Aviation Week & Space Technology

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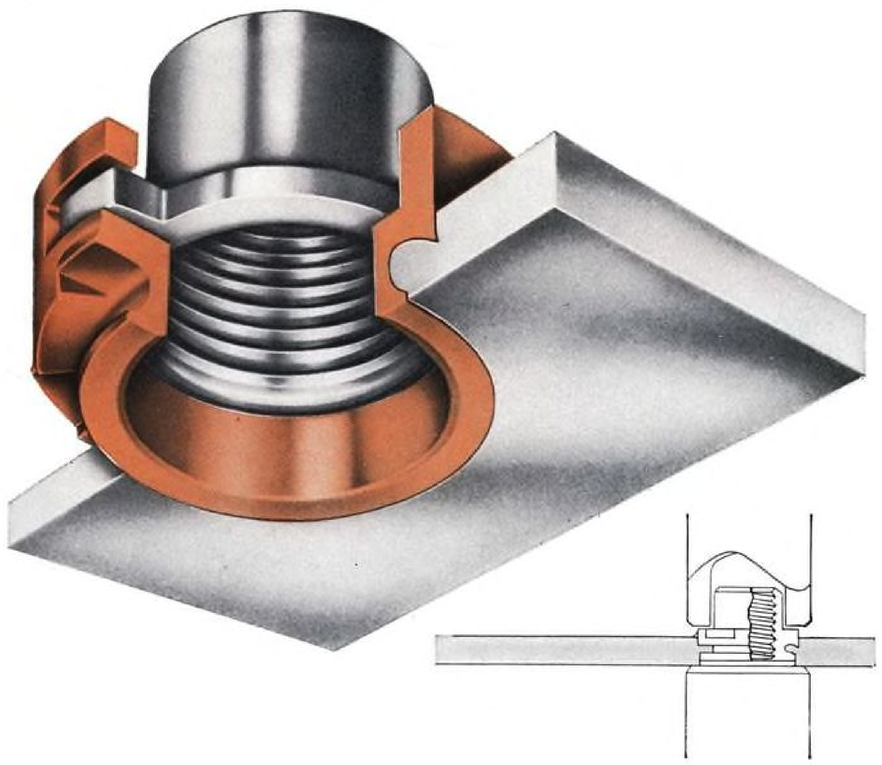
A McGraw-Hill Publication

December 2, 1963

SPECIAL REPORT:

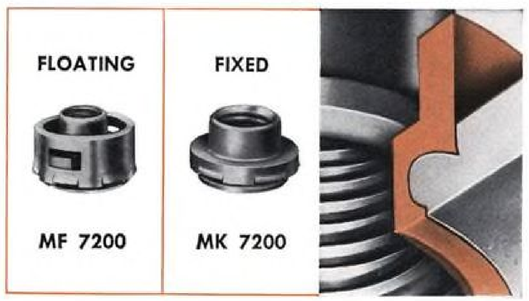
Titanium Applications, Problems

Bell Aerosystems Hydroskimmer



KAYLOCK® MINIATURE STAKE NUTS

Here's your answer to Stake nut reliability with maximum weight/space savings! Save up to 33% of hardware weight. And weight savings can accrue as a result of thinner parent material requirements. Staking action of the Kaylock self-locking nut provides maximum retention against push-out and torque-out exceeding the requirements of MIL-N-25027.



THE PROBLEM • Conventional stake nuts have a tendency to torque out or push out of the parent material under various stresses. There has been a critical need—especially in the aerospace industry—for installed reliability of threaded elements in minimum thickness materials.

THE SOLUTION • The new Kaylock miniature stake nut provides greater structural integrity through a cold flow of material that provides a positive interlock between the nut and the parent material. This results in high resistance to push-out loads, offers you high anti-rotational advantages.

Kaylock® *first in all-metal self-locking fasteners*

KAYNAR MFG. CO., INC. • KAYLOCK DIVISION • BOX 3001 • FULLERTON, CALIFORNIA

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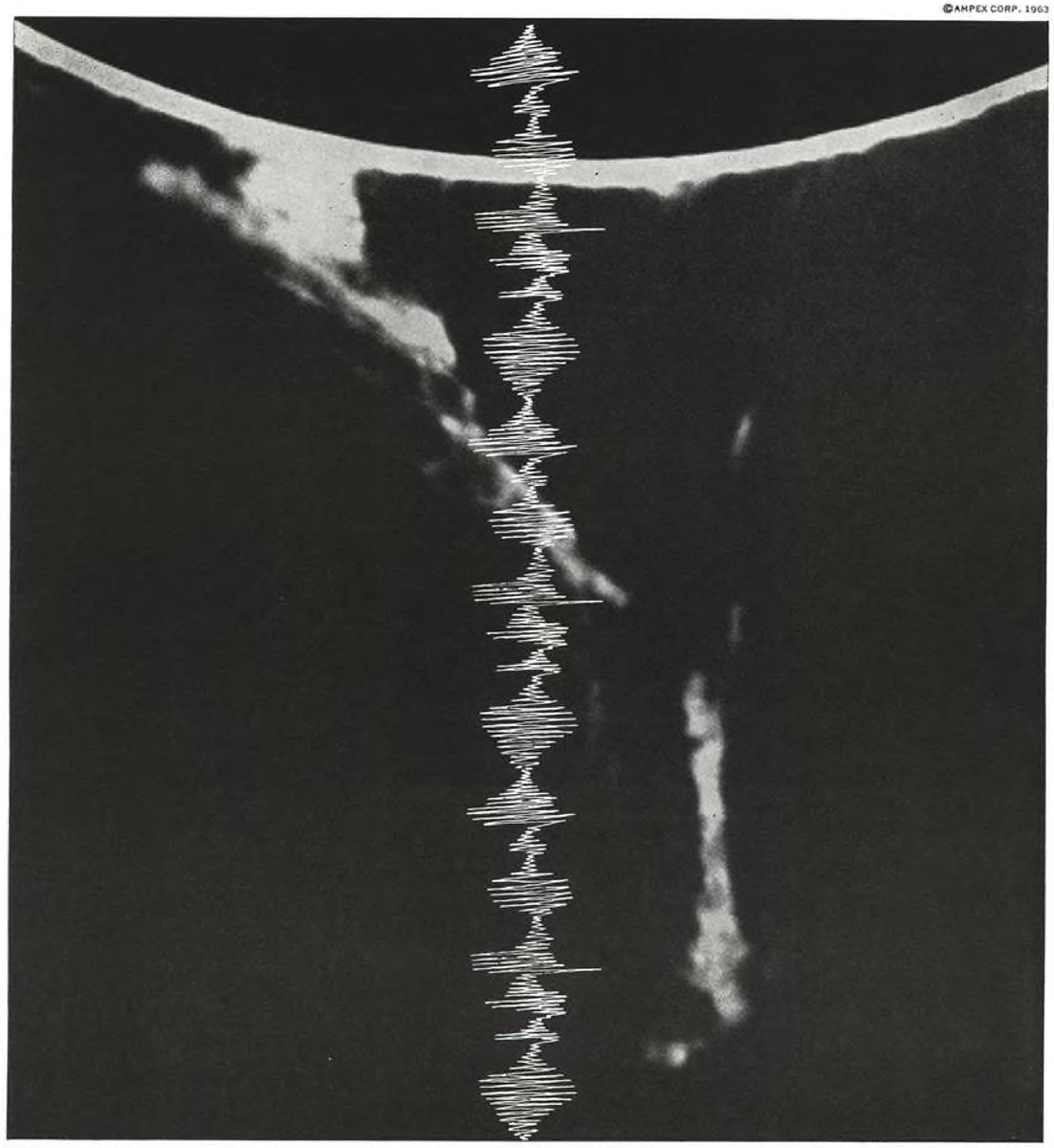

Who gathers sun storm data on one recorder, replays it exactly on 8 others? **AMPEX**

Here's something new under the sun: nine different recorders with identical electronics and heads. For the first time, you can record a missile shot at Canaveral and play it back exactly on a different recorder at Seattle, Santa Monica, Huntsville, or Woomera. There's no longer a need for duplicity of recorders to insure precise reproduction. And it's no longer necessary to bring field recorders back to the lab for playback. Another advantage of the new Ampex family: the electronics are interchangeable. This cuts down on the amount of spare parts you need. Electronics can be shuttled around where they are needed and not remain idle in an unused recorder. The new Ampex family includes the FR-1200, the FR-1300, the FL-300, the FR-100 C, the DAS-100, and the modernized FR-1100, FR-100 A, FR-100 B, and FL-200. Each offers superb performance and outstanding reliability, with frequency response to 300 KC Direct, to 20 KC FM and PBM. Each is designed for versatility in the lab or in the field. Now, all are truly compatible. For additional information on this Ampex family write to the only company providing recorders, tape and core memory devices for every application: Ampex Corporation, Redwood City, California. Sales and service engineers throughout the world.

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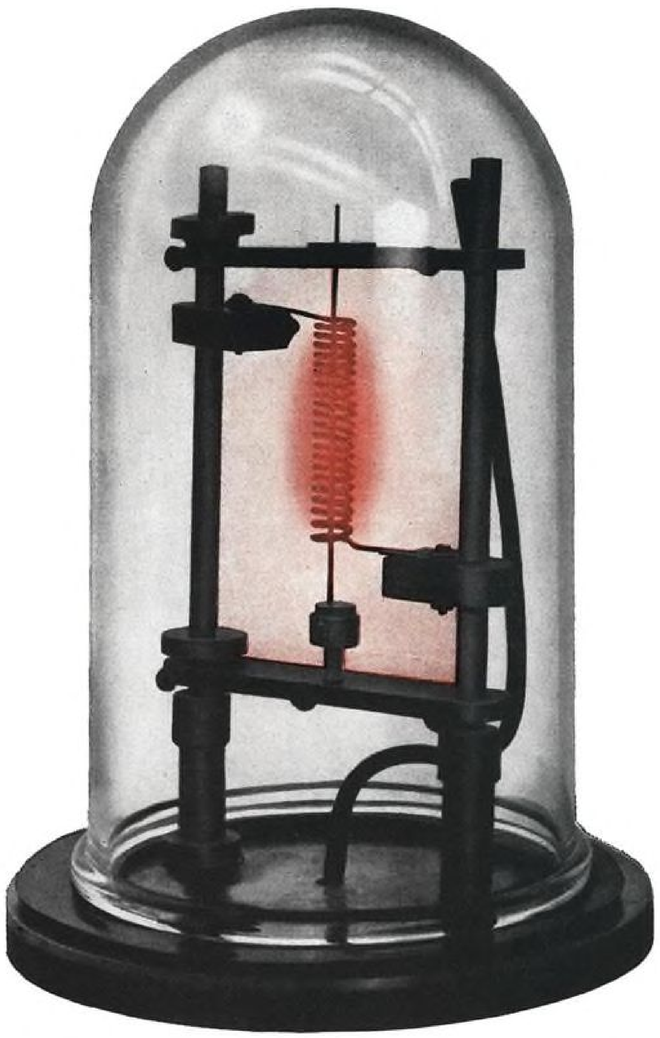

To optimize a TWT . . . use a crystal ball

STC-278, 50 watt pulsed C band TWT, provides superior electrical performance as a driver in radar transmitters, rf amplifiers, and other wide band applications.

"Pyrolytic deposition" is the fancy name for it. In simpler terms, it's Sperry's method of using heat and a controlled atmosphere to put attenuation on TWT support rods in a very precise manner. Result: higher gain and improved efficiency for Sperry traveling wave tubes.

This is only part of the Sperry effort to optimize the electrical parameters of TWT's. Attenuators are important . . . beam focusing, amplitude fine structure, and gun design get their share of attention too. All these programs are devoted to a single objective . . . the production of TWT's with a near-perfect mix of electrical characteristics.

Many of these efforts are already bearing fruit in the form of operational hardware. Production tubes like the STL-405 and STS-101 (200 W performance over octave bandwidth at L and S bands) and the STC-278 (exceptional fine structure and phase linearity characteristics) vouch for Sperry's success.

A NEW TECHNICAL PAPER gives full engineering and scientific details of the considerations involved in electrically optimizing traveling wave tubes. For your copy, write Sperry, Gainesville, Florida, or contact your Cain & Co. representative. In Europe, contact Sperry Europe Continental, Paris.

SPERRY ELECTRONIC TUBE DIVISION
SPERRY RAND CORPORATION
GAINESVILLE FLORIDA

AEROSPACE CALENDAR

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

(Continued on page 7)

AVIATION WEEK & Space Technology

December 2, 1963
Vol. 79, No. 23

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The SDS 9300 is faster than the 7090.

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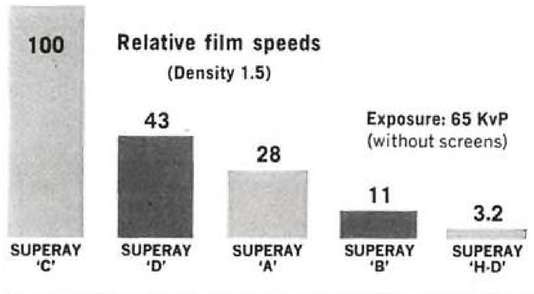
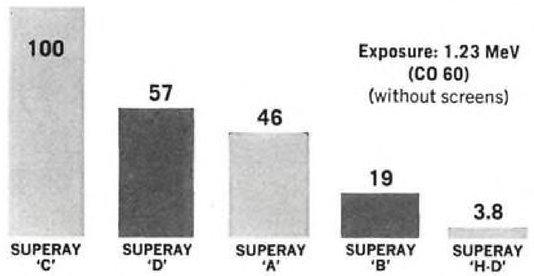
INDUSTRIAL X-RAY FILMS

FILM CLASSIFICATIONS

CLASS	FILM	SPEED	CONTRAST	GRAIN
I	H-D†	Moderate	Very High	Ultra Fine
I	B†	Medium	Very High	Very Fine
II	A†	Fast	High	Fine
III	C†	Very Fast	High	Medium
III	D†	Fast	Moderate	Fine
IV	D‡	Ultra Fast	Medium	Medium

†Used direct with lead foil screens ‡Used with fluorescent screens





NOTE: Speed determinations made at density 1.5 and all films developed for 6 minutes at 68°F. in Ansco Liquadol Developer.

Ansco Superay® 'A' X-ray Film. This very versatile film is excellent for inspection of all metals... from thin sections at low energy levels to heavy sections and castings with super voltages and radioisotopes. It may be used with X-rays or gamma rays. Its fine grain and high contrast recommend it where recording small defects or fine details is essential. Its high speed permits short exposures over the full range of specimens and sources. May be used with or without lead screens.

Ansco Superay 'B' X-ray Film. When very fine radiographic definition is desired, select this film. Its extra-fine grain and very high contrast improve image quality with all types of gamma or X-radiation. It's particularly useful in light alloy radiography, where exacting sensitivity is more important than high speed. It permits accurate identification of discontinuities and inclusions in all metals. Use with or without lead screens.

Ansco Superay 'C' X-ray Film. Superay 'C' is the fastest Ansco industrial X-ray film... and is recommended wherever a high relative film speed is of prime consideration. For example, in rapid production line testing or in the detection of gross flaws in heavy specimens with gamma radiation, Superay 'C' reduces exposures to an economical minimum. Generally used with lead-foil screens, it does have a number of non-screen applications.

Ansco Superay 'D' X-ray Film. Here is a medium-fine grain film with moderate contrast and very wide exposure latitude. It offers extremely high speed when used with calcium tungstate type screens... but may also be useful in radiographing specimens having a wide range of thickness. And it's ideal for testing heavy metals with low voltage equipment.

Ansco Superay 'H-D' X-ray Film. Superay 'H-D' has an ultra-fine grain and very high contrast. It's designed for high definition radiography, provides the ultimate in image quality. Since high definition work often involves minute subjects and very thin materials, low voltage techniques are generally used with Superay 'H-D'. However, the film maintains its high definition characteristics and maximum image quality throughout the full KvP range.

ANSCO SUPERAY INDUSTRIAL X-RAY FILM AVAILABILITY

SHEET FILM SIZES (inches)	STANDARD PACKAGING 75 sheets interleaved	STANDARD PACKAGING 150 sheets non-interleaved	SUPERPAK PACKAGING Superpak 300 300 sheets interleaved	SUPERPAK PACKAGING Superpak 600 600 sheets non-interleaved	INDIVIDUAL PACKAGING Monopak 100 envelopes (100 films)	INDIVIDUAL PACKAGING Twin-Pak 60 envelopes (120 films)	INDIVIDUAL PACKAGING 'A-B' Sandwich Pak 60 envelopes (120 films)
3½ x 17	A, B, C, D	A, B, C, D*	A, B*	A, B	B		
4½ x 10	A, B, C, D, H-D	A, B, C*, D*					
4½ x 17	A, B, C, D, H-D	A, B, C*, D*	A, B*	A, B	A*, H-D*		
5 x 7	A, B, C, D	A, B, C*, D*	A*, B	A, B	A, B, H-D*	A*, B*	Yes
7 x 17	A, B, C, D*, H-D	A, B, C*, D*	A, B*	A, B	A, B	A*, B*	Yes
8 x 10	A, B, C, D*, H-D	A, B, C*, D*	A, B	A, B	A, B, H-D*	A*, B*	Yes
10 x 12	A, B, C*, D*, H-D	A, B, C*, D*	A, B*	A, B	A*, B	A*, B*	Yes
11 x 14	A, B, C*, D*, H-D*	A, B, C*, D*	A*, B	A, B	A*, B	A*, B*	Yes*
14 x 17	A, B, C, D*, H-D	A, B, C*, D*	A, B	A, B	A, B, H-D*	A*, B*	Yes
			*Special (stocked on demand)				
ROLL SIZES	70 mm x 100'	70 mm x OL☆	52 mm x OL☆	35 mm x 100'	35 mm x OL☆	1⅜" x 25'	
	A, C	A, B, C, D	A, B	C	B	C	
			☆Odd lengths (101' to 800')				
SPECIAL SIZES AND PACKAGING	1⅜" x 16" 25 sheets interleaved	8 x 10" 25 Monopaks (25 films) per carton	5 x 7" 25 sheets interleaved	8 x 10" 25 'A-B' Sandwich Paks (50 films) per carton			
	C	B	D	A, B			

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X-RAY PRODUCTS
GENERAL ANILINE & FILM CORPORATION
BINGHAMTON, NEW YORK

AEROSPACE CALENDAR

(Continued from page 5)

ence, 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.

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. 4-6—Symposium on Thermal Radiation of Solids, San Francisco, Calif. Sponsors: National Bureau of Standards; National Aeronautics and Space Administration; USAF Aeronautical Systems Div.; University of California at Berkeley.

Mar. 9-10—Aerodynamic Testing Conference, Marriott Twin Bridges Motor Hotel, Washington, D. C. Sponsors: American Institute of Aeronautics and Astronautics; U. S. Navy.

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

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.

