B engines. The latest version is a 235-hp. Lycoming O-540 engine, which had increased the potential payload from 800 lb. to 1,200 lb.

Pipers' PA-18 Super Cub also has been a favorite agricultural aircraft, but now is being replaced by the Pawnee.

Piper has captured about 80% of new agricultural aircraft sales during the past five years. It hopes to maintain this dominance during the period through 1970. The company foresees a 25 to 30% increase in the number of aircraft engaged in agricultural work by then, based on the increased productivity of farm land.

In order to keep this volume of sales, Piper believes there is a possibility of a need for an entirely new agricultural airplane to supplant the Pawnee in the future. Current development work by the company, however, is directed toward improvement of the present aircraft, rather than a new machine.

Sales of the Pawnee have been so good during the past two years that Piper has been able to keep its agricultural aircraft production line at its Lock Haven, Pa., factory open all year with firm orders rather than inventory production. The production rate has varied from 4 airplanes a week to one every other week. Since the sale of agricultural aircraft is heavily influenced by the season, Piper formerly shut down its line from October to January.

Introduction of the 235-hp. version of the aircraft has allowed the Pawnee to begin successful operations in high-altitude areas where it formerly was unable to compete with older, but higher-powered, airplanes.

The Pawnee now is being operated in areas of the Rocky Mountains and in the high plains area of West Texas, from which it formerly was excluded. Piper said 58 Pawnees now are in operation from Lubbock, Tex., which has an average of 3,241 ft. and where summer temperatures often exceed 100F.

Increased power also has probably increased the replacement rate of older aircraft. Piper calculated the rate some time ago at 3% per year, but believes it probably is greater now.

The only area in which Piper reports some hesitancy on the part of farmers and operators in accepting the Pawnee is in the rice-growing country of California. This lack of enthusiasm apparently was caused by a desire for an aircraft carrying a heavier payload. Piper believes the newer version of the Pawnee will provide this.

The Pawnee 235 carries a 1,200-lb. payload, compared with an 800-lb. payload in the Pawnee 150. Furthermore, the 20-cu-ft. hopper on the airplane cannot be overloaded on the 235 versions as it could on the 150-hp. model.

Farmers, Piper has noted, are becoming more and more critical of the type of equipment used in spraying their fields and often give their business to operators of new equipment.

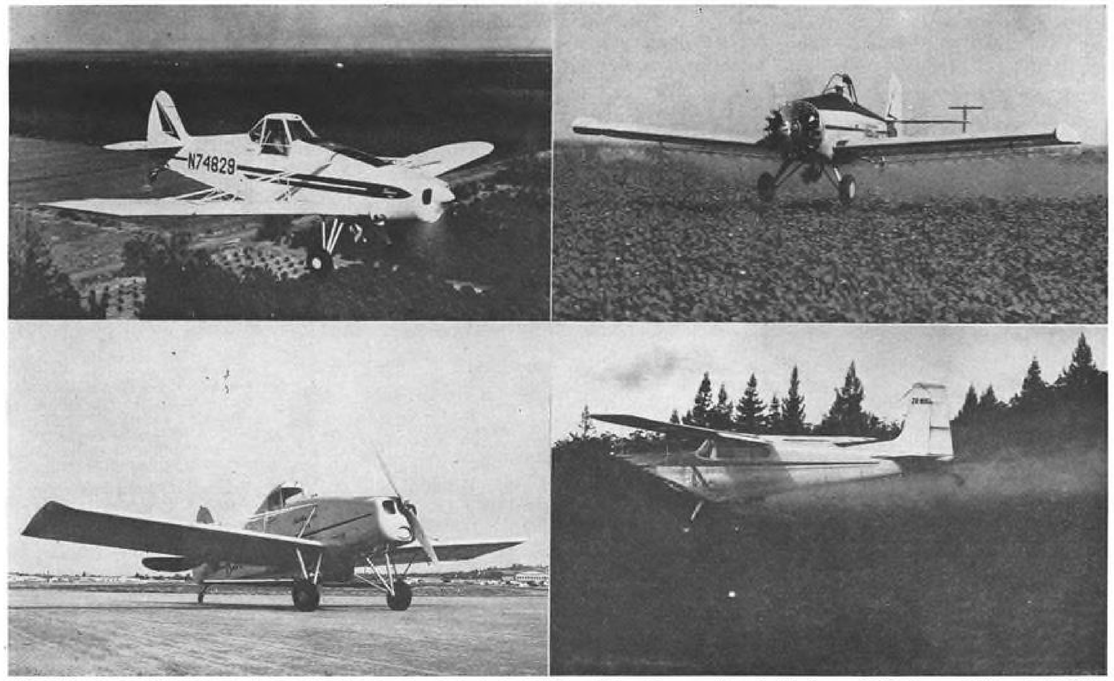
Feedback from both farmers and operators has indicated some points they would like improved. One unusual request has come from farmers and operators in sparsely settled wheat country in Idaho and the Dakotas, who would like provision for a jump seat installed so the pilot could carry his flagman—who marks off swath widths for the pilot—in the aircraft to the work site.