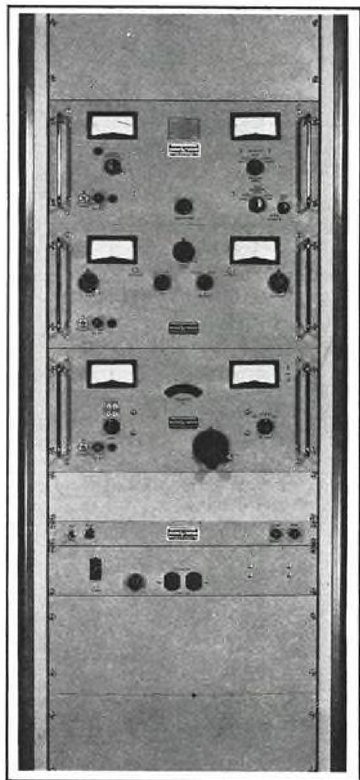
Apr. 1-3—Fifth Annual Structures and Materials Conference, American Institute of Aeronautics and Astronautics, Riviera Hotel, Palm Springs, Calif.

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,

(Continued on page 9)



WATCH DEI

TTR-1

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Dual Purpose Monopulse 215-260 mc Receiver

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- **Complete Telemetry Facilities**
- **Three Channel Monopulse with DC and AC Error Signals**
- **Plug-In IF Amplifiers with Switchable Bandwidths**
- **Optional Phase Lock Demodulators**

The ability to track and demodulate IRIG satellite signals *simultaneously* is now possible with the TTR-1 Monopulse Tracking and Telemetry Data Receiver from Defense Electronics, Inc.

Designed for use in advanced aerospace programs, the unit has been refined not only to obtain instant antenna direction for a satellite, but to demodulate and record the signals in conventional telemetry formats.

As a 3-channel tracking receiver in the 215-260 mc band, the TTR-1 has the capability of tracking the RF carrier in a narrow band mode up to the point where good data can be received. Switching to wide band, signals can be demodulated as in other DEI telemetry receivers.

A space saver, the modular TTR-1 employs single-knob tuning with a tuning indicator, choice of two crystals or VFO operations over the complete 215-260 mc band, front-panel switchable IF and video bandwidths. The solid state correlation detectors have excellent noise balance over a bandwidth in excess of 2 mc, allowing use of 1.5 mc IF bandwidths.

To combine the best in a tracking and telemetry receiver, ask about the TTR-1 . . . and Watch DEI.

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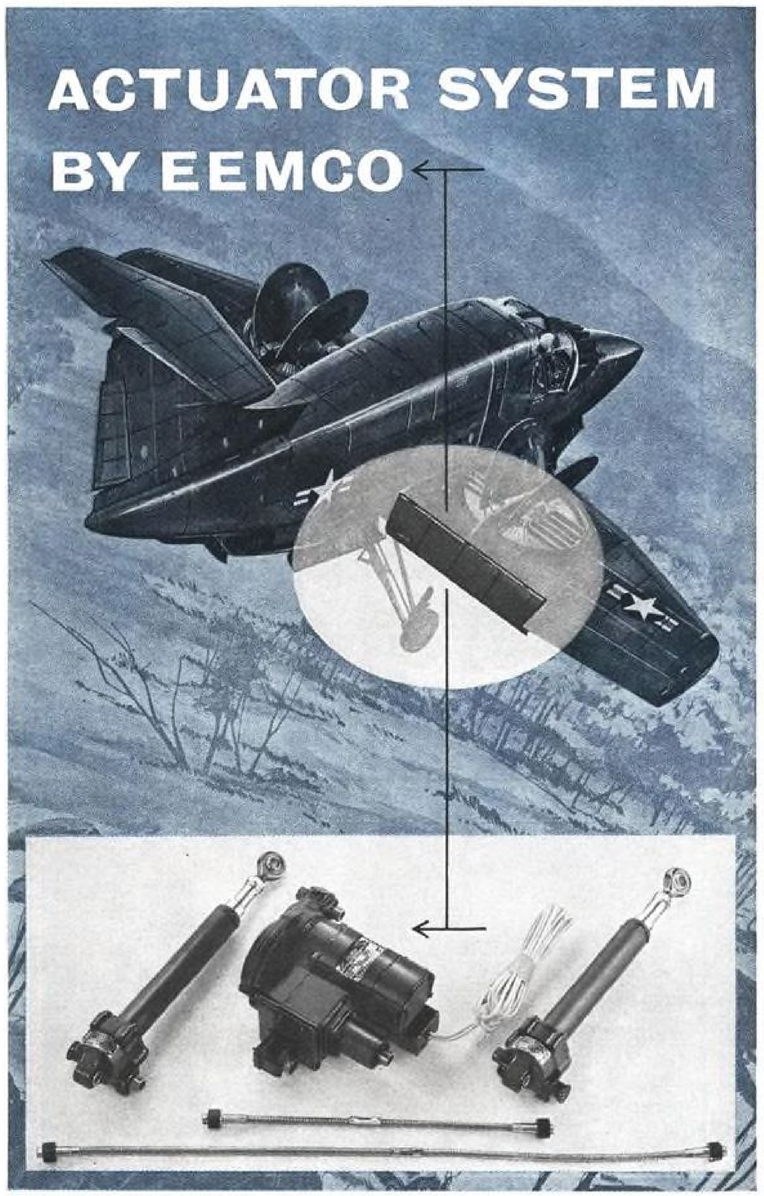

The vertical landing and take-off feature of the Army's XV-5A aircraft demanded a light weight, reliable, wing flap actuator system. EEMCO built it for Ryan Aeronautical Company, builders of the XV-5A, the world's first lift fan aircraft. □ The EEMCO flap actuator system is exceptionally light weight, 11.75 pounds, and consists of two ball-type screw jacks powered by a central drive unit through flexible shafting. The jacks are irreversible with non-jamming end stops. The drive unit is powered by a 28 volt DC motor having an electro-mechanical clutch and brake. Adjustable travel and interlock switches obtain an electrical stroke of 5.9 inches with an adjustment range of ± .25 inches. □ For further information on wing flap actuator system D 1518—or for information on motors and actuators for aerospace and industrial applications—write or call the EEMCO Division of Electronic Specialty.

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AEROSPACE CALENDAR

(Continued from page 7)

Institute of Electrical and Electronics Engineers, Westward-Ho Hotel, Phoenix.

Apr. 20-22—First Canaveral Space Congress, Ramada Inn, Cocoa Beach, Fla. Sponsor: Canaveral Council of Technical Societies.

Apr. 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Sheraton-Park Hotel, Washington, D. C.

Apr. 22-24—Southwestern Conference & Electronic Show, Institute of Electrical and Electronics Engineers, Dallas Memorial Auditorium, Dallas, Tex.

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

Apr. 29-May 2—National Aeronautics and Space Administration's Annual Conference on the Peaceful Uses of Space, Boston.

May 4-6—10th National Aerospace Instrumentation Symposium, Instrument Society of America, Biltmore Hotel, New York, N. Y.

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

May 4-7—American Astronautical Society's 10th Annual Meeting, "Technical Progress on Lunar Flight Programs," New York Hilton Hotel, New York, N. Y.

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

May 7-10—International Air Fair, Biggin Hill, Kent, England.

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

May 11-14—35th Annual Scientific Meeting, Aerospace Medical Assn., Americana Hotel, Miami Beach, Fla.

May 13-15—20th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 18-21—23rd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton-Dallas Hotel, Dallas.

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.

May 31-June 7—International Air Show & International Airport Equipment Exhibition, Caselle Airport, Turin, Italy.

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.

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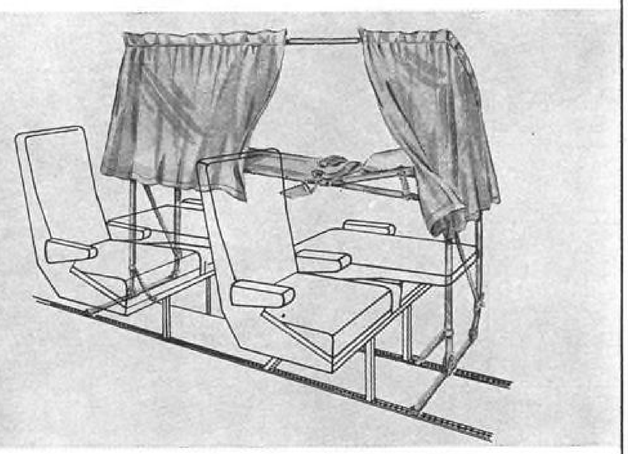
WITH
AERO-STRETCHER
by Aerotherm



No Seat Removal
Aero-stretcher . . . eliminates costs incidental to seat removal, storage, pitch changes, and re-installation. Passenger seats remain in the aircraft . . . not on the ground.

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Aero-stretcher . . . Integral curtains provide complete privacy or may be opened along entire inboard length.

Comfort
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OTHER AEROTEC DIVISIONS: Aircraft Equipment Div., Precision equipment for aircraft, missiles, nuclear applications; Industrial Div., Dust collecting systems, gas scrubbers, fans, stacks and allied equipment.

"'I'm off to the moon!' cried Wan Hoo as the rocket fuses were lit. But the rockets collapsed with a roar and he was battered and foiled again."

(Based on 16th century Chinese chronology)

It was back to the drawing board for Wan Hoo. But even if his concept had been right, this "rocket ship" never could have made it. Materials to meet the strength-to-weight and heat-resistant requirements of high performance rocket cases just didn't exist when this flight was attempted.

Today aircraft designers and engineers can find materials to cope with almost any condition of temperature or stress. And many of these alloys owe their properties largely to nickel. The new maraging nickel steels, for example, have strength-to-weight ratios of over 1,000,000 to 1. They're the ideal answer to many of aerospace's toughest problems—including solid fuel rocket cases.

Maraging nickel steels, invented in Inco's research labs, are easily heat treated, require no quench, and undergo virtually no distortion during heat treatment. And they're the only ultra-high strength steels that can be used effectively where field-welded fabrications or repairs are involved.

For more information about how specific maraging steels can answer your aerospace applications (or for any application requiring strength in the 200,000-300,000 psi range) send for the Interim Data Sheets on Maraging Nickel Steels.

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67 Wall Street INCO New York 5, N.Y.

DDP- 24 digital computer introduced March, 1963

29

17 Orders to date* including . . .

Three DDP-24 Computers To EAI For Hydac – 2400

FRAMINGHAM, MASSACHUSETTS — Electronic Associates, Incorporated, Long Branch, New Jersey, has ordered three DDP-24 general purpose digital computers from Computer Control Company, Inc. The three computers were ordered as part of a continuing EAI/3C contract by which 3C supplies the digital portion of EAI's new HYDAC-2400 — the first standard, commercially available analog/digital computer system. The design of the HYDAC-2400 provides for the system to function as a totally integrated unit and also as separate analog and digital computers.

3C Delivers DDP-24 Computer For Gemini Trainer

FRAMINGHAM, MASSACHUSETTS — Computer Control Company, Inc., delivered the first of two DDP-24 Digital Data Processors ordered by McDonnell Aircraft Corporation for use in the Gemini Flight Trainer System.

The DDP-24 will be the basic computer in the system and will provide real-time simulation of the on-board guidance computer through all phases of launch, boost and insertion, orbit, rendezvous and docking, retro and re-entry, and letdown. The computer also [illegible]

NASA Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A DDP-24 Digital Data Processor has been ordered from Computer Control Company, Inc., by NASA for the Goddard Space Flight Center.

The high speed, general purpose computer will be used as a simulator for a world-wide tracking network for manned spacecraft. Data will be utilized in determining vehicle orbits, prediction of landing sites, etc. The DDP-24 is supplied with a comprehensive [illegible]

Litton Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Litton Industries for their Communication Sciences Laboratory in Waltham, Massachusetts.

Litton will use the high speed DDP-24 for open-shop scientific and engineering computation. Included as part of the standard DDP-24 contract agreement is a comprehensive software package including FORTRAN II and 3C engineering support services.

Air Force To Get 3C DDP-24

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by the Air Force Systems command, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

The Air Force will use the high speed DDP-24 for on-line data format conversion and also off-line for general purpose computation. Included with the DDP-24 is a comprehensive software package [illegible]

3C DDP-24 Slated For Haskins Lab

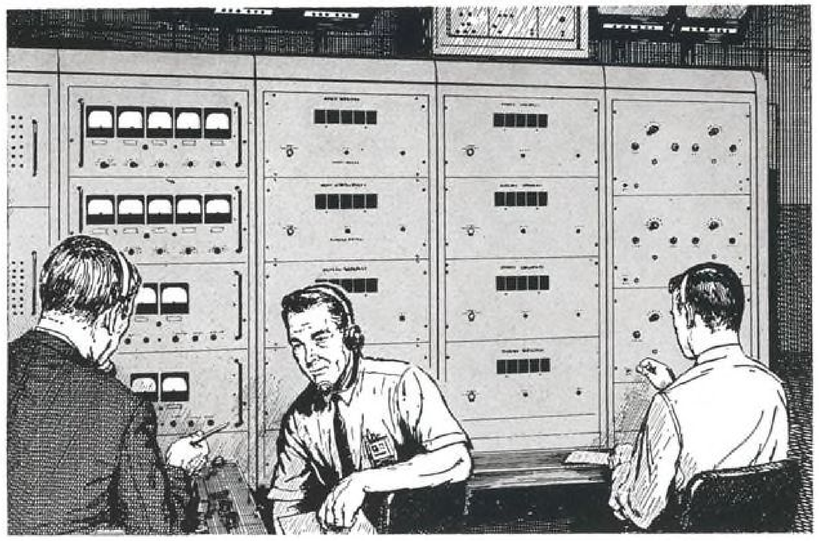
FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Haskins Laboratories, Inc., New York, N. Y. Haskins will use the very high speed, 24-bit word DDP-24 for applications in speech simulation [illegible]

3C

COMPUTER CONTROL COMPANY, INC.

OLD CONNECTICUT PATH, FRAMINGHAM, MASS. • 2217 PURDUE AVE., LOS ANGELES 64, CALIF

* ~~OCTOBER 30, 1963~~ NOV. 19, 1963



In "check out" system similar to this, EI engineers first developed the input filter now standard on all EI voltmeters.

Classic Jobs of Measurement

Performed by Electro Instruments

THE EI VIEWPOINT

by Dr. Walter East
President, Electro Instruments, Inc.

Almost never, in actual practice, is a purely stable source of voltage encountered in measuring DC voltages. Minor variations go undetected if measurement is done with an instrument employing a mechanical needle movement, because of the friction involved in the needle movement itself. On the other hand, a digital voltmeter – highly sensitive to, and reacting rapidly to minute voltage changes – reflects even small variations faithfully. The trouble is, rapid voltage fluctuations will have the voltmeter reacting so rapidly that accurate, stable reading is impossible.

Dr. East

Two Types of Interference

Besides variations inherent in a voltage source, a secondary set of variations can come about with the introduction of a magnetic field, either natural or man-made. We know these variations as normal mode and common mode interference voltages, with unwanted normal mode voltages being called "ripple." It was over two years ago that Electro Instruments took the forward step that other digital voltmeter manufacturers still have to make. Recognizing that, in 95% of cases, unwanted variations in DC voltage measurements result from normal mode voltages rather than common mode voltages, we incorporated an input filter in every model voltmeter in our extensive line.

An interesting story about "ripple" appears above. It's another actual instance in which we fulfilled our promise: "You name it, we'll find a way to measure it!"

Filtered EI Voltmeter Ends Threat to Aircraft Program

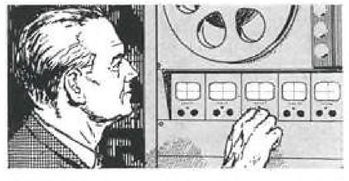
What is today a standard feature of Electro Instruments' voltmeters was first developed to meet the emergency needs of a major aircraft designer*.

In actually flight testing a new type aircraft, it had been planned to telemeter information gathered by transducers placed throughout the ship to a ground-located monitoring station. Equipment of latter included several EI digital voltmeters.

Threat of Costly Delay

Despite satisfactory preliminary tests, actual engine run-up produced unwanted normal mode voltages so great that accurate voltmeter readings were impossible. Trouble was traced to electrical wiring within the aircraft. Rewiring would mean a 30-day program delay, and a loss of $100,000.

At this point, EI engineers suggested filtering out the undesirable noise at the input to the voltmeters, and letting major portions of all transmitted information be channeled through them. The suggestion was adopted, and a satisfactory filter developed within days. This first successful use of a "ripple" filter led to its being made an integral part of future Electro Instruments' voltmeter models. *Name on request.

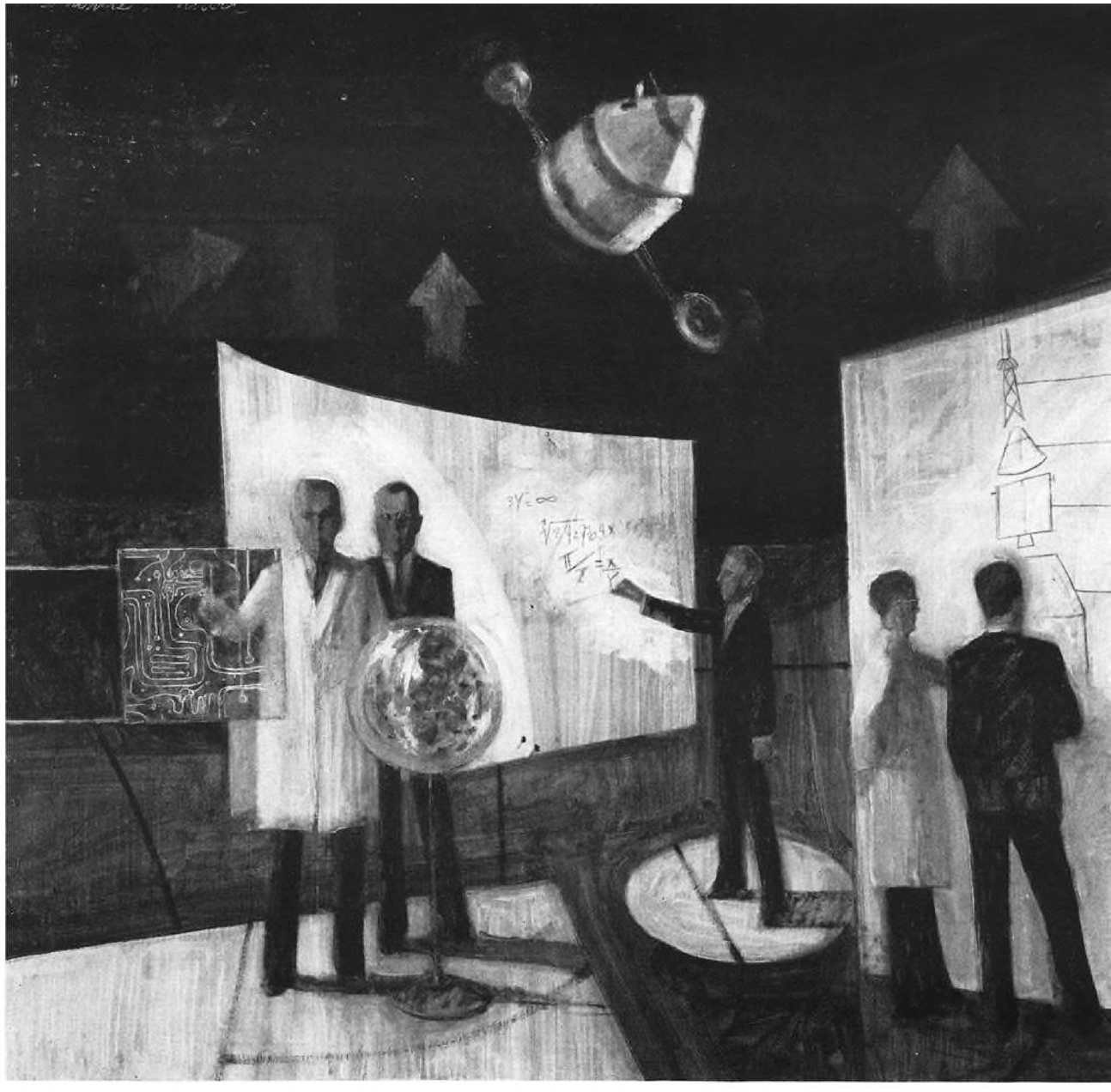


Oscilloscope Raises Level of Confidence in Tape Recordings

The mere presence of recorded electronic impulses on tape does not necessarily constitute usable information. Operational tests of aircraft, missiles, spacecraft, etc., rely on tape recordings for depth analysis of performance. Mechanical needle movement metering provides only quantitative observation. Use of monitor oscilloscopes provides qualitative presentation as well, increases confidence level of tape recorded information.

Electro Instruments, Inc.
8611 Balboa Avenue, San Diego 12, California

EI SALES, SAN DIEGO, CALIF. • ELECTRO INTERNATIONAL, INC., ANNAPOLIS, MD. • TRANSFORMER ENGINEERS, SAN GABRIEL, CALIF.



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

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

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

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

For these are the flexible men.

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

RAYTHEON AT WORK

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

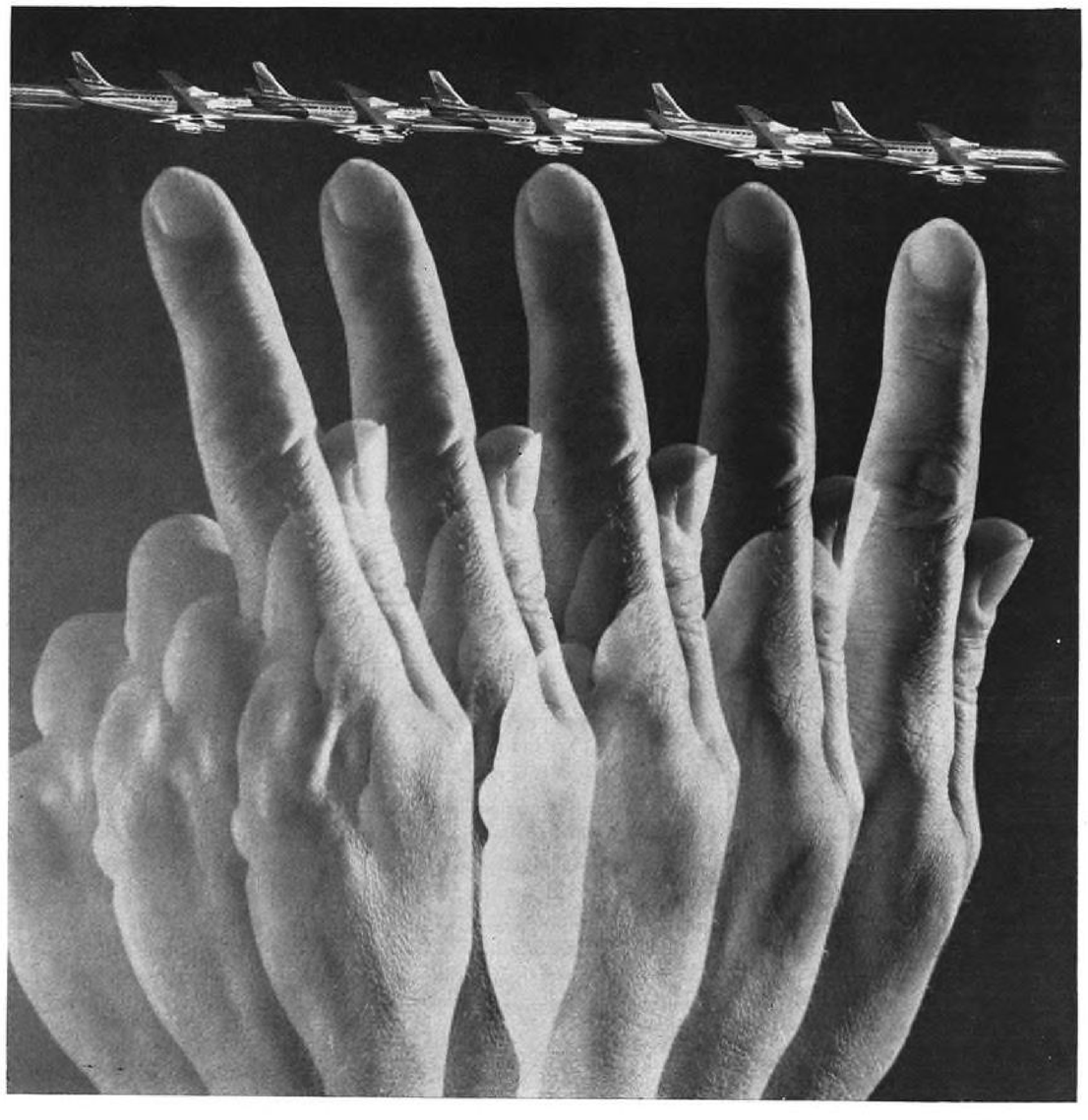
Point by point, minute by minute around the clock, the Federal Aviation Agency's air traffic control system keeps its radar finger on U.S. commercial flights.

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

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

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

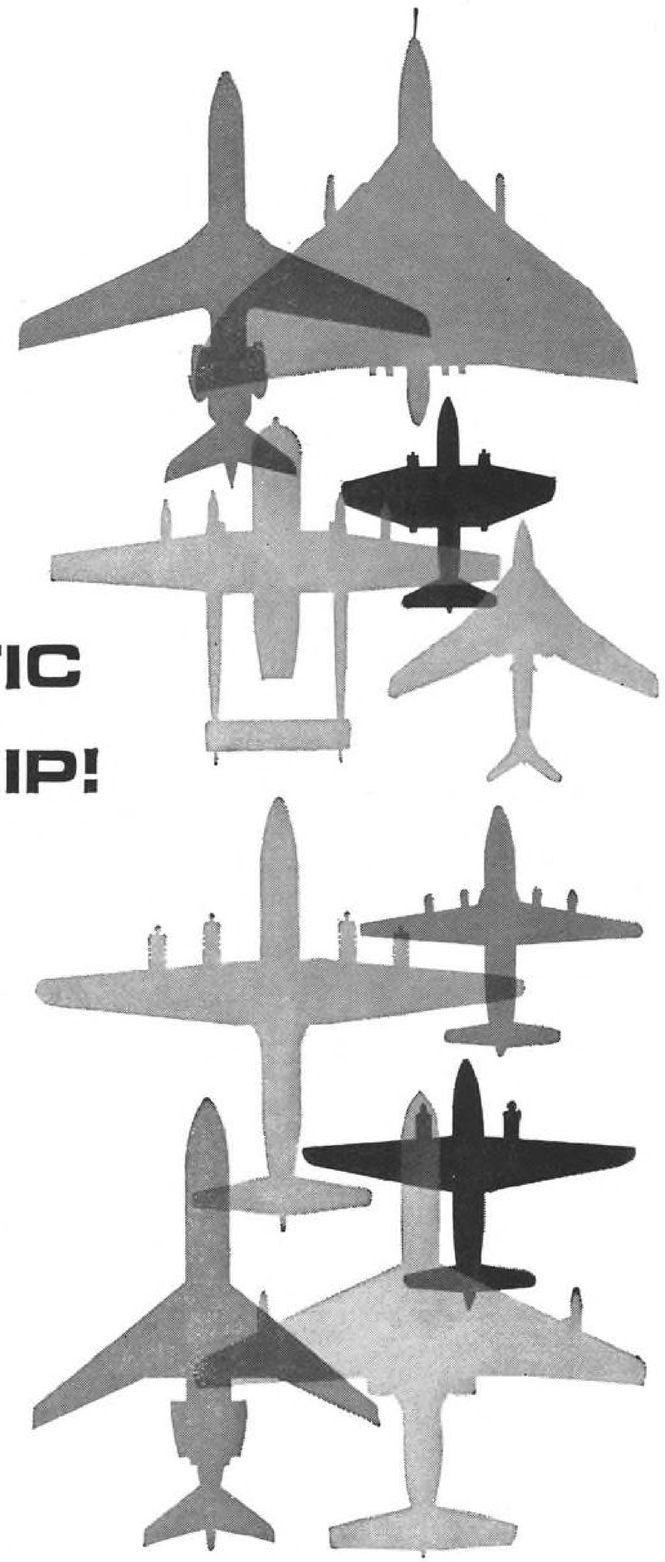
RAYTHEON



Royalty airborne.

The King Air, Beechcraft's first turbine powered aircraft, is the new leader of a royal lineage established by the Queen Air and the Baron. United Aircraft of Canada is proud that its Pratt & Whitney PT-6 engines were chosen to power this crowning achievement in executive aviation. The PT-6 is the newest member of another proud lineage—weighing in at a lean 250 pounds and delivering a powerful 578 ESHP; the PT-6 incorporates the design experience, endurance and rugged dependability that have won renown for Pratt & Whitney engines the world over. It's more than a royal marriage. It's a winning combination.

United Aircraft OF CANADA LIMITED



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SMITHS CHOSEN FOR TEN OUTSTANDING TYPES SMITHS Automatic Landing Systems are being actively developed for use, or have already been fitted to, ten different types of aircraft. Fifteen years of development and foresight, millions of hours experience in autopilot operations and 10,000 successful automatic landings have put SMITHS years ahead in design and practical accomplishment under *actual* conditions.

SMITHS IS A FLIGHT-PROVED SYSTEM SMITHS automatic landing system is no mere experimental prototype – it is not limited to the control of one experimental aircraft under simulated conditions.

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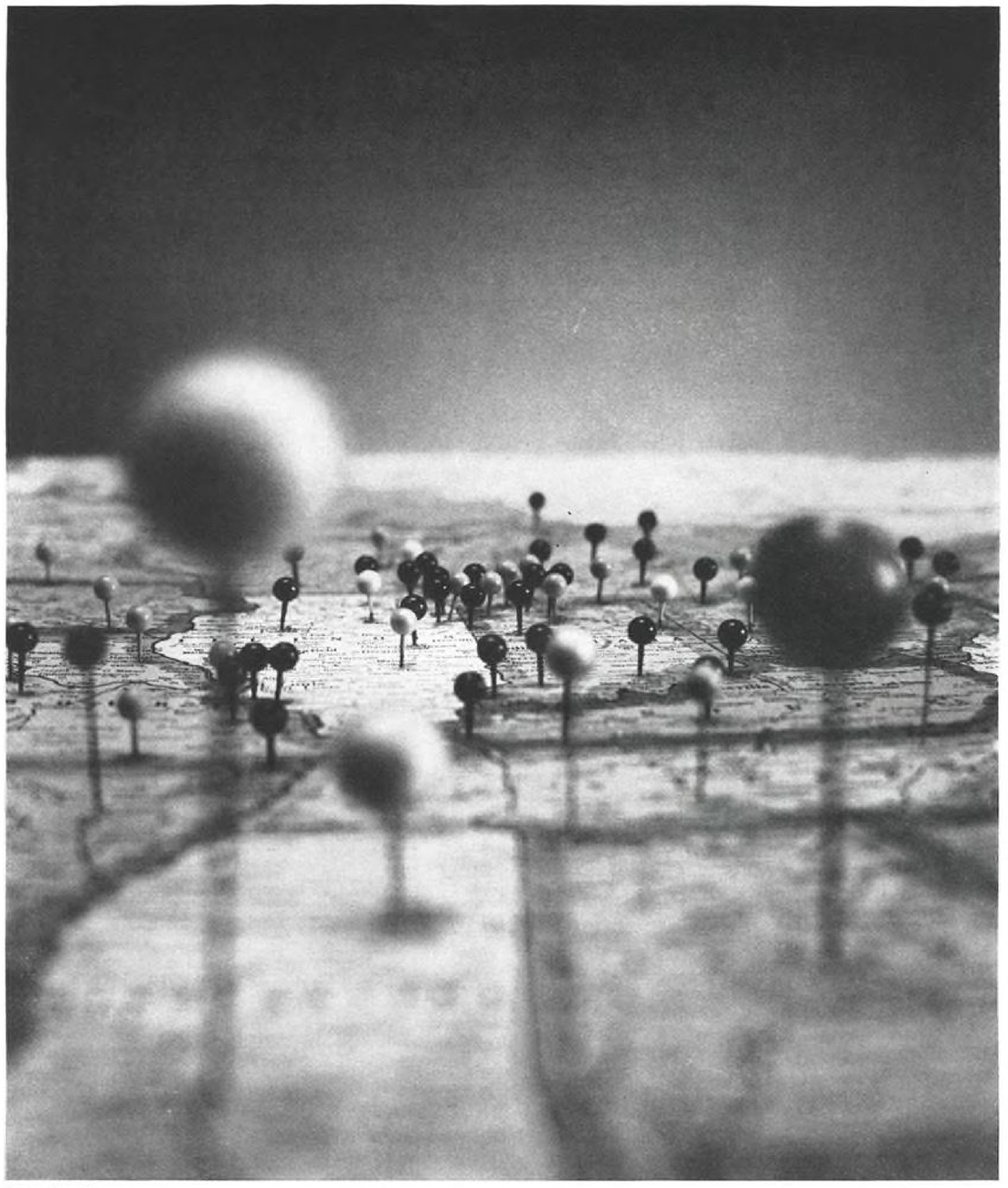

Task Force. Under Sperry systems management, 337 companies, including 18 major subcontractors, share responsibility for the navigation of every Polaris-firing submarine. It was Navy's precept that the nation's best talents be teamed for the job.□Because the system must continuously and precisely provide exact position information for launching the Polaris, our long experience in navigation and inertial technology made Sperry a logical management choice.□Among new technologies contributed to the program by Sperry were ultra-low drift gyroscopics, the SINS inertial system, the advanced NAVDAC computer, and new processing techniques for a sea of technical and management data. Vital to U.S. defenses, Polaris will serve other free world forces as well. *SPERRY POLARIS, Sperry Gyroscope Co., Great Neck, New York.*

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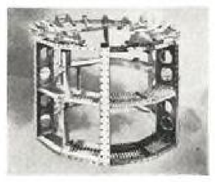

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COVER: Bell Aerosystems' SKMR-1 Hydroskimmer is shown making a full-power run over Lake Erie, near Buffalo, N. Y. This ground effects machine was built for the Navy as a research vehicle designed to travel 70 kt. while riding on an air cushion 12 to 24 in. above the surface. Follow-on production vehicle could be used for amphibious warfare operation or as a commercial passenger transport. For a pilot report on the Hydroskimmer, see p. 68.

PICTURE CREDITS
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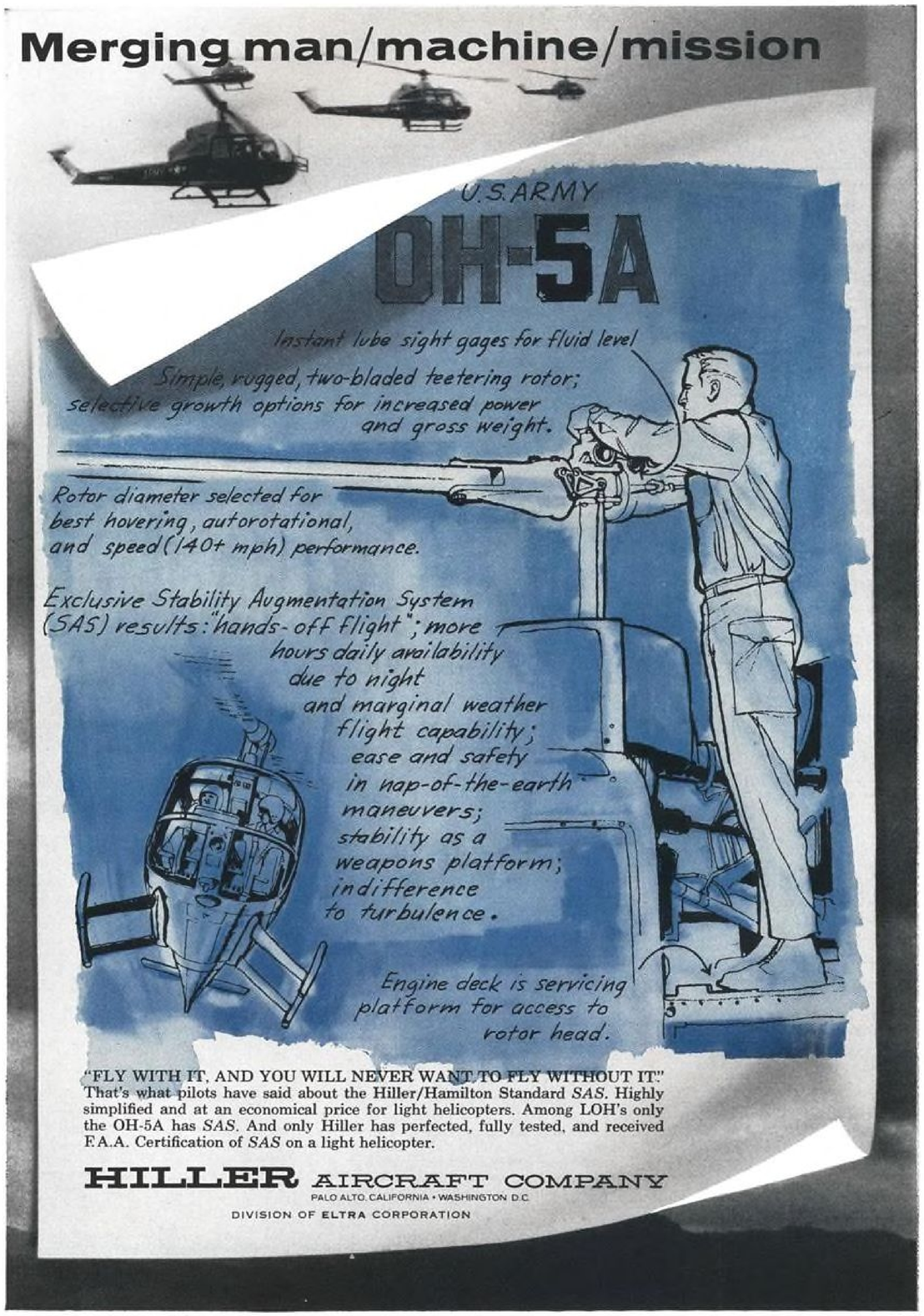


EDITORIAL

An Indelible Mark

President John F. Kennedy left an indelible mark on the space and defense policies of this nation. The policy changes he initiated may be modified with the passing of time, but their directions will not be reversed from the basic course he set when he gave the country its first marching orders under his command: "forward!"