Piper also has done considerable work on a spreader for application of solids. Lack of a suitable spreader was noted by a number of manufacturers, all of whom are pursuing independent research into the matter.

Because the Pawnee is certificated both under CAR Part 3 and Part 8, it has been singularly effective in penetrating the export market.

CAR Part 8 is a utility category sufficient for agricultural aircraft in the U.S. and in many South American nations. Part 3 is a passenger category and requires improved stability and considerable additional paperwork on inspection procedures and manufacturing processes. Most British Commonwealth nations require Part 3 certification.

In 1960, 98 Pawnee 150s were exported—42 of them to Mexico and Cen-



CURRENT PRODUCTION OF AGRICULTURAL aircraft includes 235-hp. Piper Pawnee (top, left), Snow S-2C (top, right) and IMCO's Callair A-9 (bottom, left). A number of standard utility aircraft are being converted for use in the agricultural field. They include the Cessna 180, shown with New Zealand registration markings (bottom, right). Increased power in newer aircraft has helped popularity with utility-minded users. Piper foresees a 25-30% increase in number of agricultural aircraft in use by 1970.

tral America. In 1961, the total jumped to 118, with Mexico and Central America receiving 38 and South America 39. Europe and North Africa received 19 aircraft that year and 11 Pawnees went to Australia.

In 1962, 133 Pawnees were exported, 32 to Mexico and Central America, 27 to South America, 9 to Israel and 26 to Europe and North Africa, including 10 to Spain.

Revision of important restrictions in New Zealand this year opened a new market for Piper and through August, 14 aircraft had been delivered there with 6 more on order. Total export sales for the first eight months of 1963 was 149 Pawnees with 25 more on order. Of this, 18 went to South America with 15 more on order, 60 went to Mexico and Central America with 4 more on order and 28 had been delivered to Europe and North Africa.

One Biplane Design

Grumman's Ag-Cat, the only biplane design among the new agricultural aircraft, also has received a new engine which increased its ability to carry larger loads at high elevations and temperatures.

The aircraft now is being offered with the 300-hp. Jacobs R-755A2M1 and about a dozen have been sold with this engine.

Grumman currently is in the early stages of certificating the Ag-Cat with a standard line of Jacobs engines, to replace the Pratt & Whitney W670 and Gulf Coast engines which were the original powerplants.

Besides the 300-hp. engine, test work on the others, the 275-hp. R-755B2M and the 245-hp. R-755-9 modified with dual magnetos and a revised oil plumbing system to the two lower cylinders, is under way, but Federal Aviation Agency certification work has not yet begun.

In the meantime, the Ag-Cat is being sold with a choice of a 220-hp. Continental W670 engine or a 240-hp. Gulf Coast W670-240 engine.

Some Ag-Cats Modified

Since the Ag-Cat was introduced in 1958, Grumman has sold 238 of them, mostly in the domestic market and mostly in the South and Gulf Coast areas and the Mississippi River Delta. Some aircraft operating on the West Coast have been modified by French Aviation of Bakersfield to have 450- and 600-hp. engines of various makes, to enable them to carry a heavier load at high altitudes.

The Ag-Cat is produced for Grumman by the Schweizer Aircraft Corp. of Elmira, N. Y. and Grumman plans to keep its production line there open during the winter with inventory production. Production rate normally varies from 5 to 12 aircraft per month, depending on the season.

Grumman has been promoting an Ag-Cat finance plan to further sales of the aircraft. The plan essentially is a buy-back agreement, based on an original 20% down payment. Grumman will purchase the airplane back from the operator during the first four years it is in operation, provided it is in flyable condition.