He was a truly modern President, who quickly grasped the significance of the new products spawned by aerospace technology. He used jet helicopters, long-range jet transports and satellites, both communication and reconnaissance, as routine tools of his trade. He had an intuitive grasp of the significance of new technology as an essential element of modern power. As a sometime seafarer, he enjoyed the company of the air- and spacefarers who were opening these new frontiers. He spent more time with them than did any other President, both in the White House and among the gantries and the launch pads. He enjoyed being initiated by them into a layman's understanding of their strange vehicles and equipment.

As commander-in-chief of the armed forces, he reversed the policy of using a budgetary ceiling as the primary element of defense planning and applied the military strength needed as his basic measuring rod. He never shrank from asking for the fiscal increases this policy required, however unpopular the action proved.

He continued to strengthen the basic nuclear deterrent forces, but switched from sole reliance on them to building effective conventional forces to deal with every other type of aggressive threat short of full-scale nuclear war. He insisted on utilizing the full flexibility and mobility offered by air transport to ground forces, and launched a massive program to modernize military air lift.

The founding fathers' principle of civilian control of the military was never practiced more firmly than by his Administration. It also conducted the most successful attempt yet to dissolve the unnecessarily parochial service boundaries into a more effective instrument of national power. Although some of this went too far in ignoring competent military advice, it was effective in shaking the traditional military leaders out of their narrow, service-oriented viewpoints, into which it will be difficult for them to ever retreat again. It also shocked them into a more responsible perspective on their role in the decision-making process.

President Kennedy was the first commander-in-chief to exercise fully and effectively the massive nuclear deterrent to repel a major strategic threat to this country's security. The Russians' withdrawal of their ballistic missiles from Cuba was a major turning point in history. It would not have been possible without the skill and determination of the commander-in-chief's deployment of the nuclear striking forces. The pattern it set is likely to determine the character of U.S.-USSR relations for some time to come.

The supersonic transport program was transformed from a vague exploratory effort into an actively pursued, firm national goal by his personal stimulus. As with other programs he initiated, the subsequent fumbling of his aides cannot obscure the fact that it was he who personally galvanized supersonic transport research into hardware-oriented action.

But it is in space that his hallmark is most certain to survive corrosion of time. In his special message to Congress on "Urgent National Needs" (see p. 25), the national space program was transformed from a sluggish, reluctant reaction to Soviet triumphs into a sparkling American challenge which demanded that this nation strain its every resource to achieve pre-eminence in this new technology of modern power. The imaginative audacity of focusing this program on a manned lunar landing still leaves many Americans gasping, as does the magnitude of the effort required to achieve this technical leadership.

This policy, too, has traveled a roughly cobbled road, but President Kennedy welcomed the jousting with his critics. On the last occasion we saw him in action he was awarding the Collier Trophy to the seven Mercury astronauts in the White House rose garden, just a month before his death. He was in his characteristic jaunty, gregarious, humorous mood that is the way so many people will remember him. As the formal ceremony was concluded he moved around the portico steps spotting familiar faces in the audience of aerospace notables and beckoning them up for a personal word—Jimmy Doolittle, Jackie Cochran, Hugh Dryden and others. Then, with the spontaneity of a man who has just recaptured a straying thought, he again took the microphone and began a pointed thrust at critics of his space program. He compared these critics with those supposedly wise men at the turn of the century who sagely informed the world that what those Wright brothers were then doing in Dayton would never amount to much and that manned flight through the air would never have much significance for the world. He noted that space was now technically in the same relative stage that the Wrights were in during the first years after Kitty Hawk. Smiling, he said he wouldn't be surprised if the people who thought we were foolish to try to voyage into space would turn out to be just as right as the early evaluators of the Wright brothers. He left his audience chuckling at a point well made.

He made it even better in his last major speech the day before his death in Dallas. On Nov. 21, speaking at the USAF School of Aerospace Medicine in San Antonio, he said:

"The conquest of space must and will go ahead. That much we know. That much we can say with confidence and conviction. . . .

"Frank O'Connor, the Irish writer, tells in one of his books how, as a boy, he and his friends would make their way across the countryside, and when they came to an orchard wall that seemed too high, too doubtful to try, too difficult to permit their journey to continue, they took off their hats and tossed them over the wall—and then they had no choice but to follow them. This nation has tossed its cap over the wall of space—and we have no choice but to follow it."

And when the first American astronauts return safely from the moon, as they surely will, we should remember that it was John F. Kennedy, as our 35th President, who tossed our caps over the wall of space and made us surmount it successfully.

—Robert Hotz

WHO'S WHERE

In the Front Office

Eugene D. Stirlen, board chairman of Laboratory For Electronics, Inc., Boston, Mass.

B. D. Blackwell, elected a director of Bristol Siddeley Engines, Ltd., London, England, and technical sales director of the company's Aero and Power divisions. **A. D. Cawse** succeeds Mr. Blackwell as business manager (Aero).

Harold E. Showalter, vice president-controller, Douglas Aircraft Div., Long Beach, Calif., and **A. D. Jamtaas,** vice president-director of product development, Douglas Charlotte Div., Charlotte, N. C.

Blevins R. Fondren, vice president-finance, The Hardman Co., Los Angeles, Calif.

Morris R. Lynn, vice president, Operations Div., Hycon Manufacturing Co., Monrovia, Calif., and **William Piper,** financial vice president.

Arthur L. Chapman, executive vice president and general manager, the Hallicrafters Co., Chicago Ill., succeeding **Stanley E. Rendell,** resigned.

Alfred Goldberg, vice president-maintenance, Capitol Airways, Inc.

Bayard Fox, vice president and general manager-Europe, Leach International, S. A., a subsidiary of Leach Corp., with newly established offices in Geneva, Switzerland.

Herbert W. Pollack, a vice president and director of Polarad Electronics Corp.; he continues as president of Polarad Electronic Instruments Div., Long Island City, N. Y.

Chester D. May, controller, Hoffman Electronics Corp., Los Angeles, Calif.

E. C. DeHart, special assistant to the vice president-advanced systems, Data Systems Div., Litton Industries, Canoga Park, Calif.

Honors and Elections

Max Hymans, former secretary General for Civil Aviation of France and president of the board of directors of Air France, has been posthumously awarded the International Civil Aviation Organization's third Edward Warner Award, given for "outstanding contributions to the development of international civil aviation."

Charles J. J. Cox, controller and assistant treasurer of Western Air Lines, has been elected president of the Airline Finance and Accounting Conference of the Air Transport Assn.

Dr. Ugo Fano and **Dr. Richard C. Mockler** have been awarded National Bureau of Standards' 1963 Samuel Wesley Stratton Awards, established to recognize outstanding individual scientific or engineering achievement in support of the NBS mission by a member of the staff. Dr. Fano is an assistant director and senior research fellow; Dr. Mockler is chief of the Atomic Frequency and Time Interval Standards Section, NBS Boulder (Colo.) Laboratories.

Dr. Robert L. Pritchard, director of engineering at Motorola Inc.'s Semiconductor Products Div., has been awarded the Electronic Industries Assn.'s Radio Fall Plaque for his "many contributions to national and international standardization of semiconductor devices. . ."

INDUSTRY OBSERVER

► First vehicle in the low-observability re-entry vehicle (LORV) series, being developed by Avco Corp. (AW July 16, 1962, p. 23) for Air Force Systems Command's Ballistic Systems Div., will be flight-tested this month aboard a General Dynamics Atlas D missile scheduled for launch down the Pacific Missile Range. The LORV design is intended to reduce the observability of a re-entry system to enemy radars.

► **USAF is reviewing its bomber requirements and considering further extension of the operational life of the Boeing B-52 Stratofortress. Air Force may also consider an air-to-surface missile, possibly featuring an anti-radar capability, as armament for the aging B-52s.**

► Second USAF-McDonnell ASSET (aerothermodynamic-aerothermoelastic structural systems environment test) experimental glider now is scheduled for launch from Cape Canaveral in February, 1964. This aerothermodynamic model will be flown to a higher altitude and will re-enter at a greater velocity than the first glider (AW Sept. 23, p. 37), because the second ASSET will be boosted by a Douglas Thor vehicle with a modified Delta second stage. The first glider was launched atop a single Thor.

► **The Boeing Co. probably will decide by the end of the year on the advisability of authorizing a backup propulsion program for Advanced Research Projects Agency's high-acceleration booster experiment (Hibex). The basic Hibex motor is being built by Hercules Powder Co. for Boeing, which is the prime contractor to ARPA on the Hibex program. Boeing anticipates rocket acceleration well beyond current state-of-the-art for ICBM re-entry vehicle intercept.**

► Studies of airborne electronic countermeasures for use in the terminal phase of flight to deceive enemy defense radars are being conducted by USAF Systems Command's Aeronautical Systems Div. The ECM gear probably is intended for use aboard future Air Force aircraft, such as the advanced low-altitude manned penetrator (AMP), now under study (AW Nov. 11, p. 25).

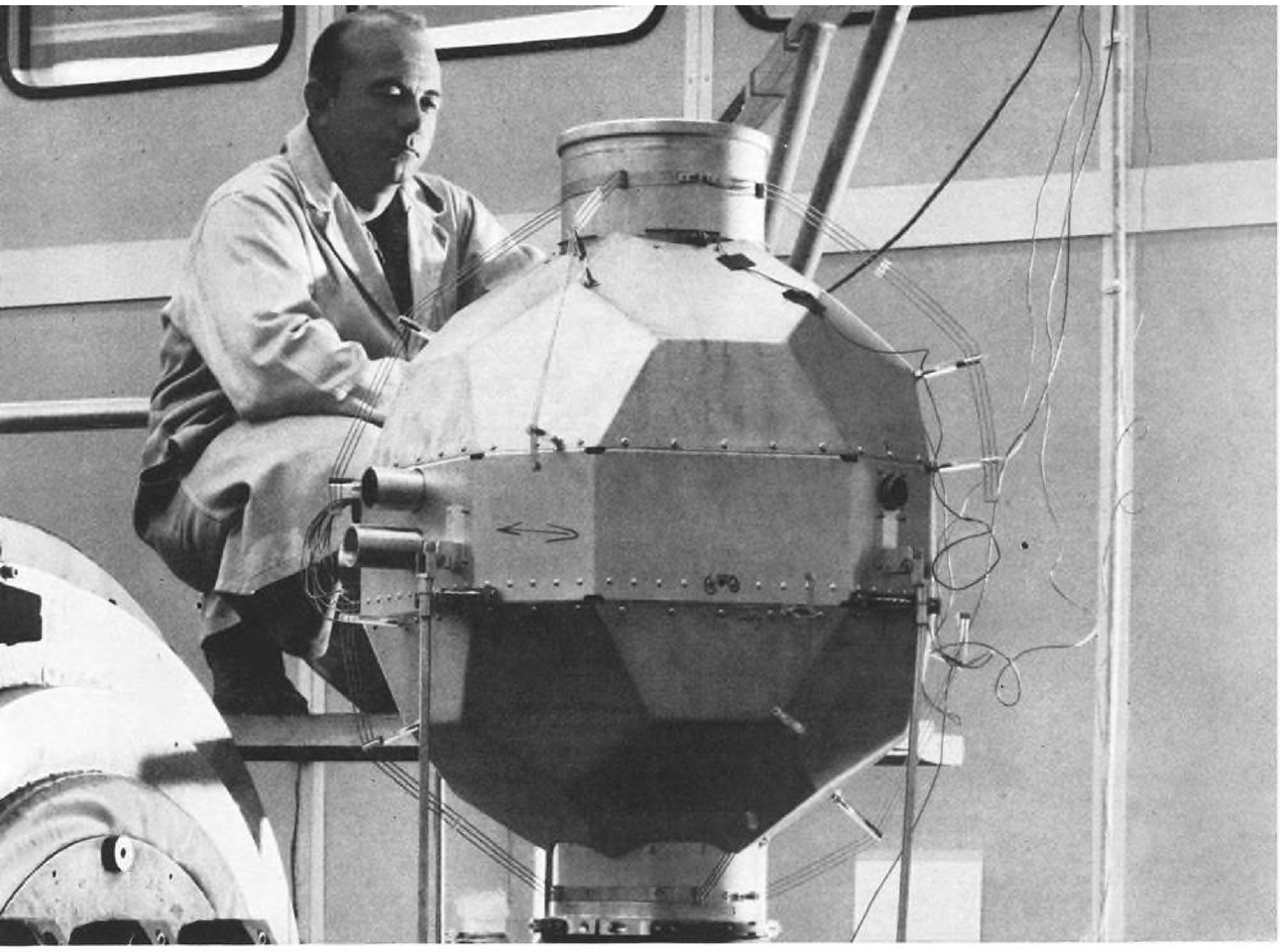
► **Clarity and quality of data being returned from the first two Vela Hotel nuclear explosion detection satellites are reported to be so good that Air Force may delay by several weeks or months the launch of the second pair. They were scheduled for launch during the first quarter of 1964 from Cape Canaveral. The first two were orbited Oct. 16 (AW Oct. 21, p. 30).**

► British Ministry of Aviation has approved development and construction of a jet engine and air intake test facility, capable of speeds up to Mach 3.5, at the National Gas Turbine Establishment at Pyestock. Vickers-Armstrongs (Engineers) is the contractor. The facility will include heat exchangers to simulate a temperature range of 50C to 1,700C.

► **Throttleable hybrid rocket engine which utilizes a liquid oxidizer sprayed simultaneously on both ends of a solid fuel core is under development at Lockheed Propulsion Co. Oxidizers under consideration include oxygen difluoride, and fuels being studied incorporate light metal additives.**

► New competition for an improved electronic countermeasures (ECM) system for the Boeing B-52 bomber is expected to be conducted shortly by USAF's Aeronautical Systems Div. in the wake of the indictment of a former vice president of Loral Electronics, accused of attempting to bribe an ASD civilian employe (AW Aug. 26, p. 37). ASD had flight-evaluated prototype equipment supplied in parallel efforts by Loral and Melabs and was about to award a contract at the time of the alleged bribe attempt.

► **Race car driving and other strenuous or stressful sports are more demanding physically than orbital space flight, according to results of a series of recent tests. NASA Manned Spacecraft Center's crew systems division reports that the mean pulse rate for a number of drivers in a 60-lap event was 200 and the respiration rate 42, compared with a maximum pulse rate of 134 beats/min. and respiration rate of 19 breaths/min. during re-entry from orbit in Project Mercury flights.**



The State University of Iowa has selected Bendix Systems Division to provide the structure for the NASA Injun Explorer Satellite. Shown above, the dynamic prototype of the satellite is undergoing environmental testing in the Bendix Aerospace Laboratories. Protruding through the skin are the accurate replicas of the satellite instrumentation such as geiger tubes and scintillation counters. The cylinder at the top is a canister for housing a 12-foot inflatable sphere (Air Density Explorer) which is ejected, inflated and separated from the Injun Explorer before the Injun Explorer separates from the booster rocket. The behavior of the Air Density Explorer will be observed from earth to measure density of the upper atmosphere.

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Bendix Systems Division THE Bendix CORPORATION **WHERE IDEAS UNLOCK THE FUTURE**

The Basic Challenge

(The basic change in U.S. space policy was made by the late President John F. Kennedy in a special message on "urgent national needs" delivered to a joint session of Congress on May 25, 1961. Since the portion of this message on space defines the policy that now prevails, and raises the challenge the nation is now working to meet as well today as it did when it was delivered, we are republishing the pertinent portions of that message as a reminder of where we are going in space and why.—RBH)

Finally, if we are to win the battle that is now going on around the world between freedom and tyranny, the dramatic achievements in space which occurred in recent weeks should have made clear to us all, as did Sputnik in 1957, the impact of this adventure on the minds of men everywhere, who are attempting to make a determination of which road they should take. Since early in my term, our efforts in space have been under review. With the advice of the Vice President, who is chairman of the National Space Council, we have examined where we are strong and where we are not, where we may succeed and where we may not. Now it is time to take longer strides—time for a great new American enterprise—time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on earth.

I believe we possess all the resources and talents necessary. But the facts of the matter are that we have never made the national decisions or marshalled the national resources required for such leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment.

Recognizing the head start obtained by the Soviets with their large rocket engines, which gives them many months of lead-time, and recognizing the likelihood that they will exploit this lead for some time to come in still more impressive successes, we nevertheless are required to make new efforts on our own. For while we cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will make us last. We take an additional risk by making it in full view of the world—but as shown by the feat of Astronaut Shepard, this very risk enhances our stature when we are successful. But this is not merely a race. Space is open to us now and our eagerness to share its meaning is not governed by the efforts of others. We go into space because whatever mankind must undertake, free men must fully share. . . .

I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish. We propose to accelerate development of the appropriate lunar space craft. We propose to develop alternate liquid and solid fuel boosters, much larger than any now being developed, until certain which is superior. We propose additional funds for other engine development and for unmanned explorations—explorations which are particularly important for one purpose which this nation will never overlook: the survival of the man who first makes this daring flight. But in a very real sense, it will not be one man going to the moon—if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there. . . .

Let it be clear—and this is a judgment which the members of Congress must finally make—let it be clear that I am asking the Congress and the country to accept a firm commitment to a new course of action—a course which will last for many years and carry very heavy costs of 531 million dollars in Fiscal 1962—an estimated seven to nine billion dollars additional over the next five years. If we are to go only half way, or reduce our sights in the face of difficulty, in my judgment it would be better not to go at all.

Now this is a choice which this country must make, and I am confident that under the leadership of the space committees of the Congress, and the appropriating committees, that you will consider the matter carefully.

It is a most important decision that we make as a nation. But all of you have lived through the last four years and have seen the significance of space and the adventures in space, and no one can predict with certainty what the ultimate meaning will be of mastery of space.

I believe we should go to the moon. But I think every citizen of this country as well as the members of the Congress should consider the matter carefully in making their judgment, to which we have given attention over many weeks and months, because it is a heavy burden, and there is no sense in agreeing or desiring that the United States takes an affirmative position in outer space, unless we are prepared to do the work and bear the burdens to make it successful. If we are not, we should decide today and this year.

This decision demands a major national commitment of scientific and technical manpower, material and facilities, and the possibility of their diversion from other important activities where they are already thinly spread. It means a degree of dedication, organization and discipline which have not always characterized our research and development efforts. It means we cannot afford undue work stoppages, inflated costs of material or talent, wasteful inter-agency rivalries, or a high turnover of key personnel.

New objectives and new money cannot solve these problems. They could in fact, aggravate them further—unless every scientist, every engineer, every serviceman, every technician, contractor, and civil servant gives his personal pledge that this nation will move forward, with the full speed of freedom, in the exciting adventure of space.

Johnson Stress on Military Space Seen

Push to fulfill Kennedy's plans expected before new President asserts his own ideas in aerospace fields.

Washington—President Lyndon B. Johnson is likely to play a more direct role than his predecessor in the nation's military space and supersonic transport programs after the current transitional period, during which the emphasis is on showing the nation and the world that President Kennedy's commitments will be fulfilled.

This means there will be no immediate policy changes in space, defense and civil aviation. But the aerospace industry, during the next year, can expect the new President to put his mark on several programs through changes in emphasis rather than in basic design. Industry can expect President Johnson at the same time to yank many of the Kennedy Administration proposals out of their congressional pigeon holes and push them through the legislative mill.

Time, politics and the temperament of the new President all point toward this course of action, as does his own message to Congress last week (see p. 28). President Johnson has less than a year between now and the 1964 presidential election to build his record; space and defense budgets are too near completion to make major shifts without causing a wholesale disruption in fiscal planning; and he prides himself on his ability to work his will on Congress.

Within this broad framework of action there are many issues in space, defense and aviation that President Johnson must decide over the next several months. AVIATION WEEK & SPACE TECHNOLOGY interviewed officials in the White House, Congress, Pentagon, National Aeronautics and Space Administration and aviation community to obtain the following consensus of what President Johnson's leadership will mean to the aerospace industry:

Space Policy

• **Consensus.** President Johnson is even more enthusiastic about the national space program than was President Kennedy, and will support it wholeheartedly. However, he will insist on an adequate role for the military even if it means spending more money. But no immediate head-on collision with Defense Secretary Robert S. McNamara—who is yet to be sold on military space—is anticipated. President Johnson will insist on close NASA-Defense Dept. coordination, and will knock heads if he does not get it. He probably will go along with NASA's plan to ask Congress for about $5.5 billion for Fiscal 1965. Space agency asked for $5.7 billion for Fiscal 1964. Congress voted $5.1 billion (AW Nov. 25, p. 31). Chances appear slim that President Johnson will go so far as to ask Congress to reverse itself by requesting a supplemental appropriation next January to make up for this year's cut.

These are among the imminent policy decisions President Johnson will have to make on specific projects:

• **Gemini.** Air Force up to now has privately protested that the Jan. 21, 1963, NASA-Defense Dept. agreement does not give it any significant role in this next manned space flight program (AW July 22, p. 225). President Johnson will review the objections and may enlarge the Air Force role. Some space officials foresee an amendment of the agreement which will allow Air Force not only to man Gemini capsules, but also to plan and control some missions.

• **Apollo.** President Johnson is expected to oppose budget cutters and keep this massive program to land a man on the moon by 1970 on schedule. He is credited with being the architect of the large booster program acceleration, which began in March, 1961, and with being the most outspoken proponent in the White House family for the lunar landing goal, which was made a national policy two months later.

• **Military space station.** Question is whether this expensive project—estimated to cost from $500 million to $3 billion—should be undertaken and, if so, whether NASA or Air Force should manage it. Rep. Thomas Morris (D.-N.M.), member of the House space committee and advocate of the project, said President Kennedy told him several weeks ago that he had not made up his mind on it. Rep. Morris feels the Air Force should manage the station because NASA already is overburdened with space projects, while the military has comparatively few.

• **USAF-Boeing X-20** (Dyna-Soar). No immediate prospect is seen for President Johnson to reverse McNamara and accelerate its development. Some predict X-20 will be abandoned in 1965 in favor of a space station or another winged re-entry vehicle program.

• **Personnel.** NASA Administrator James E. Webb expected to be retained. President Johnson said last March "there is no man in this country that has done a finer job than Administrator Webb."

Chairman Clinton P. Anderson (D.-N.M.) of the Senate space sciences committee said, "I don't see any change . . . in the basic programs or policies" coming immediately from President Johnson's stewardship. Chairman George P. Miller (D.-Calif.) of the House space committee expressed the same view.

Defense Implications

• **Consensus.** Unlike President Truman, who did not know of the atom bomb's existence while he was vice president, President Johnson participated fully in military policy-making while he was vice president. He also has praised McNamara highly. And any sharp shifts in defense policies would be disturbing to U.S. allies in this period of transition. In addition, the Fiscal 1965 Defense Dept. budget is just about finished and is slated to go to print Dec. 15 (AW Oct. 14, p. 26). Target figure is $47 billion. All this indicates President Johnson will make only minor changes in emphasis within the already set confines of the Fiscal 1965 Defense Dept. budget.

Soon after the new budget is presented to Congress—or even before, in some cases—President Johnson will have to make major decisions in these areas:

• **Military space.** The dollar investment in this area—in addition to the specific projects detailed above—will have to be determined. Anticipated Fiscal 1965 total is about $1.7 billion—same as Fiscal 1964. President Johnson is expected to bear down hard to avoid duplication of effort.

Rep. Bob Casey (D.-Tex.) of Houston, a member of the House space committee and friend of President Johnson, predicted the new President will not increase military space spending at the expense of NASA. He said there is no immediate need for President Johnson to change the balance between NASA and Defense Dept., since the civilian space agency's development work is applicable to future military missions. He said the time to have separate NASA-Defense Dept. space programs may come after the Gemini program is completed. "There was a time," Rep. Casey said, "when coordination between NASA and Defense was pretty poor. But this past year there has been closer coordination. So there is no use of having two programs now."

Space officials predict that eventually, however, President Johnson will tip the space balance more toward the military. They cite his long record while in Congress of demanding more money for defense, and his emphasis while vice president on the security value of space exploration.

• **Budget ceiling.** McNamara has stated that military spending has hit a plateau and will level off in the future (AW Nov. 25, p. 29). President Johnson undoubtedly will try to fulfill that pledge. The question is whether he can rely on transfers of money under that ceiling to make changes in emphasis. Chairman George H. Mahon (D.-Tex.) of the House defense appropriations subcommittee is among those predicting President Johnson will try to keep the Defense Dept. budget on its present plateau.

But the Republicans in election year 1964 will decry any cuts in weapon systems to stay within this ceiling. A House Republican group already is claiming there is too little spending for military space. Rep. Gerald R. Ford (R.-Mich.), ranking Republican on the Mahon subcommittee, said such built-in increases as pay raises and inflation are bound to make the Defense Dept. budget keep rising unless the Johnson Administration cuts personnel or hardware. Rep. Ford, a party leader, said the cuts should be in personnel—indicating this will be one of the many military issues in the 1964 campaign.

• **USAF-General Dynamics B-58** bombers. USAF Gen. Thomas S. Power, commander of the Strategic Air Command, is asking his superiors to re-start the General Dynamics production line in Ft. Worth and build 228 more B-58s. McNamara has rejected past requests, including ones from Congress, to build more B-58s. But there is a chance that President Johnson may decide otherwise after he learns the expense of keeping the USAF B-52s in service, and the

President's Space, Military Background

Washington—President Lyndon B. Johnson comes to his new job with considerable legislative experience in space and military activities as a result of his committee assignments while a member of Congress from 1937 through 1960, and his chairmanship of the National Aeronautics and Space Council since his election as vice president.

He took the lead in creating the Senate Special Space and Astronautics Committee in 1958, and became its first chairman. He remained chairman of that body when it became the permanent Aeronautical and Space Sciences Committee.

His military legislative background started with the former House Naval Affairs Committee in 1937. He served there until 1947, when he went to the successor group—House Armed Services Committee, under Rep. Carl Vinson (D.-Ga.). In 1944 and 1945 he was a member of the House Select Committee on Postwar Military Policy.

When he went to the Senate in 1949, President Johnson was named to the Armed Services Committee and became chairman of its Preparedness Investigations Subcommittee when it was founded in 1950. His work there convinced him a separate space committee was needed.

His investigating subcommittee on Jan. 23, 1958, said Russia was ahead of the U.S. in several military areas and recommended 17 remedial actions, including accelerated weapon development and a broader space program.

He was Senate Majority Leader from 1953 to 1961, when he became vice president. In his message to the Senate Apr. 23, 1960, Johnson listed as among "the major challenges of the 60s," the "challenge of the exploration of space."

He was a Navy lieutenant commander in 1941 and 1942, receiving the Silver Star while serving in the Pacific.

'Military Vigilance' Ordered

Defense Secretary Robert S. McNamara ordered a state of "military vigilance" among U.S. worldwide forces within an hour after the assassination of President Kennedy was confirmed on Nov. 22. Later that day, President Johnson concurred in the decision.

"Military vigilance" is an informal term requiring that top commanders or deputies of specified and unified commands and their staffs be available in their headquarters.

McNamara and McGeorge Bundy, presidential assistant who maintains the White House situation room, briefed President Johnson on the strategic military situation immediately after his return to Washington from Dallas. The situation room is a compact operations control center where current tactical and strategic situations are displayed. It also contains communications to Joint Chiefs of Staff and unified and specified commands.

McNamara and Bundy informed the President that the Joint Chiefs of Staff had met twice since the assassination, and on both occasions agreed that the normal alert, with the added proviso of military vigilance, was sufficient to maintain national safety. Normal alert places 50% of Strategic Air Command bombers on ground alert, along with a full alert of Polaris missile submarines and Air Force ballistic missiles.

A yellow alert would have placed most forces on standby, ready for deployment and action. Top readiness condition is red alert, in which combat forces are ready for defense or strikes.

Relay Beams Live Coverage Abroad

Washington—Live television coverage of the events following President Kennedy's assassination was beamed via the Relay communications satellite to more than 200 million viewers in Japan, Europe and Russia.

Combined domestic and overseas audience totalled nearly 400 million—the largest ever to watch live coverage of a news event. It was also the first time the Soviet Union requested that coverage of a live U.S. event be transmitted to Russia.

Ironically, a broadcast to Japan Nov. 22 was to have included a message from President Kennedy, filmed and recorded outside the White House by the late President on Nov. 20 (see p. 31). In the actual transmission at 3:30 p.m. Nov. 22—two hr. after the assassination—President Kennedy's message was omitted. The telecast included a biographical sketch of President Kennedy's life then being shown on U.S. networks.

Four hours, 30 min. later, in another transmission, network news coverage was sent to Japan. Other broadcasts were:

• Saturday—Four 10-min. transmissions to Western European countries.

• Sunday—Three broadcasts, two for 15 min. and one for 20 min., to Western Europe.

• Monday—Half-hour broadcast to every country in Europe, including Russia, of coverage of the funeral procession to St. Matthew's Cathedral; also, two transmissions to Japan.

U.S. Information Agency estimates that most of the 58 million viewers in Japan, 164 million in Europe and Russia saw one or more of the telecasts.

Johnson Familiar With Aerospace Facilities

Cape Canaveral—Both President Johnson and the late President Kennedy demonstrated intense interest not only in policies of the space program, but also in the people, hardware and facilities of the entire aerospace field.

Both visited here three times. President Johnson's first trip was Jan. 13, 1961, six days before he was sworn in as vice president. He also visited here with President Kennedy on two occasions—Feb. 23, 1962, to greet Marine Lt. Col. John H. Glenn, Jr., first U. S. orbital pilot, and for briefings on Sept. 11, 1962.

Their September, 1962, visit was part of a trip to space installations that included the Manned Spacecraft Center in Houston, and the McDonnell Co. plant in St. Louis (AW Sept. 17, p. 26).

President Johnson also visited West Coast aerospace facilities, including the Pacific Missile Range and Edwards rocket test center, in October, 1961 (AW Oct. 9, p. 26).

President Kennedy last visited here Nov. 16, six days before his assassination.

poor reliability figures on strategic missiles. He unsuccessfully urged Gen. Curtis E. LeMay, USAF chief of staff, in 1961 to build more B-58s rather than rely solely on the North American B-70. Rep. James C. Wright, Jr. (D.-Tex.) of Ft. Worth—who also is pushing for resumption of B-58 production—said he is "not too hopeful" about President Johnson reversing McNamara on the issue at this time.

• **USAF-North American B-70.** President Johnson is not expected to push this program beyond the three prototypes that are currently under development.

• **Follow-on aircraft.** Associates of the President declare his long-time enthusiasm for military aircraft improves Air Force chances for obtaining full funding for the three concepts now under study—advanced manned penetrator (AMP), multi-purpose long endurance (Maple) aircraft and a small, high-altitude bomber.

• **Personnel.** Pentagon insiders feel they will get a significant reading on President Johnson's attitude toward present military leaders by what action he takes on these scheduled 1964 retirements and subsequent promotions of others: Gen. LeMay, Gen. Power, and Adm. Harry D. Felt, commander-in-chief, Pacific. Another question is whether Gen. Maxwell D. Taylor, chairman of the Joint Chiefs of Staff who first was recalled to duty by President Kennedy to help reorganize the services as presidential military adviser, will continue in those positions (AW Nov. 11, p. 25).

On Mar. 26, President Johnson said McNamara is "a brilliant and able man." But some associates of the new President doubt that the rapport between the two will equal the Kennedy-McNamara relationship—partly because President Johnson is expected to take a more direct hand in military matters.

Sen. Barry Goldwater of Arizona, Republican front-runner for the presidential nomination before President Kennedy was assassinated and a harsh critic of Administration defense policies, said it is too early to predict any changes. "Knowing this man as I do," Goldwater said of President Johnson, "I doubt there would be any changes in defense personnel or policy." Sens. Henry M. Jackson (D.-Wash.) and Stuart Symington (D.-Mo.) said they foresee no immediate defense policy shifts.

Continued Space Effort

Washington—President Johnson pledged to continue the late President Kennedy's "ideas and ideals," including "the dream of conquering the vastness of space," in his first address to a joint session of Congress on Nov. 27. This reference to space was the first item of unfinished business he mentioned.

He said the U. S. will maintain "military strength second to none," and will honor its foreign military commitments "from South Vietnam to West Berlin" while continuing to seek "areas of agreement even with those with whom we disagree. . . ."

His brief speech was characterized by frequent calls for action, primarily in the key domestic issues of civil rights and tax legislation. There were 14 separate references to the need for action, making it clear that President Johnson expects early congressional action on pending legislation.

Although he set no time limit or schedule for congressional action, he punctuated his remarks with such phrases as ". . . this is no time for delay. It is a time for . . . strong, forward-looking action," and "the need is here. The need is now."

Civil Aviation

• **Consensus.** President Johnson will inject himself into the supersonic transport effort to get action, even if it means tramping hard on FAA Administrator Najeeb E. Halaby's toes or finding a hard-driving successor. The President's aviation interest also generally embraces the air transport industry which expects a more sympathetic attitude from the White House.

• **Air traffic control modernization.** President Johnson is expected to give this slow-moving FAA program a push.

• **International air policy.** Specialists in this area predict President Johnson will pay more attention than his predecessor did to the view of the carriers themselves. Several industry leaders felt the Kennedy Administration's international air policy paper was done without adequate consultation with the parties most directly concerned—airlines and labor. "President Johnson won't work that way," said one veteran airline executive who knows him. He predicted the new President in the civil aviation field will concentrate more on getting policies implemented rather than thinking up new ones.

• **Personnel.** Halaby's future is uncertain, but Alan S. Boyd is expected to be reappointed as Civil Aeronautics Board chairman when his term expires Dec. 31.

Among the uncertainties is the new President's stand on airline mergers.

Other Aerospace Areas

• **Disarmament.** President Johnson worked for Senate passage of the nuclear test ban treaty and is expected to continue President Kennedy's efforts to reach as many accommodations as practical with Russia. He said while a senator in 1957 that "we now face the prospect of destroying ourselves not as the result of an armaments race but merely by indulging in the race . . ." On Oct. 15, he said the test ban treaty showed "it is possible to lower world tensions without lowering our guard."

• **Nuclear projects.** Leaders on the Joint Congressional Atomic Energy Committee expect continued White House support. But they see little prospect of President Johnson stepping in to rescue the Pluto and Rover nuclear propulsion projects. Civilian defense officials question whether these projects are worth the cost.

IMP in Orbit

Cape Canaveral—First of a series of seven interplanetary monitoring platforms (IMP) which will map magnetic fields of space and the effects of solar winds and cosmic rays on the earth's magnetosphere was launched here at 9:30 p.m. (EST) Nov. 26 by National Aeronautics and Space Administration.

Initial orbital parameters of the satellite (AW Nov. 4, p. 28), designated Explorer 18, were: apogee, 172,234 mi.; perigee, 118 mi.; inclination, 33 deg., and a period of 152.73 hr. All telemetry indicated that the 10 instruments aboard the 138-lb. satellite were functioning normally.

Funeral Influx Tests Dulles Operations

By Robert H. Cook

Washington—Sudden influx of world leaders attending President Kennedy's funeral here last week provided Dulles International Airport with its first opportunity to function as a key international gateway to the U. S.—the purpose for which it was designed.

The $115-million terminal, which went into service a little over a year ago, had until last week functioned primarily as a domestic terminal. But when the emergency arose, Dulles' personnel and facilities were equal to the task.

Most of the highest-ranking dignitaries and their aides entered the U. S. at Dulles, where they were greeted by Secretary of State Dean Rusk before departing for their various embassies under heavy security measures.

Balance of the prominent mourners, including foreign delegations, U. S. legislators, state officials and other prominent citizens, arrived by scheduled airlines or Military Air Transport Service flights at Washington National Airport. Andrews AFB, in nearby Maryland, handled the arrival of Prince Bernhard of the Netherlands in an Air Force Lockheed JetStar and the Soviet delegation, led by Deputy Premier Anastas Mikoyan, in an Ilyushin Il-18, a four-engine turboprop aircraft.

The sudden swelling of air traffic into both Dulles and Washington National operations had little noticeable effect on the airports. With the exception of three MATS flights, all delegates arriving at National were on scheduled flights. Arrivals and departures totaled 740 on Nov. 24, and increased to 770 the following day. Andrews estimated traffic was up 25%, partially because many MATS aircraft flew there after discharging their passengers at National. In addition, 27 flights carrying top-level military and civilian dignitaries—including former Presidents Truman and Eisenhower—also landed at Andrews.

Dulles experienced no difficulty since it has in the past handled 102 aircraft movements in one hour. To its customary Sunday schedule, the airport added eight special foreign charters, plus two more the following day. The total included: Air France; Sabena Belgian World Airlines; El Al, the Israeli carrier; Irish Airlines; British Overseas Airways; Ethiopian Air Lines; Alitalia, the Italian airline; Swissair and Lufthansa. Ordinarily, the airport's international service is supplied only by BOAC and Pan American World Airways.