Grumman has made about 3,000 engineering changes in the Ag-Cat since its market introduction in 1958, but aside from the engine changes, all have been relatively minor.

South American Market

Export sales of the Ag-Cat have been almost exclusively to South and Central America, with the biggest single order —10 aircraft—having been recently delivered to Guatemala. Other aircraft have gone to Chile, Argentina and Uruguay.

Possible drawbacks to more extensive sales on the international market are Ag-Cat's price—$16,170 with the 220-hp. engine, $16,615 with the 240-hp. engine and $20,320 with the 300-hp. engine—and the fact that it is not certificated under CAR Part 3, a necessity for sales in many foreign nations.

Price of the metal Ag-Cat—only portions of the wing are fabric-covered—is about $4,000 higher than the Pawnee, which is fabric over a metal frame. The Pawnee sells for $12,195 with a 150-hp. engine, $14,675 with 235-hp. engine.

Despite a relatively small over-all market, a heavy seasonal influence and intense competition, a number of companies are making a success of producing only agricultural aircraft.

Several, in fact, are making plans for expansion of sales and manufacturing facilities, in anticipation of a growing agricultural market.

Multi-Purpose Aircraft

A number of other manufacturers are edging into the agricultural market by producing aircraft which can be converted to agricultural use, while retaining their utility for other work.

Largest among the agricultural-aircraft-only manufacturers is Snow Aeronautical Corp. of Olney, Tex., which has produced about 200 S-2 series aircraft since 1958 and is in the process of expanding its production facilities to about twice their present size.

Snow produced about 50 aircraft in its last fiscal year, which ended in July, and expects a sales increase of about 50% during Fiscal 1964.

The current production model, the S-2C, sells for $16,995 without engine, $21,660 with a 450-hp. Pratt & Whitney R-985 engine and $21,230 with a 600-hp. Pratt & Whitney R-1340.

(Continued on p. 121)

(*Continued from page 119*)

The R-985 is in short supply, accounting for the higher price.

The expansion program is expected to be complete in early 1964, and should allow about a 30% increase in production capability with the same work force, due to a more efficient layout. The expansion was financed by reorganizing the company and selling an interest in the company to several aerial applicator operators. Among these was Crop Culture, Ltd., of England, which operates a fleet of about 30 Snow aircraft in a world-wide agricultural operation.

None of the interests sold was a controlling one, the company said.

Snow's policy has been to allow purchasers of S-2 aircraft to supply their own engines and propellers for factory installation, if desired. Up until last year, about 60% of the purchasers preferred to do this, but now Snow is finding that most customers prefer to have zero-time remanufactured engines and propellers installed as part of a factory-complete aircraft.

This past year, only 30% of the purchasers of S-2 aircraft supplied their own engines.

Snow sells about 35% of its production for export, almost all to South and Central America. Leland Snow, designer of the aircraft and president of

Tandem-rotor Jovair 4 E Readied for Production

Four-place, tandem-rotor Jovair 4 E Sedan helicopter has received Federal Aviation Agency certification and preparations for production are under way. Helicopter is powered by a 210-hp. Franklin 6A-335 engine which turns two 23-ft.-dia., three-bladed rotors. Fuselage is 18 ft. long, 4 ft. 3 in. wide and 5 ft. 4 in. high. Rotors are set more than 8 ft. above the ground. Gross weight is 2,300 lb. and empty weight is 1,463 lb. Cruising speed is 90 mph. and endurance is 2 hr. Service ceiling is 8,000 ft.

the company, flew there as an agricultural pilot for several years.

Snow is certificating the S-2C under CAR Part 3 so that it may be sold in the British Commonwealth nations. Like most other agricultural aircraft it is currently certificated under Part 8.

The company also is working on an optional cockpit canopy, similar to one recently introduced by Grumman Aircraft Engineering Corp. for the Ag-Cat.

Current production rate at Snow is about one aircraft per week, mostly equipped with the 600-hp. R-1340 engine.

Snow sees the agricultural market calling for larger and larger payloads on its aircraft for several reasons and has designed into the S-2C one of the larger hoppers on the market, with a 300-gal. capacity.

By contrast, the Grumman Ag-Cat has a 220-gal. hopper and the Piper Pawnee has a 150-gal. hopper.

Reasons for the need for increased payloads, as Snow sees them, are an increased tolerance of insects to pesticides, which requires a heavier application to make sure a fatal dosage is given and a trend toward larger areas to be covered. This latter is the result of owners of adjacent farms getting together and having the operator work all fields as one.

Snow, along with several other manufacturers, cited increased customer desire for newer aircraft to work their fields. Farmers apparently have determined which types of aircraft do a good job and which don't and are demanding the better aircraft, Snow believes.

Operators also are becoming more and more conscious of their reputation as the percentage of "gypsy" operators, who never worked the same area twice, declines. Operators are counting on renewed contracts to maintain their business and ability to maintain a schedule is a valuable asset to their reputation.

Schedule maintenance is becoming more important because some chemicals have to be applied at specific times and hours for maximum effect. Newer aircraft, being less subject to failures and having a more readily available supply of spare parts, are able to keep schedules better.

Trial Distributorship

Snow's business has been entirely in factory sales and largely by word-of-mouth advertising, but the company now has a modest advertising program under way and is exploring the possibility of a distributor network. A trial distributorship is being established to evaluate this method of selling aircraft.

Intermountain Manufacturing Co. (IMCO), which purchased the assets of the bankrupt Callair, Inc. at Afton, Wyo., in February, 1962, currently is the smallest of the companies with a specialized agricultural aircraft in serial production, but plans to expand production more than 100% by 1965.

IMCO redesigned the Callair series of aircraft into a single model, the Callair A-9, powered by a 235-hp. Lycoming O-540-B2B5 engine.

Currently certificated under CAR Part 8 and in the process of being certificated under Part 3 for export sales, it has a 22½ cu. ft., 170-gal. hopper in front of the pilot. Earlier aircraft had the hopper beside the pilot.

Deliver 32 Aircraft

The current A-9 sells for $10,450, the lowest price on the U. S. market for a new agricultural aircraft. The 1964, which the company hopes will be certificated under Part 3, will sell for $10,950. This aircraft will have an optional 28½-cu.-ft., 215-gal hopper.

IMCO rolled out its first production A-9 last January and since then has delivered 32 aircraft, with 10 on order for delivery this year and 12 on order for delivery by the summer of 1964.

Production rate originally was one aircraft every two weeks but this was increased in March to one aircraft per week and will be increased again in 1964. The company plans to produce a minimum of 70 A-9s in 1964 and possibly 100, depending on export sales.

Projected production for 1965 is a minimum of two aircraft per week, or 100 for the year.

Sales so far have been directed from the factory, which E. H. Anderson, IMCO general manager considers a major competitive factor in the company's favor.

Major Competitor

"Our major competitor is the Piper Pawnee and if an operator is going to make a decision between us on the basis of price, that $1,000 or $1,500 in sales commission we don't have to pay can make a big difference," Anderson said.

The Snow S-2C and the Grumman Ag-Cat do not rate highly as competitors, according to Anderson, because of their relatively high price. He feels that if an operator wants a larger aircraft and can afford it, he will go to the Snow or the Grumman, leaving Piper and IMCO to compete in the low-price market.

Only three aircraft were sold for export this year and IMCO is considering the establishment of distributors in overseas areas to make a major push in the foreign market. First of these distributors is being set up in Central America, where all three export aircraft went this year.

Foreign sales are being counted on to help keep production up during the latter half of the year. So far, domestic orders have allowed production at the maximum possible production rate for the first six months of the year, but seasonal demand has slacked off during the last half year.

The IMCO factory now employs about 32 persons and plans to expand this number to approximately 50 employes in 1964.

Dispersal Gear

Dispersal gear for the A-9 is manufactured by Transland Aircraft Div. of Hi-Shear Corp., Torrance, Calif. Optional equipment on the A-9 aircraft is Transland's Swathmaster solids applicator.

IMCO is owned by two Afton businessmen, Doyle Child and Ted Frome.