Less than three hours after State Dept. first alerted the airport the initial delegation — from Mexico — arrived aboard American Airlines Flight 58. This was about 4 p.m. Nov. 24. Arrivals continued throughout the night and the following morning, with the last delegation—from Pakistan—arriving aboard a Swissair charter at 10 a.m. Peak traffic loads were experienced on Sunday, Nov. 24, between 3 and 5 p.m.—a period in which ordinarily only 14 aircraft movements would occur. On this day, the total reached 30. Scheduled movements decreased sharply after 9 p.m. By then seven of the total 17 flights with delegations had arrived at Dulles.

Balance of the delegations arrived on U. S. carriers. Size of the delegations varied widely. Some flights were full—one Pan American flight carried delegates representing six countries—while the Swissair charter included only one passenger and the Alitalia flight three.

Ground handling of the foreign airliners—primarily long-range Boeing 707s—was accomplished by present Dulles tenants, through interline agreements. Swissair was handled through Delta, Air France through Northwest, Lufthansa by American, Alitalia by Delta and Ethiopia by Trans World Airlines. El Al and Irish Airlines were handled by Page Airways International, a fixed-base operator.

State Dept. security precautions and protocol measures at the terminal were so time-consuming they occasionally forced an airborne slowdown of some foreign flights. At the same time, these measures provided unique employment for the mobile lounge—as a moving conference room for Secretary Rusk.

Since Secretary Rusk was personally greeting each head of state, and flights were often scheduled for close arrival, controllers were forced to direct several flights to throttle back or assume holding patterns, at State Dept. direction.

On the ground, the entire top-level enplaning road entrance before the terminal building was reserved for embassy vehicles on a flight priority basis. Dulles kept State Dept. officials constantly advised of arrival time changes, so that as each dignitary departed, the greeting party for the next flight was moved into line from a staging area on the far side of the parking lot.

Customs and public health inspections were cut to a minimum, with U. S. agents boarding each flight as it arrived on the ramp.

Ten mobile lounges were kept in almost continuous operation from gate positions one, two and three. Their engines were kept running for a 12-hr. period. There were no mechanical problems, and the only substitutions occurred when two spare lounges were put into service while the others were being cleaned. Most flights required the use of only one lounge, but a few—such as Irish, Air France and BOAC—required two for large delegations.

President Charles de Gaulle of France, a frequent target of assassins, gave the lounge operation its greatest compliment and State security agents their worst concern. The security-minded French president and many other heads of state originally insisted that embassy cars meet them on the ramp alongside the aircraft, but while en route over the Atlantic the French president agreed to use the lounge and set an example for the remaining dignitaries. State Dept. spokesmen admit their greatest concern was at Dulles, where a majority of its 200 security agents were assigned because of the high rank of the delegates arriving there. Most of the Dulles police force put in a double shift during this period, and each foreign aircraft parked on the ramp was also under a heavy military guard, with no one permitted near unless cleared by an airport and State Dept. security list.

Exposure of the terminal to so many top-level world leaders is almost certain to result in more foreign flag carriers applying to use Dulles as a major port of entry, Dulles officials believe. Air France may begin operations at Dulles early next year. Lufthansa has been actively exploring the possibility and many others may then follow, they contend.

Dulles also needs more adequate facilities for live television coverage, so that the terminal building will not be blocked or cluttered with equipment. Only a small space was available for greeting the delegations, and this was strewn with radio and TV cables.

Military Fly-By

Washington—Air Force and Navy aircraft combined in a ceremonial fly-by over the grave of the late President John F. Kennedy during the funeral at Arlington National Cemetery last week.

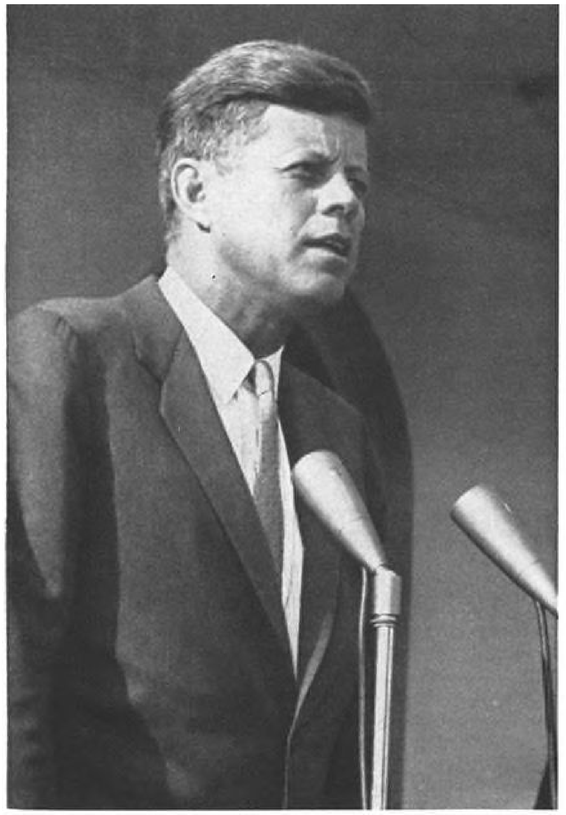
Formation of 30 Republic F-105 Thunderjets from USAF's 4th Tactical Fighter Wing led the group, followed by 20 McDonnell F-4B carrier-based fighters from the Navy's Carrier Air Group Six based at Oceana, Va. The F-4Bs flew in three-aircraft elements with the wing man of the last element missing to symbolize a fallen comrade.

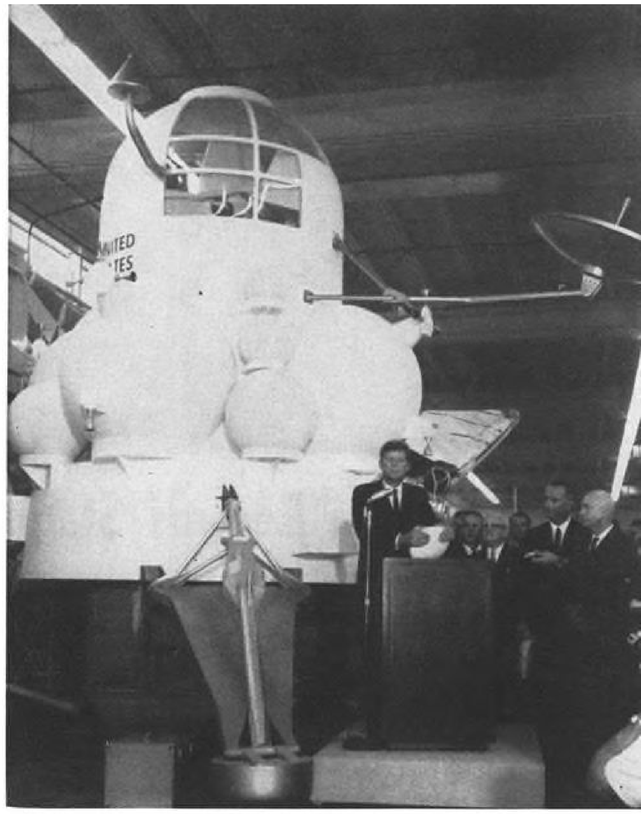
Following the fighters, Air Force One, the Boeing VC-137C jet transport used by the President, swept in low across the gravesite and Col. James B. Swindal, who had flown the President on many trips, dipped the huge transport's wings in a farewell salute.

The late President Kennedy and President Johnson are briefed in Hangar S at Cape Canaveral on the Mercury capsule by Astronauts Walter M. Schirra and Gordon Cooper. Among those in the party are Air Force Secretary Eugene M. Zuckert, NASA Administrator James E. Webb; Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, and Maj. Gen. Leighton I. Davis, Atlantic Missile Range commander.

Late President, Successor Saw Development of Space Program

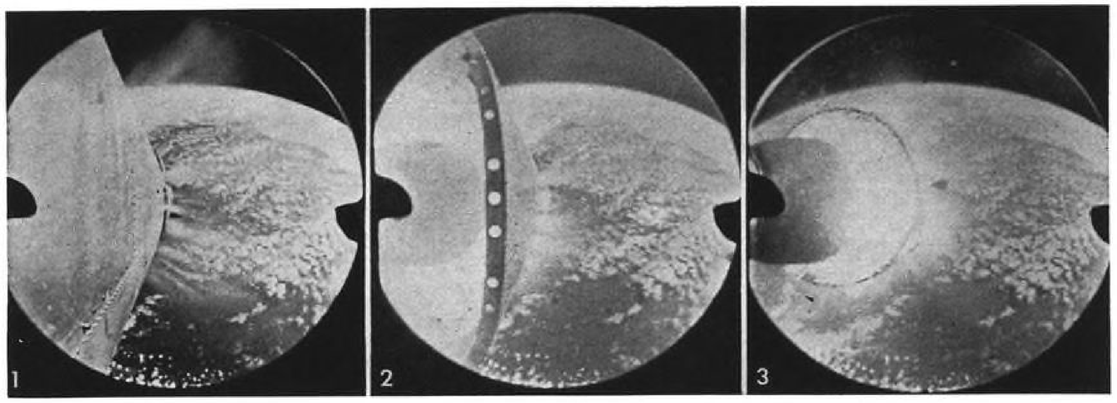
Astronaut John Glenn demonstrates to the late President Kennedy the flexibility of the glove used on full pressure suits during Project Mercury flights (left). The glove is in a pressure chamber. The demonstration took place in September, 1962, during a visit President Kennedy made to the Manned Spacecraft Center in Houston. In the background are Robert R. Gilruth, center director; President Johnson; Walter C. Williams, then deputy director of the center; NASA Administrator James E. Webb; Brainerd Holmes (partially obscured), then director of NASA manned space flight operations, and Robert C. Seamans, Jr., associate NASA administrator.





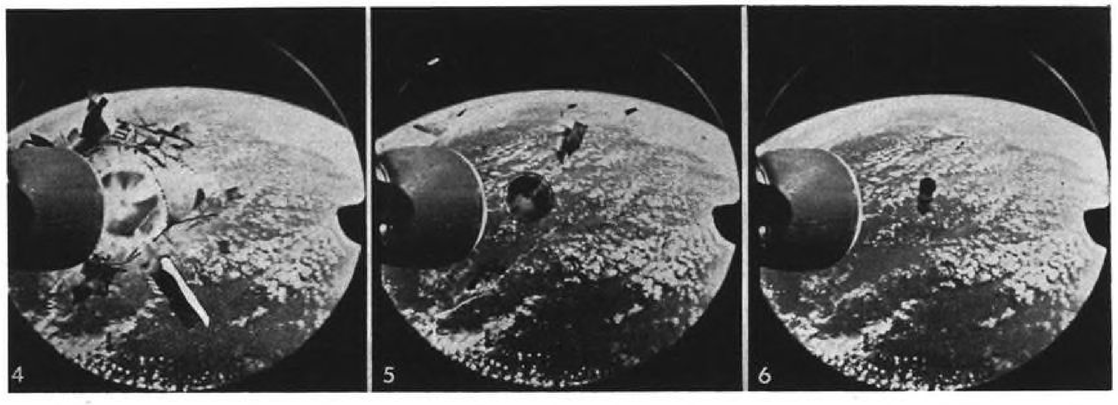
The late President Kennedy (left) taped a goodwill message at the White House only two days before his death for transmission to Japan via the Relay communications satellite (see p. 27). The message was never sent. The President was assassinated 2 hr. before scheduled transmission time. The manned lunar landing program was a subject of President Kennedy during his 1962 visit to the Manned Spacecraft Center in Houston (right). Behind him is a wooden mockup of an early Lunar Excursion Module design. Among those near the rostrum are President Lyndon Johnson, Robert R. Gilruth, director of the center, and Walter C. Williams, then deputy center director.

Astronaut Virgil I. Grissom explains a Gemini spacecraft mockup to President Johnson and the late President Kennedy. At right is Robert R. Gilruth, director of the Manned Spacecraft Center, where the briefing was held in September, 1962. At left rear is Lt. Col. Stanley White, who formerly headed the center's bioastronautics division.



Camera Records Staging Sequence of Titan 2

Separation of the USAF-Martin Co. Titan 2 ICBM launched from Cape Canaveral Nov. 1 (AW Nov. 18, p. 36) was recorded by a 16-mm. camera mounted in a pod on the second stage skirt. Start of the sequence (1) shows ignition of Aerojet-General single-barrel, second stage engine after 150 sec. of first stage burning. Note exhaust vented through four rectangular cut-outs at the base of the interstage adapter. Upper flange of the adapter is visible (2) with the nozzle skirt of the second stage engine. Second stage engine ignition, shutdown of 430,000-lb. thrust first stage and firing of separation bolts takes less than 3 sec. Second stage (3) now is clear of the adapter, which disintegrates (4) under the heat loads and pressures of second stage ignition and thrust buildup to 3 min. of burning. Wreckage of the adapter falls away (5). Black markings on spent first stage are visible as it drops away (6). Flame of the Titan 2's hypergolic propellants is so clear (AW Sept. 11, 1961, p. 75) that first stage is easily visible. Pictures were made by a D. B. Milliken Co. camera operated at 400 frames/sec. at *f*5/6 setting with 110-deg. lens. Photos were taken at 40-mi. altitude.



Agena Is Retrofitted for Midas

Lockheed Missiles and Space Co. is retrofitting the Agena spacecraft for USAF Space Systems Div.'s missile defense alarm system (Midas) program in accordance with new, very-high-reliability specifications. This indicates that increased emphasis is being placed on the Midas infrared-detection satellite for pinpointing missile launches.

The aim of the high-reliability program for Midas apparently is to minimize chances of random failure, to achieve extremely high mean time between failure. Observers feel that the program may set a pattern for future high-reliability requirements, because of the thoroughness of the approach and its rigidly enforced demands.

Equipment involved in the Agena retrofit program for Midas includes avionic components and probably some mechanical units. Indications are that the retrofitted Agena will not be ready for use before late 1964. Six flight articles probably will be fitted initially with the new higher reliability hardware. Conservative estimates are that cost of the retrofitted Agena will be at least 50% greater than Agena vehicles used routinely for other programs.

Extensive and stringent lot testing is required of component manufacturers, which have established lot testing capabilities in accordance with Lockheed requirements. These manufacturers are established as the only qualified sources for particular components. Where no manufacturer has established the lot-testing capability for a particular component, Lockheed will run the tests itself.

When the parts are delivered by a manufacturer, the package is required to be labeled with a notice that it contains high-reliability parts.

Marshall Studies Advanced Large Vehicles

NASA's Marshall Space Flight Center has discussed with airframe and propulsion manufacturers its projections for three advanced large launch vehicles which could cost about $20 billion, over a 20-year period, for extended studies, development and test.

During the last 15 years of this work, average funding would run about $1.3 billion per year. Work on the first of the vehicles might be initiated with funding of $50 million to $100 million in Fiscal 1966.

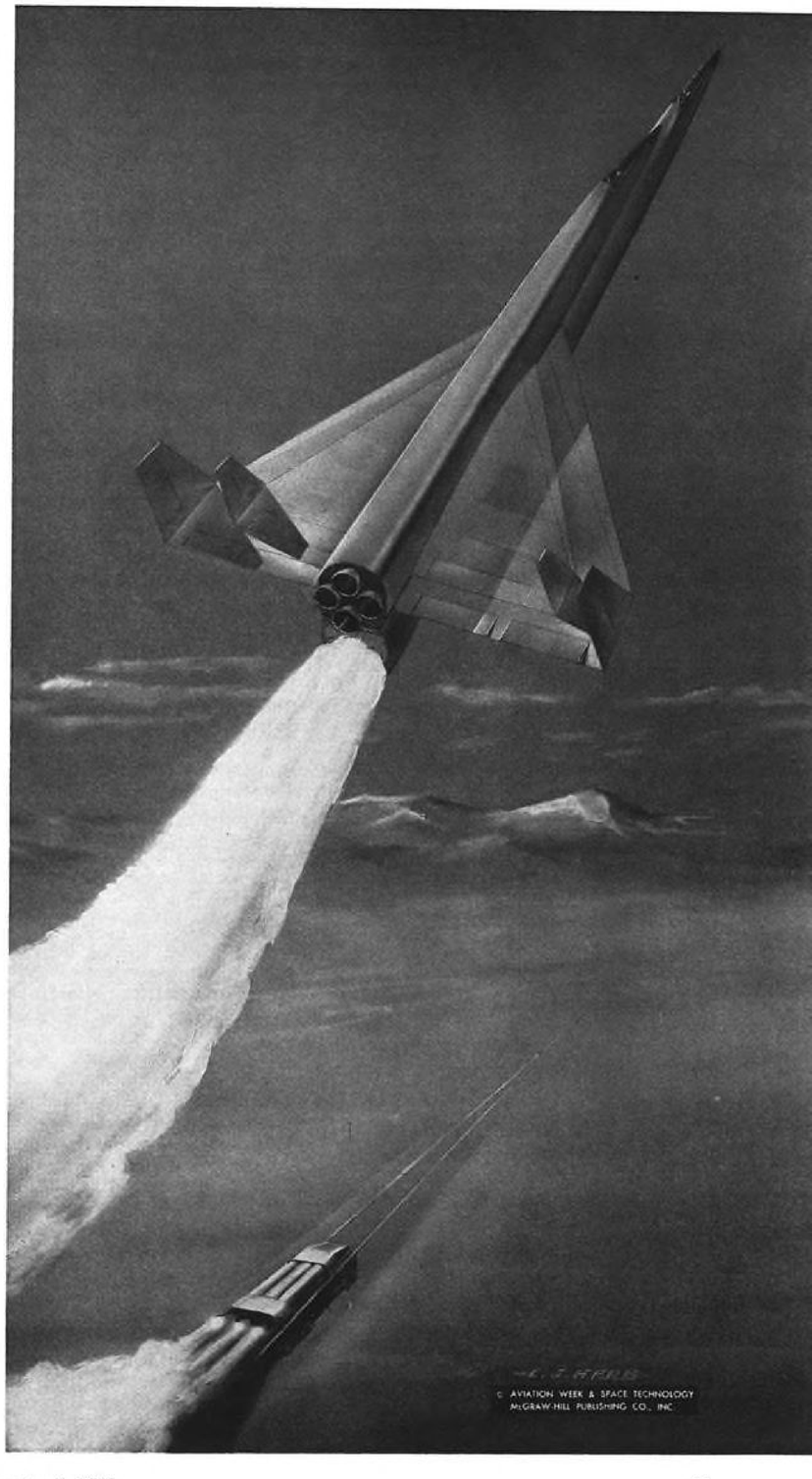
A key hurdle in MSFC's projections for these vehicles might be to convince NASA headquarters to support the plan.

The launch vehicles envisioned by MSFC would be recoverable configurations (AW July 8, p. 81) for as many as 100 reuses, and would include these three types:

• **Earth-to-orbit** rocket plane having a liftoff weight of approximately 500 tons for its horizontal takeoff mode. Its landing would also be in a horizontal attitude. This vehicle would carry a total payload of about 25,000 lb.—made up of two crewmen, 10 passengers, life support and associated systems, and about 6,600 lb. of cargo. Availability would be targeted for early in the 1970s. Studies of configurations to meet this operational category are being performed by Lockheed-California Co. and North American Aviation's Space and Information Systems Div. under contract with MSFC's future projects office, as an outgrowth of a basic, prior effort supported by the center (AW Mar. 26, 1962, p. 20).

One version of the horizontal takeoff and landing configuration contemplates use of a rocket sled for launch acceleration to the velocity at which the rocket plane could be airborne safely and sustained by its own engine power. Takeoff might be from a track installation at a favorable location, such as Edwards AFB. The horizontal landing regime probably would have to be compatible with existing airports accommodating large jet transports.

The rocket plane configuration would be a stacked arrangement of two distinct vehicles (see drawing). The lower vehicle would be a high-wing configuration, and the upper vehicle would be



10-PASSENGER, 6,600-lb.-cargo, recoverable orbital plane configuration might be dual arrangement, with nested upper and lower winged vehicles. Initially accelerated by a rocket sled, the lower vehicle would boost the upper one, then separate and glide back to earth. The upper vehicle would continue under its own power to orbit with its passengers and cargo.

a low-wing design. This would permit the wing of the upper vehicle to nest on the top surface of the wing of the lower vehicle, to minimize disturbing aerodynamic interactions.

After separation from the rocket sled, the lower vehicle would function as a boost vehicle for the upper vehicle. At the end of its boost phase, the lower vehicle would separate and glide to earth, under control of crewmen, for recovery.

The upper vehicle would continue on to orbit under its own rocket power. Upon return from its space mission, the upper vehicle also would glide to a horizontal landing under control of its crewmen.

In all likelihood, the thrust vector control system for each plane would be augmented by tip-mounted jets which would provide effective forces because of the moment-arm available.

• **Cargo transport** for space station and lunar logistics, associated with a Nova-type vehicle, would be a second category. Operational readiness is projected for about 1977. Economy of the configuration is estimated to be many times that achievable with NASA's Saturn 5 design. Nova studies have been performed for MSFC by Boeing Co., Douglas Aircraft Co., General Dynamics/Astronautics and Martin Co.

• **Rocket-powered plane** serving as a space truck with accommodations for 50 to 100 passengers. This third category would be aimed at a "big brother" version of the 10-passenger configuration. Liftoff weight might be approximately 22,000 tons. This configuration might be available by 1980, and its launch rate might be as high as 16 per month.

Associated rocket engine developments seen necessary in the time period required for the vehicle developments would include at least two throttleable liquid oxygen-hydrogen types, each operating with the relatively high chamber pressure of about 3,000 psi. One type would develop about 250,000 lb. thrust, and the other as much as 1.5 million lb. thrust.

One-Year Apollo Delay Cited

Los Angeles—Development of the Apollo spacecraft for manned lunar landing is now approximately one year behind the schedule originally planned, according to John W. Paup, vice president of North American Aviation, Inc.'s Space & Information Systems Div. and manager of its Apollo program.

"We're about one year behind what we thought we'd be able to do as compared with what we're doing," Paup said here recently. He said, however, that the manned lunar landing can be made prior to 1970, the objective set by the late President Kennedy.

The successful Apollo pad abort test last month (AW Nov. 25, p. 52) was approximately five months later than the originally scheduled date. North American was selected by NASA to design and build the spacecraft two years ago.

While Paup declined to elaborate on specific problem areas, NASA officials in recent weeks have mentioned the Apollo fuel cell, navigation and guidance system, and attitude control system, among others, as areas where there are technical problems.

A North American spokesman, in amplifying Paup's remark about the development delay, said that a program as complex as Apollo is bound to have constant schedule changes. This spokesman said that a major factor in the year's delay was NASA's decision to change from a direct ascent concept of moon landing to the lunar orbit technique.

Paup said that all three Apollo components for which North American is responsible have been designed and all major units for them have been ordered. These three elements are the command module, the service module and the adapter for the Lunar Excursion Module. LEM prime contractor is Grumman Aircraft Engineering Corp.

Paup said that opportunities for accelerating the program would become more apparent a year or two from now, after the first spacecraft is in orbit. On the other hand, he noted, it later may become necessary to introduce additional steps into the program leading to the manned lunar landing, such as a "drag-the-field" moon flight in order to select more confidently a landing site for LEM.

Centaur Successful

Cape Canaveral — Second National Aeronautics and Space Administration-General Dynamics/Astronautics liquid hydrogen-fueled Centaur upper stage was orbited here last week in the long-troubled program's first successful flight. Two-stage, 109-ft. tall vehicle, using Atlas 126D as booster, lifted off at 2:03 p.m. EST Nov. 27.

Centaur's two Pratt & Whitney RL-10A-3 15,000-lb. thrust engines were ignited at 900,000 ft. and burned for 378 sec. in the first successful flight test of liquid hydrogen. Initial orbital parameters were: apogee 1,058 stat. mi.; perigee 368 mi. and a period of 108 min.

NASA left several hundred pounds of liquid hydrogen unburned to study effects of zero-g on the propellant during its lifetime.

News Digest

Philco and Space Technology Laboratories will continue program definition studies of the military communications satellite pending a decision on the future of the program (AW Oct. 28, p. 25). Defense Dept. said the parallel study contract held by General Electric-Motorola team is ended.

West German Defense Ministry tentatively plans to resume negotiations for 33 Lockheed TF-104G two-place supersonic jet trainers, abruptly abandoned after the firm's sales tactics had been publicly berated by Defense Minister Kaiuwe von Hassel (AW Nov. 11, p. 32). German displeasure was directed primarily at Lockheed efforts to sell the C-130 turboprop transport to the German armed forces after von Hassel already had requested funds to purchase the competitive Franco-German C-160 Transall.

Next Saturn 1 vehicle test is expected to be delayed a week until Dec. 17 following an explosion and small fire Nov. 27 in the venting system and burning pool for the hydrogen-fueled second stage. The explosion took place about 500 ft. from the launch pad.

India launched its first sounding rocket—a Nike Apache supplied by NASA and assembled by Indian technicians—carrying a 65-lb. payload of sodium vapor Nov. 21 from the Thumba rocket base, near the Indian Ocean 15 mi. from Trivandrum. Sodium vapor was ejected from second stage at 111-mi. altitude.

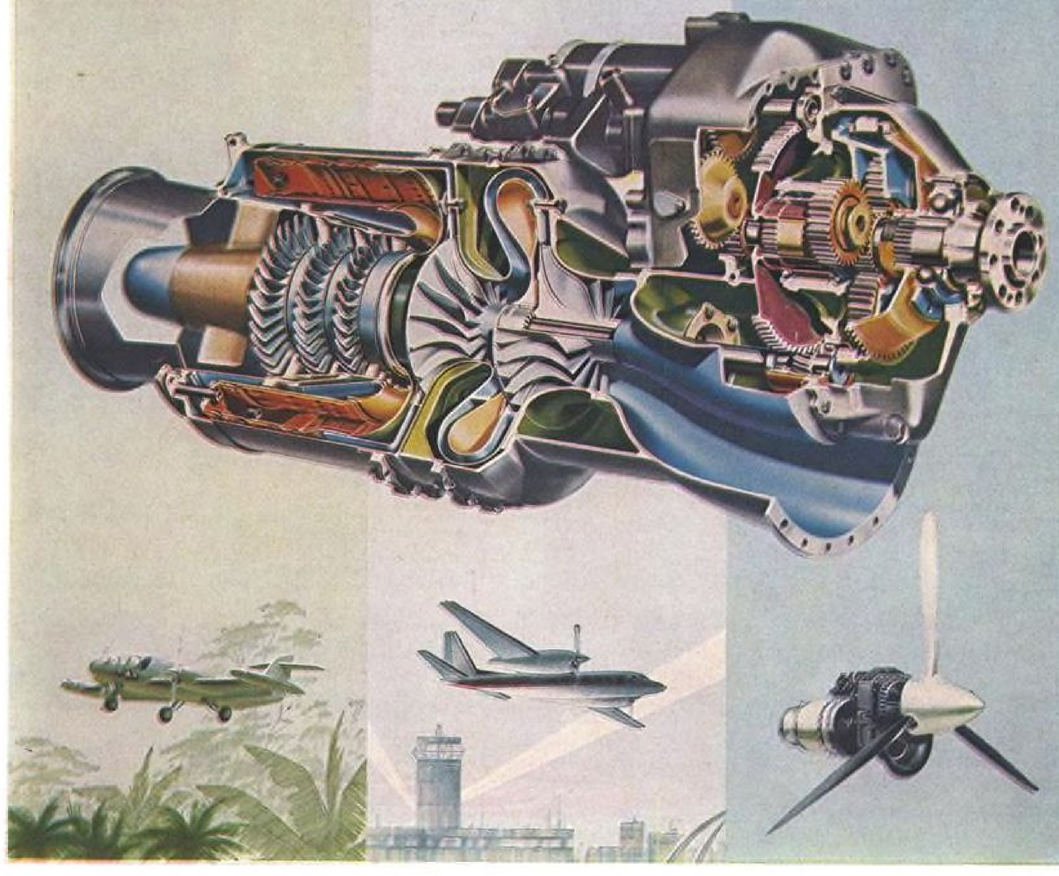
Westinghouse Defense and Space Center has been reorganized into four operating divisions under Buford M. Brown, center president. Divisions and chiefs, who are vice presidents, are: N. V. Petrou, aerospace; James M. Beggs, surface; John H. Clotworthy, underseas, and Albert M. Bethel, operations.

Lockheed Aircraft Co. and North American Aviation, Inc., are receiving follow-on contracts for the chemical low-altitude missile (CLAM) program from USAF's Aeronautical Systems Div.

John A. Johnson has resigned as general counsel of the National Aeronautics and Space Administration to join the legal staff of the Communications Satellite Corp. He is to be succeeded at NASA by his deputy, Walter D. Sohier. Paul G. Dembling, formerly director of legislative affairs, will become deputy general counsel.

TURBOPROP ENGINE FOR LIGHT AIRCRAFT

AIRESEARCH MODEL 331



This 600 horsepower turboprop engine is designed to power the new generation of light, fixed wing aircraft for both civil and military applications. • The Garrett-AiResearch TPE-331 has a specific fuel consumption of .62 pound per shaft horsepower-hour, and a weight to power ratio of .45 pound per horsepower. The engine has a response rate from flight idle to full power of approximately 1/3 of a second. A military version has been designated the T76 by the U.S. Navy. • Designed specifically as a prime power plant, the model 331 is backed by the company's experience in producing over 10,000 gas turbine engines. A unique offset gearbox permits flexibility of application while a straight forward induction system minimizes installation costs. Opposite output rotation can be made available, and controls are adaptable for a prop governing, beta, or combination system. The Model 331 engine is programmed for additional performance growth. The turboshaft version (TSE-331) has been flight tested as a power plant in rotary wing and vertical lift vehicles. Please direct inquiries to the Phoenix Division.

GARRETT

AIRESEARCH MANUFACTURING DIVISIONS

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SYSTEMS AND COMPONENTS FOR: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

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

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

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INORGANIC CHEMICALS DIVISION
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Domestic All-Jet Cargo Race Starting

TWA will inaugurate first scheduled service this week; American, United to add cargo jets soon.

New York—Annual increases of at least 20% in transcontinental cargo volumes are anticipated for the next several years as a result of the jet cargo schedules soon to be initiated by three major carriers—the first one this week.

Trans World Airlines will inaugurate domestic jet cargo service Dec. 3 with its Boeing 707-320C. American Airlines, using the same type aircraft, will follow later in the month or early in January. United Air Lines will receive the first of its three Douglas DC-8F freighters next year.

American, on the basis of initial orders, would have been the first to start domestic jet cargo service. It placed its order in November of last year (AW Nov. 29, 1962, p. 43), several months ahead of TWA. But TWA then leased two aircraft already under construction in anticipation, Boeing officials said, of orders from other carriers. TWA thus received an aircraft ahead of American and is able to claim the first transcontinental jet all-cargo service.

No difficulty is expected in attracting the required market growth. The 1.3 billion cargo ton miles carried domestically in 1962 was a 19.6% increase over the 1961 volume, and the sales appeal of jet speed and faster ground handling should easily maintain, if not accelerate, this growth for several years.

Air freight, the principal factor in air cargo, rose 22.5% in 1962, accounting for 898.1 million of the total cargo ton miles flown. Mail and express comprised the remainder. Cargo operators are also receiving added revenues from first class mail, which the Post Office Dept. ships by air on a space-available basis. Of last year's total cargo volume, 88.6 million ton miles was attributed to first class mail.

Cargo officials are confident of their ability to attract enough business to make money on the cargo jets, and coming months should indicate whether that confidence is justified. Not only are they taking a big step with airplanes capable of carrying three times the load of existing piston freighters, but their companies have also expended large sums in support equipment for the jet operation.

TWA is spending $3.3 million on cargo terminal buildings alone. New structures are being erected at Los Angeles, San Francisco and Chicago, and existing terminals are being expanded at St. Louis, New York, London, Paris, Frankfurt, Milan and Rome. Another $500,000 is going for ground equipment, including 10 loaders and 237 trailer carts.

American, in what it terms a multi-million dollar program, is also expanding ground facilities. Its terminal space at Idlewild alone is being doubled from 20,000 to 40,000 sq. ft., and expansion is under way at Los Angeles, Boston, Chicago, Detroit and San Francisco. Handling equipment at these stations will cost in excess of $800,000.

None of these costs includes the price of the jet cargo aircraft. A Boeing or Douglas freighter, complete with interior roller system and heavy-duty floor, costs over $7 million—more than a passenger jet. American is receiving four such aircraft, and TWA is buying five in addition to the two leased Boeings with which it is inaugurating service.

An attitude of determination is evident in the airlines' approach toward air cargo. This is particularly evident with American, whose jet freighters are not convertible to passenger use.

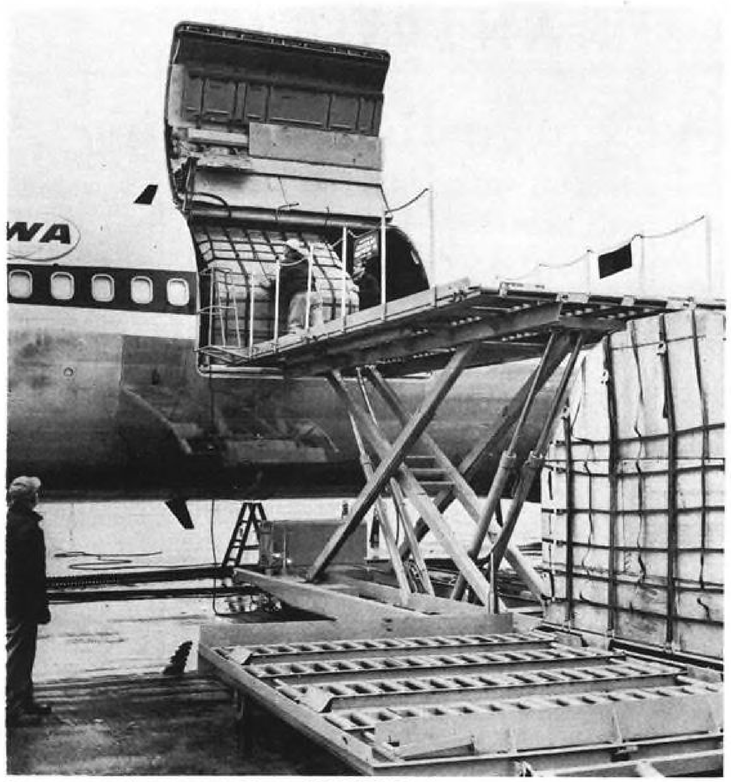
"The windows are plugged with metal," said David A. Highman, director of freight sales. "To convert them to passenger configuration would require 2½ months of work involving $500,000. These airplanes must earn their way with freight."

Although TWA's five freighters will have standard glass windows, the entire fleet will not be available for quick conversion to passenger use. The airline is buying only one kit of detachable hat racks, emergency oxygen and interior lining equipment. United plans to use its DC-8Fs strictly for cargo.

TWA's first two airplanes, which it is leasing from Boeing, have the passenger conversion features. But these airplanes will be returned to Boeing, unless TWA exercises an option to buy them, when the five freighters it is buying are delivered next year.

The cargo pallets used by the domestic operators will all measure 125 x 88 in. This compares with the 108 x 88 in. pallet used by Pan American, which leaves an access aisle down one side of its aircraft to conform to Military Air Transport Service specifications. The smaller pallet will also fit into Pan American's DC-7F piston freighters. TWA and American are

AMERICAN AIRLINES CARGO TERMINAL at San Francisco features loading directly from the freight dock. Three men can unload and reload a Boeing jet freighter in 40 min.



CARGO LOADING ON TWA Boeing 707-320C freighters is performed with a scissors lift. TWA this week is inaugurating the first transcontinental jet cargo schedules.

sacrificing the aisle for larger pallets.

Differences exist in the features of ground handling equipment purchased for the various airline cargo terminals. All of them, except American, are following established practice in carting cargo out to aircraft from the terminal. American's six terminals are designed so that the jet can nose into them for loading directly from the dock.

"It is common practice with passengers today to bring the aircraft right up to the terminal for loading," Highman said. "It makes sense, in the interest of time, to do the same for cargo."

This is accomplished with a system built by the John Bean Div. of the FMC Corp. at San Jose, Calif. With it, an 80,000-lb. capacity freighter can be unloaded and reloaded in 40 min. by only three men, one running the machinery and two positioning the pallets within the airplane.

Cargo for any specific city is consolidated on a pallet and stored in a bin. When it is time to load, one man shuttles a mobile lift on tracks leading from the aircraft to the bins. The lift automatically pulls the pallets from the line of bins and slides them into the aircraft.

"With this system, we can receive a shipment only 30 min. before departure time and still get it on the airplane," Highman said.

American has also purchased a fleet of radio-equipped trucks for its principal cargo cities to speed up ground delivery.

TWA, like Pan American, carries its loaded pallets to the aircraft on cart trains. Pallets are lifted aboard one at a time on a scissor-type platform of rollers called the Cochran loader. United will use a lift built by DorTech, Inc., which is mounted on a snub-nosed tractor and can carry two pallets at once.

TWA officials say that their Cochran system, like American's, can also complete the load-unload cycle in 40 min. However, this is from the time the load is beside the airplane. American claims a time advantage in eliminating transport across the parking ramp, and less interference during bad weather because the airplane is nosed into the terminal.

Facilities in the aircraft are generally the same for all carriers. TWA's floor-roller arrangement was supplied by Boeing, and is almost the same as the American Machine & Foundry system on American's freighters. United, like Pan American, will use the Douglas-adapted AMF system, which is compatible with that carrier's DC-7F freighters. All of these are basically the same, with no difference in the time required for positioning and locking-down of pallets.

Schedules for TWA indicate the rapidity with which a jet freighter can be in and out of an on-line station. TWA's Flight 580 will depart Los Angeles daily, except Sunday, at 11:45 a.m. Arriving at San Francisco at 12:50 p.m., it will be on the ground 1 hr. and 10 min. before departing for Idlewild, arriving there at 10 p.m.