Fletcher Aviation Co., a division of A. J. Industries, Inc., of El Monte, Calif., currently is certificating its FU-24 utility/agriculture aircraft for op-

U. S. Business & Utility Plane Shipments

August, 1963

Make & Model	No. of Units	Net Billings
Aero Commander 500A	3	
560F	1	
680F	1	$1,162,000
680FP	2	
Grand Commander	3	
Beech Super 18	2	
23 Musketeer	17	
33 Debonair	8	
35 Bonanza	11	$2,379,000
55 Baron	8	
80 Queen Air	7	
95 Travel Air	3	
Cessna 150	38	
172, Skyhawk	65	
P172	4	
180	6	
182, Skylane	58	$3,623,000
185 Skywagon	23	
205	16	
210	4	
310	8	
320 Skyknight	2	
336 Skymaster	15	
Champion 7FC Tri-Traveler	1	
7GCB Challenger	3	$105,000
402 Lancer	3	
Lake LA-4	2	$53,000
Mooney Mark 20C (Mark 21)	30	$539,000
Mark 20D Master	10	
Piper PA-18-150 Super Cub	16	
PA-22-108 Colt	24	
PA-23-235 Apache	7	
PA-23-250 Aztec	17	
PA-24-180 Comanche	4	$3,653,000
PA-24-250 Comanche	1	
PA-25-235 Pawnee	18	
PA-28-160 Cherokee	3	
PA-28-180 Cherokee	51	
PA-28-235 Cherokee	5	
PA-30-160 Twin-Comanche	45	
Totals	553	$11,513,000

Note: This brings shipments through August to total of 4,907 aircraft having a net billing value of $96,029,000. Units shipped through August, 1963 were up 11% over the period last year and factory billings up 15%.

eration with a 310-hp. Continental GIO-470-A engine.

The aircraft, in production since 1952, currently is powered by a 260-hp. Continental IO-470-D engine.

All 100 FU-24s currently in service are operating in New Zealand and Australia, but the manufacturer says it intends to press for sales in other parts of the world, except the U. S.

High price—$24,000 in flyaway condition and $19,500 in kit form—is the reason for no domestic activity.

The aircraft was designed by Fletcher to the specifications of several New Zealand operators. The company has been shipping about 15 aircraft per year to that country and Australia and currently has 10 on order.

The FU-24 also can carry five persons or cargo.

Building New Factory

Scheduled for certification under Part 8 next year is an agricultural aircraft designed by the Gail Aircraft Engineering Co. of Sacramento. Aircraft currently flying has folding wings to conserve hangar space, a 24-cu.-ft. hopper and is powered by a 190-hp. Lycoming O-435.

The company, says the price will be approximately $10,000. The company is building a new factory at Sutter, Calif.

Though neither company makes an aircraft only for agricultural use, both Cessna and Champion Aircraft Corp., of Osceola, Wis., estimate that a substantial number of their high-wing utility aircraft perform agricultural work.

Neither company can give exact figures on how many of their aircraft are used for agricultural work, since most of these aircraft are also used for a variety of other jobs.

Cessna, for example, says there are approximately 2,330 Cessnas of all types owned by persons engaged in farming, commercial forestry and commercial fishing, yet only 46 of these are used in full-time aerial application work.

Two Champion Versions

Champion puts somewhat more emphasis on the agricultural market and has two versions of its current production line—Series 7 aircraft—for application work. Agricultural model has integral hopper tanks, a beefed-up airframe and a 150-hp. Lycoming O-320 engine.

Other aircraft in the line, like Cessna's models, have removable tanks and spray booms. Four Cessna models—the 180, 185, 172 and Skyhawk—are certificated for Sorenson spray equipment.

Champion estimates that about 600 of its aircraft are active in agricultural work, including about 260 of the agri-

cultural model, which sells for $9,610.

Spray equipment for standard aircraft costs approximately $800.

Cessna has no figures available on the number of its aircraft in agricultural work overseas, other than to say the number is believed to be considerable. Champion estimates that about 60% of its agricultural aircraft are in use out of the country.

(This is the first of two articles on the U. S. agricultural aircraft industry. The second article, dealing with the impact of rotary-wing aircraft on the industry, will appear in a subsequent issue of Aviation Week & Space Technology.*)*

New Light Aircraft Aids Sold By Piper

New light aircraft navigation equipment and autopilots for the general aviation market have been developed by Piper Aircraft Corp.

The company now is offering the PRC-4 radio direction finder which has automatic needle sensitivity, a low-frequency homing device, and a voice filter to eliminate VOR station codes during weather broadcasts.

The unit has been designed to fit a standard-size ADF instrument panel cutout.

Piper's PM-1 three-light marker beacon weighs 29 oz., complete with receiver, antenna and a built-in voltage regulator. The system is mounted in a streamline glass-fiber unit that is attached under the aircraft.

A new VOR/ILS localizer indicator, designated the Piper OL-1, is a self-contained, transistorized unit which combines the converter and indicator into a single package to fit a standard instrument cutout.

Piper will market the H-4 AltiMatic autopilot for the Aztec B. The H-14 will use 3-in. gyros, which will also be available on the earlier Autocontrol 2 and AltiMatic 2 autopilots.

Omni Tone Filter

New tone filter mutes Omni station identification for clearer reception of voice transmissions or for long-term monitoring. The filter, developed by National Aeronautical Corp. (Narco), Ft. Washington, Pa., is available in two models: Model VP-12, for use with Narco Mk 5 and Mk 12; and VP-13, for use with Mk 10. Weight is less than 5 oz. It is 3¾ in. deep, has 1¾ in. dia.

WHO'S WHERE

(Continued from page 23)

Honors and Elections

William T. Middleton has been elected chairman of the Public Affairs Committee of the Air Transport Assn. of America, and **A. W. Henderson,** vice chairman. Mr. Middleton is director-area civic affairs for Trans World Airlines; Mr. Henderson is director-state and community affairs for American Airlines. Also: **T. M. Miller,** vice president of traffic and sales for Delta Air Lines, has been elected president of the Air Traffic Conference of America, a division of ATA; **Graydon Hall,** vice president-sales for Southern Airways, was elected first vice president of the conference, and **Marvin Davis,** vice president-sales for Continental Air Lines, second vice president.

Changes

Dr. William M. Helvey, technical director of the newly formed Lockheed Missiles & Space Co.'s Bioastronautics Organization, Sunnyvale, Calif., and **Dr. Jack A. Kraft,** assistant technical director.

Dr. George A. Albright, chief of space environment and life sciences, Republic Aviation Corp., Farmingdale, N.Y., succeeding **Dr. William M. Helvey** (see above).

Ralph R. Theile, regional manager of project sales, the Flying Tiger Line, with offices in Washington, D.C.

Dr. Stanley H. Autler, head of cryophysics research, Westinghouse Electric Corp.'s Research Laboratories, Pittsburgh, Pa.

Thomas R. Joiner, manufacturing manager, Relay Div. of Leach Corp., Los Angeles, Calif.

Don E. Fry, director of materials, Avco Corp.'s Lycoming Div., Stratford, Conn.

Robert E. Baker, Eastern regional manager for Hycon Mfg. Co., with offices in Washington, D.C. **Thomas D. Burson** succeeds Mr. Baker as manager of contracts administration for Hycon, Monrovia, Calif.

Robert J. Greenway, director of program operations, Motorola's Chicago (Ill.) Military Electronics Center.

Bruno J. Uberti, chief engineer, Piasecki Aircraft Corp., Philadelphia, Pa.

Dean Shepherd, senior staff engineer, Defense Products Dept., Allis-Chalmers, West Allis, Wis.

Thayer S. Crispin, general manager, Douglas Aircraft Co.'s Aircomb Div., Cudahy, Calif., succeeding **Remy L. Hudson,** resigned.

Warren J. Nichols, manager, Materiel Div., Space-General Corp., El Monte, Calif., a subsidiary of Aerojet-General Corp.

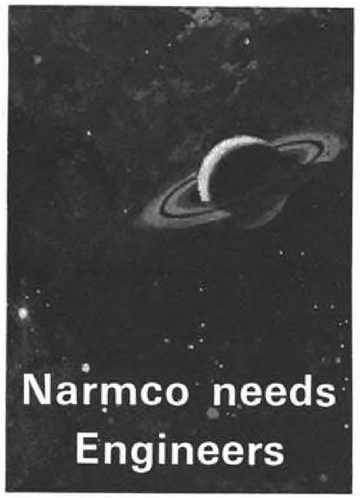
Stanley Rosenberg, manager-marketing, RCA's Aerospace Systems Div., Burlington, Mass.

Wesley A. Kuhrt, associate director of research, United Aircraft Research Laboratories, East Hartford, Conn.

Bernie E. Zettl, director-program planning, Dynalectron Corp., Washington, D.C.

Gerald W. Heidisch, general auditor, Electronic Communications, Inc., St. Petersburg, Fla.

James H. Smith, product manager-advanced developments, Dalmo Victor Co., a division of Textron, Inc., Belmont, Calif.



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AVIATION WEEK, NOVEMBER 18, 1963

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

LIFE IN GEORGIA

Ceiling Is Unlimited For Garretts

By Doris Lockerman
Atlanta Constitution Columnist

When Lockheed flew Jeanne Garrett and her two tall sons, David and Dennis, over Metropolitan Atlanta on a sky-high survey of their prospective new region, they could not believe the lushness of the land beneath them. The boys kept looking down and exclaiming, "Trees! Look at those trees." But the thing that really shook them all was something native Georgians take for granted: the clear, sunny, limitless ceiling.

"We hadn't seen such blue sky for years."

That was more than a year ago. Since then all horizons have opened wide for the Garretts, who have seen a gorgeous, exuberant spring, and an unbelievable autumn and find themselves trying to live outside every minute. They have a handsome, spacious new music-filled home in the Amber Glades section of Sandy Springs, 10 miles from the Lockheed-Georgia plant where Mr. Garrett is Assistant Project Engineer for the C-141 jet transport.


Doris Lockerman

"My life has changed completely. I had gotten in a rut in California." Mrs. Garrett is a lithe, dark-eyed honey blonde, who looks more like a sister to her sons than their mother. It is incredible to envision her in any rut, but she is certainly cutting new swaths in Georgia. She golfs. She bowls. She and her husband have taken up bridge. She's been knitting like crazy and a new, mad interest in a tea-cup collection has sent her exploring the antique shops in the region. She has become a volunteer worker in a local political party headquarters.

The Garretts are a confirmed Lockheed family. Doyle Garrett recently won his 25-year pin. He met Jeanne in the engineering department at Lockheed, Burbank ("I stayed two years, just long enough to catch my husband"), and his father and mother-in-law both work for Lockheed in California. Together they have about 63-years service, which is something of a record in an industry as young as the aircraft business.

If yours is an engineering or scientific family, join the swing in Atlanta. Write Lockheed-Georgia Company, 834 West Peachtree, Atlanta 8, Georgia, an equal opportunity employer.

LETTERS

Management Maze

Recent articles have indicated increasing DOD concern with contractors with regard to actual job performance as opposed to the magnificence to their management schemes, i.e., Pert, Smart, ULP, ad nauseaum. It would almost appear that the realization has struck that in the limit, people or a single person must run a job. The concept that a series of arrows and ellipses could take the place of management ability, however, is one that DOD itself has helped to foster.

With the successful application of Pert to Polaris, a veritable plague of perting spread throughout the industry. Projects ranging in size from million dollar systems to the production of model airplanes were required to be perted, ULPed or whatever.

Proposals are required to contain excrutiatingly detailed descriptions of how a job would be managed. Once the job is awarded, the charts are reduced to break down smaller and smaller sub-tasks almost with the idea that the total of ellipses and length of interconnecting lines is some measure of proper management.

I have found that the best basis for success lies in having:

(a) Good, dependable people working for you, and

(b) Some measure of confidence that you can truly manage the job.

I have been extremely fortunate in obtaining (a) and in having the ego, and some training, to permit a yes to (b).

Management by exception, awaiting for troubles on the critical path, implies no true activity on the part of management beyond that produced by a transient in the system. It is based upon having the resources to switch to the trouble area—it implies conscientious personnel at every level in the project—it is a dream.

I have Pert charts for projects with 15 people. If competent, I know which tasks are the longest and most troublesome, what operations are the most critical. I am only permitted enough people to do the basic job. If trouble arises, the schedule slips because I have no resources to dip into. If people are taken off one phase of the job, it becomes critical.

This technique will only work successfully when dealing with huge efforts, large sums of money and competent management in the first place.

My only summary is sort of a sad feeling that DOD is in the same state as everyone else; wanting to do a better job, but not quite knowing how—and a willingness to substitute computerese and "advanced procedures" for sound engineering management.

STANLEY FIERSTON
Swampscott, Mass.

Comanche Critic

The Piper Corp. officials who describe their perpetually forthcoming 400 horsepower Comanche as a "four-place P-51" (AW Oct. 28, p. 99) are exhibiting more enthusiasm than the facts would appear to justify. The 400 hp. Comanche will undoubtedly be a lively airplane, but estimates indicate that its performance figures (maximum cruise speed, maximum level flight speed, airframe limiting speed, rate of climb, and service ceiling) will typically run a little over half those obtainable with civilian 51 conversions. In addition, the structural integrity and quality of construction of the Mustang (which cost, in quantity, about 75,000 1942 dollars, without electronics or armament) place it in a category altogether distinct from any light civilian aircraft.

It would seem that Piper officials should emphasize such features of their line as operating economy, ease of maintenance, and fool-proof handling properties, rather than indulging in grandiose metaphors which might lure Comanche owners beyond their, or their aircraft's, capabilities. The Mustang is neither inexpensive nor particularly easy to fly, but its performance and the attendant fun, render comparison with any of the Lock Haven products absurd. When, and not before, Piper begins turning out an aircraft in which a competent pilot can perform a few aileron rolls on take-off, climb through severe turbulence and icing, break out at 25,000 ft. about 8 min. after lift-off, cruise at flight level 370 at 350 mph., and descend in a 6g spiral at a TAS of 500 mph. (all of which the Mustang can readily do), the officials' claim will take on a degree of validity.

ARTHUR STASNEY
Corona del Mar, Calif.

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.

Signal Gain

We were tickled to see your report on our new cyclotron wave amplifier (called the DIFTRON) described in your Nov. 4 issue (p. 91), but we were a little sad that you credit this device with only 5 db. of signal gain. The press note from which your paragraph was taken said 15 db., so this was probably a misprint, but a sad one. Actually, we have 20 db. by now.

ROBERT ADLER
Vice President
Director of Research
Zenith Radio Corp.
6001 Dickens Ave.
Chicago, Ill.

TFX Issue

I saw in the Letters section of your Oct. 28 issue (p. 110) a letter from a Mr. Pripps regarding the TFX (F-111) conflict. I think it would be wise for Mr. Pripps to start thinking "positive" for a change.

Naturally, hindsight shows up errors in judgment. This may or may not hold true in the case of previous plane contracts in which Mr. Pripps seems to think the Boeing Co. miraculously received the B-47 and B-52 contracts. Most likely Boeing would not have been chosen if the designs it submitted were inferior to any others. This is not the case of the TFX contract award. It is simply a political issue, Texas will do more for the Democrats, so Texas gets the contract, unfair as it is. What should worry Mr. Pripps is the fact that our Pentagon heads are not selecting the plane that is superior.

Mr. Pripps did a little toe-trodding himself on Boeing, and shouldn't worry about the past but the present and future. Boeing has every right to be furious at the Pentagon for giving the award to General Dynamics/Ft. Worth for an inferior plane. The Boeing design is less expensive and has an edge on the Convair design in almost every classification. The Navy and Air Force heads both agreed it was the design worthy of winning. By expressing their views Admiral Anderson is out of a job, and General LeMay is only assured of a job until next year.

The fact of the matter is that the United States is now getting a "second rate" plane. Come on now Mr. Pripps, let's be realistic!

THOMAS CHAMBERLIN
Princeton, N.J.

Mr. Robert Pripps, in his letter on the TFX conflict (AW Oct. 28, p. 110), stated that perhaps the controversy should be stirred up again. Well, just for the sake of correcting his error he will get his wish.

The Martin B-51 was not in competition with the B-47. In 1944 the Air Force let three separate contracts for a jet bomber evaluation. They were as follows:

- Convair XB-46 Top speed 545 mph. Service ceiling 43,000 ft. First flew on Apr. 2, 1947
- Boeing XB-47 Top speed 600 mph. plus First flew on Dec. 17, 1947
- Martin XB-48 Top speed 495 mph. Service ceiling 43,000 ft. First flew June 22, 1947

Two years later in October of 1949 Martin flew its XB-51 which was originally designated the XA-45, a high speed ground attack aircraft. Top speed was 645 mph. with a service ceiling of 40,500 ft. Only two of these aircraft were built.

Convair at this time was working on another high speed attack aircraft, the XB-53 which was cancelled before completion.

On Apr. 15, 1952, the Boeing YB-52 took off. Its top speed exceeded 600 mph., service ceiling 50,000 ft. and range was 7,000 mi. Three days later the Convair YB-60 flew. Top speed was 520 mph., service ceiling approximately 45,000 ft. and range was 8,000 mi.

I'm not attempting to say which is the better plane, or the best one won or lost; speed, altitude and range are only a part of the facts needed to do this. Too many of us are trying to judge which is best, without any—much less all—the information.

I think the main thing this points out though, is that prototypes were built, flown and tested in competition, and no other country in the world had anything at the time to compare to SAC's B-47s and B-52s.

DONALD F. GENCO
La Puente, Calif.

GEMINI is under the technical direction of NASA's Manned Spacecraft Center