Westbound Flight 581 leaves Idlewild at 2 a.m., arrives at Chicago's O'Hare field at 3:12 a.m., then departs at 4:30 a.m. for a 6:30 a.m. arrival at Los Angeles.

When TWA inaugurates transatlantic jet cargo service on Jan. 3, these flights will coincide with European departures and arrivals. That is why TWA's eastbound schedule departs Los Angeles at midday, so that it can provide a quick connection for daily 12:05 a.m. departures from New York to Europe. The 2 a.m. westbound departure will allow time for connections with daily 12:30 a.m. arrivals from Europe.

Initially, TWA's international service pattern will serve city groups with two flights weekly. The groups are London-Frankfurt, Paris-Rome, and Frankfurt-Rome on eastbound schedules, and Rome - Milan - Frankfurt, Rome-Milan-Paris, and Frankfurt-London on westbound runs.

American has yet to publish its schedules, but it is likely that its jet freighter will be in unscheduled service before the formal inauguration date. It will be used to facilitate flow of the advance build-up of Christmas mail.

Otherwise, American won't begin regular service until it has at least two Boeing freighters in hand. American officials said they don't want to start their cargo operation until everything is coordinated, and until they can provide the smooth service that shippers will expect of jet schedules.

The jet freighters will operate at substantial cost-per-mile reductions over piston cargo aircraft, but no cargo officials presently are planning to ask the Civil Aeronautics Board for rate reductions.

"When you consider what we have invested for air cargo service, you can understand why it isn't the proper time to seek lower rates," commented E. C. Taylor, American's vice president of cargo sales and services.

The airlines will also retain some of their existing piston freighters as feeder aircraft for the jet cargo terminals. TWA has five Lockheed 1649A freighters and American 14 Douglas DC-7Cs.

Jet freighters will not bring any deemphasis toward the carriage of cargo in the belly holds of passenger flights.

"The cargo jets are mainly another element toward flexibility, which is what we need in a cargo operation," one spokesman said.

Financial Plight Is Major Obstacle Confronting New BOAC Chairman

By Herbert J. Coleman

London—Sir Giles Guthrie, the merchant banker who will take over as chairman and managing director of British Overseas Airways Corp. next month, has been given a year to develop a plan for making the airline financially sound.

Guthrie, who will be paid $32,000 a year plus $2,800 for expenses, will retain his seat on the board of British European Airways, the other state-owned airline. The chairman-designate of BEA, Anthony H. Milward, will take a seat on BOAC's board, and a new BEA chief executive will be appointed.

Minister of Aviation Julian Amery commented:

"I have carefully considered whether a merger between BOAC and BEA would be in the best interests of British aviation, but on balance I have decided against it."

But, Amery continued, the two airlines should work closer together, and the two chairmen should be represented on each others boards of directors.

Amery denied that Sir Matthew Slattery, the outgoing chairman, resigned because of government refusal to write off BOAC's $240-million deficit (AW Nov. 25, p. 37).

"Our view," Amery told the House of Commons, "is that it would be illogical and wrong to ask the House to write off $240 million of public money until we can recommend a plan which we think would put the corporation on its feet financially."

At the same time, Amery refused to publish the report by Accountant John Corbett into BOAC's financial structure, commissioned by the Ministry at a reputed cost of $280,000. Amery's decision to keep the report secret brought criticism in both houses of Parliament.

Amery's position, he told AVIATION WEEK & SPACE TECHNOLOGY, is that the report is confidential to him, but that portions would be made available to Guthrie in the preparation of his financial plan.

Amery refused to discuss whether the Corbett report criticized his Ministry for interference in BOAC management, and Ministry influence in forcing BOAC to buy airplanes such as the Bristol Britannia, on which major losses were incurred, and the Vickers VC.10.

Asked about BOAC's intentions regarding the Sud-BAC Concorde supersonic transport, Amery said, "I assure you BOAC will not be left out in the cold on the Concorde program. The options have been taken."

Amery stresses the need for stronger management at BOAC. He told the House of Commons that Sir Basil Smallpeice, managing director for seven years, "after many years of devoted service to BOAC has agreed to retire to facilitate the changes," but this remark was greeted with loud laughter by the opposition Labor Party.

The White Paper, entitled "The Financial Problems of BOAC," gives prominence to the need for strengthening the airline management and notes at one point that "the government thinks it necessary to reaffirm that the corporation must operate as a commercial undertaking." In a side comment, Amery added that there will be times when the Minister will require BOAC to take steps contrary to this, i.e., like BEA's routes in the Scottish highlands and islands, which BEA operates as a social service at a loss.

The White Paper reviewed BOAC's financial and equipment problems, beginning with the Comet 1 crashes. A factor, the White Paper continued, has been that since 1956 a number of colonies have become independent nations and BOAC has thus lost most of its valuable cabotage rights. In addition, a number of countries have entered the long-haul business at a time of decline in the rate of traffic growth generally.

Introductory costs have been large. At no time since 1952 did BOAC have less than four types of aircraft in service. But the White Paper said: "It is moreover a considerable advantage to a large airline, as BEA's experience with the Viscount has shown, to have an aircraft designed to meet its own requirements."

Substantial losses with BOAC subsidiary companies have occurred, although holdings have been drastically reduced. For instance, BOAC shares in Middle East Airlines have been sold and Mid-East Aircraft Service Co. was terminated. All but 10% interest in British West Indian Airways, was sold, and association with Kuwait Airways ended last May 31.

Purpose of acquiring subsidiaries was to secure feeder traffic for main trunk services and to protect transit and traffic rights, and the investment also helped to provide a market for British aircraft. But, the White Paper said:

"Even if the policy underlying the investment was sound, its implementation was unsatisfactory. It is not possible to estimate how far the loss incurred was offset by gains to the corporation but it appears that much of the total of $42.8 million must be regarded as a net loss."

BOAC load factors kept dropping in 1961 and 1962, to 47.6 in the latter year, until they fell to a level lower than that of the industry as a whole. Causes were heavy competition on the North Atlantic, introduction of larger jets between the U.S. and Europe, making flights possible without staging in London, and political changes in Africa. "Nevertheless," the White Paper said, "the rate at which BOAC continued to expand its capacity and frequency was unduly optimistic."

In addition to the Corbett Report, the Ministry instigated studies into sales, advertising and publicity, which White Paper said were at the right level and well directed, and into the engineering and maintenance departments, which the report said have consistently given rise to excessive costs.

"Substantial savings have been achieved in recent years," the White Paper said. "The consultants, however, believe that further savings of the order of $11.2 million a year could be achieved over the next three years or so without in any way lowering the high technical standard of the work."

Turning to the future, the White Paper posed these questions to BOAC:

• **Will world airlines** be successful in

New BOAC Chairman

London—Sir Giles Guthrie, a former fleet air arm pilot, joined the board of British European Airways five years ago and had been mentioned in airline circles for some time as the probable successor to Lord Douglas of Kirtleside.

An Eton graduate, he is an undergraduate friend of Julian Amery, the minister of aviation. Guthrie is 47, wealthy and the chairman of Brown Shipley, a firm of merchant bankers.

Guthrie, who is the second baronet, has told the government he will resign his directorships to avoid any suggestion of commercial conflict with his new post. Amery said Guthrie is taking the job at a sacrifice of about $14,000 a year.

The new chairman, who last week began a series of meetings with BOAC executives, said he considers that the huge BOAC deficit should be written off. He also contends that operation of prestige routes is one of the big reasons for BOAC's present financial situation.

stimulating cargo as well as passenger service?

• **Will the political climate** be favorable to BOAC's efforts to obtain a greater share of the business?

• **What are the long-term possibilities** of fundamental changes in the pattern of world airline operations, such as the emergence of the Soviet airline, Aeroflot, as a stronger competitor in the intercontinental routes?

• **To what extent will subsonic jets** continue in service after the advent of the Concorde supersonic transport?

A particular problem in the next two years will be BOAC's incurring the costs of introducing the VC.10 into service. By 1966-67, however, the BOAC fleet should be composed of only two types of aircraft "and the fruits of the VC.10 should begin to appear."

The White Paper contains an oblique warning to other governments, in a reference to negotiations for bilateral agreements involving BOAC rights. Noting that in past negotiations, "Britain had much to give and got much in return," the BOAC White Paper continued:

"With BOAC exposed increasingly to the two-pronged attack of increased competition and restrictionism, it is right to ask how far Britain can afford to continue to grant traffic rights to airlines whose countries do not or cannot provide comparable benefits for British airlines.

"BOAC has pressed from time to time that some of the rights now enjoyed by foreign airlines in British territory should be reviewed to bring the exchange of traffic rights into better balance. Large issues are involved here. Some adjustments have already been made. Others may be necessary."

Crucial factors in BOAC's future, according to the report, "will be the success of BOAC's management in correcting existing weaknesses in organization and in forecasting accurately its future share of air traffic on the long haul routes."

In the realm of merger between the two corporations, the White Paper said certain functions could be combined—engineering and catering for example—and would give over-all economies. Size of a merged corporation would be no bigger than certain other major airlines, and overlapping services could be eliminated while through traffic from North America to Europe would be increased, according to the report.

On the debit side, the report pointed to differences in fleet structures. Gains in through traffic would be more than offset by losses of interline sales now enjoyed by BEA, and both corporations are in markedly different financial circumstances. BEA probably will report a profit next year.

Arguments for and against merger are "finely balanced," the report said, but neither of the corporations is in favor of merger at the present time.

Lower-Fare Jet Service Challenges IATA

By Ward Wright

New York—Aerolineas Peruanas' (APSA) inauguration Dec. 1 of low-fare jet service—linking Miami and Mexico City with Buenos Aires via Lima—promises to pose a new challenge to International Air Transport Assn. airlines in Latin America, one that could have a far-reaching impact on the Latin American long-haul fare structure.

APSA is the first low-fare, non-IATA, piston airline to get jet aircraft in Latin America and, as such, is in a position to gauge the effects of combining low-fares and jet equipment on competitors who adhere to higher IATA economy jet fares.

With delivery last month of a General Dynamics/Convair 990A leased from Frederick B. Ayer, an aircraft dealer (AW Nov. 18, p. 37), APSA scheduled jet service at fares substantially lower than IATA economy jet rates but higher than piston fares offered by non-IATA carriers.

APSA has proposed a jet fare between Miami and Buenos Aires of $273 one-way and $491 round trip—a saving of $31 one-way and $87 round trip over IATA economy jet fares. Between Miami and Lima, APSA charges $158 one-way and $284 round trip—$53 cheaper one-way and $117 less round trip than the IATA economy jet rate.

APSA's 990A is the first of what was to have been a two-aircraft jet equipment program. Originally, APSA had sought approval of a guaranteed loan for two Boeing 707 or 720 aircraft from the military junta governing Peru until July 28 (AW Oct. 7, p. 128). The junta didn't act because of the nearness of the time when the elected government of President Fernando Belaunde was scheduled to take office.

In the meantime, Swissair was negotiating with General Dynamics for two Convair 990A transports, built to its specifications, which had been ordered and canceled by SAS. At one point Swissair indicated it was no longer interested in the aircraft, clearing the way for their sale elsewhere.

APSA's management decided to go ahead with its jet equipment program even though it was considered too early to approach the Belaunde government, which had recently taken office, for a guaranteed loan. Faced with the difficulty of obtaining conventional jet financing without a guaranteed loan, APSA secured an arrangement through Frederick B. Ayer whereby Ayer would buy the two 990s for $6.5 million each and lease them to APSA for an undisclosed sum. Under the seven-year lease agreement APSA would have the option to buy at any time.

Plans for APSA's acquisition of the two 990s were set to go through by the end of October when Swissair reopened negotiations for one of the 990s to be paid for in cash.

General Dynamics then held up one aircraft pending the outcome of negotiations with Swissair and sold the other 990 to Ayer for lease to APSA. The status of the Swissair 990 purchase remains uncertain since it was reviewed late last month by Swissair's executive committee and must be reviewed on Dec. 18 by the airline's board of directors. Observers feel, however, that even if Swissair does not take the other 990, General Dynamics will want to observe the success of APSA's low-fare jet service before selling another 990 that could be leased to APSA immediately.

Included in the $6.5-million sales price for the aircraft is provision for:

• **$100,000 to be used** for flight crew, ground crew or stewardess training in any combination APSA desires.

• **$100,000 to cover any** modifications such as the alteration from Swissair's 98-seat dual configuration to 119 seat one-class seating and installation of a flight recorder.

• **$250,000 for other vendor** items including ground equipment.

• **$1.2-million budget** for spares to be used as needed.

• **$4.85 million for the aircraft.**

Under the terms of the lease, APSA pays a flat rate plus interest for the package.

APSA's flight crews have been familiarizing themselves with the 990 in flight tests at Miami with General Dynamics crews. General Dynamics crews are manning the 990 on scheduled passenger runs until jet operations are stopped between Dec. 25 and Jan. 1, to review the first three weeks' jet experience. Extra DC-6B schedules will be provided during this period. When jet operations resume after Jan. 1,

CONVAIR 990A JET TRANSPORT leased by Aerolineas Peruanas (APSA) from Frederick B. Ayer has been delivered to the Peruvian carrier.

APSA will begin integrating regular crews with the General Dynamics crews.

APSA's jet service began Sunday with a non-stop Miami-Lima flight arriving early Monday and continuing non-stop to Buenos Aires. Its return flight will stop at Santiago, Lima and Guayaquil, with the aircraft arriving in Mexico City Monday night.

The aircraft will turn around in Mexico City and will retrace the same route south to arrive in Buenos Aires Tuesday. The 990 then turns around and flies non-stop to Lima and non-stop from Lima to Miami where it repeats the pattern begun Sunday. The schedule will give APSA an aircraft utilization of about 14 hr. a day. APSA also will continue reduced DC-6B service.

Fare Basis

C. N. Shelton, a director of APSA and formerly the airline's majority stockholder, says APSA's jet fares are based on 6 cents a direct mile between points on the routes. This is about the same base used for IATA economy jet fares, but IATA fares are sometimes calculated on longer mileage via intermediate points no longer served. IATA also recognizes different fare levels. For instance, fares south of Lima are somewhat lower on a mileage basis than for northern points.

What bothers IATA members is that the Latin American jet economy fare structure is already one of the lowest in the world. And, at the existing level, many airlines operating in Latin America are subsidized or break-even operations, leaving them little or no leeway to meet APSA's fares. The solution may be in a demonstration that lower fares can generate new traffic.

"We don't know exactly what the breakeven passenger load factor will be at this time, but we believe it will be below 50%," Shelton said. Possible roadblocks to APSA's fare levels could come from countries such as Mexico, Chile and Argentina, who want to protect their own airlines. Shelton added however, that he didn't think these objections would seriously affect APSA's fare structure.

Although APSA's management originally felt that the airline's growth in the low-fare market with piston equipment justified an attempt to obtain two jets, the airline will concentrate on perfecting its one-jet operation.

If its low fare service is successful, APSA's management says the airline may be in the market for another 990 sometime in 1965. By that time it is possible that Swissair may have a surplus 990—a sales possibility that APSA will explore.

To get the maximum use out of its 990, APSA is exploring a "wet lease" agreement with Sabena for the use of its Boeing 707 after it completes its twice weekly Brussels-Montreal-Mexico City run. The aircraft sits in Mexico City for 12-14 hr. before returning to Europe. If leased, APSA would place this aircraft on the Mexico City-Lima route during the period it normally is on the ground. Such a lease, however, is still in the talking stage.

APSA also is exploring a possible pooling agreement with Aeronaves de Mexico. Just what fare levels such a pooling arrangement might entail—in light of Aeronaves' IATA membership—is still difficult to predict.

Shelton said APSA is considering keeping General Electric engines in Buenos Aires, Lima and Mexico City in a parts pool with Varig and Swissair—who also own 990s—to reduce costs and out-of-service time in case of mechanical difficulties.

Shelton said he believes the Peruvian government will soon request bilateral talks with the U. S. over extending APSA's routes from Mexico City to Los Angeles. Preliminary discussions to revise the bilateral agreement will probably take place early next year, to be followed by a Civil Aeronautics Board application, Shelton said. Los Angeles is APSA's leading sales point—running about 15% ahead of any other of APSA's U.S. sales districts. Beyond that application, APSA has indicated it will look into the possibility of extending its Miami service to Montreal—probably after it gets another jet.

APSA, which is neither subsidized nor government-owned, has based its jet acquisition program on steadily increasing passenger traffic and earnings achieved with one owned and two leased DC-6Bs at fares that are lower than IATA's.

Excursion Fares

Some IATA carriers can match or slightly undersell APSA and other non-IATA's carriers through 120-day excursion fares permitting them to operate comparable piston equipment to meet competition. But the present traffic picture in Latin America is plain. Low fares, regardless of equipment or flying times, have been able to attract Latin America's increasing non-business or "growth traffic" that might have been expected to go to the jet carriers offering IATA economy fares.

At the same time, traffic of carriers adhering to the IATA fare structure has been relatively static or has declined, as in the case of U.S. carriers as a group (AW Oct. 7, p. 128). Since the introduction of jets helped bring to an end the cut-rate fare wars of the 1950s, jet carriers have had to economize and live with expense account and business traffic, while the low-fare piston airlines have been free to skim off the growth traffic.

With DC-6Bs, APSA's share of all traffic in and out of Lima increased from 11.6% in 1959 to 14% in 1962. Net income, which totaled about $125,000 last year, reached $234,000 on revenues of $4.42 million for the first eight months of this year.

Indian Airlines Faces Equipment Shortage

By James R. Ashlock

New Delhi—Indian Airlines Corp. needs additional aircraft—not to provide better service to attract business, but merely to satisfy existing demands for space.

The nationalized domestic carrier is flying more than 127,000 hr. annually with its 67 aircraft, yet a non-priority traveler may have to reserve a space a month or more in advance on key routes. Approximately one million passengers are carried annually, and the volume is expected to rise 15-20% per year with the introduction of jet aircraft.

Three Sud Caravelles due to enter service in January may temporarily relieve the pressure on Indian Airlines' fleet of Vickers Viscounts, Douglas DC-4 and DC-3 and Fairchild F-27 aircraft. But officials of the carriers believe the demand will rise proportionally with Caravelle's large productivity, and the insufficient capacity situation is expected to continue.

The Caravelles will fly two round trips daily between Bombay and New Delhi and one daily between New Delhi and Madras, New Delhi and Calcutta, and Bombay and Calcutta. Service will be expanded further with the planned purchase of a fourth Caravelle.

707 Lease

Indian Airlines is leasing a Boeing 707 from Air-India International for nightly operations between Bombay and New Delhi until the Caravelles are in service.

Practically all of Indian Airlines' traffic is government or business personnel. India is working toward industrial expansion, causing a continuous circulation of businessmen between cities. The pleasure travelers who do use the aircraft are usually foreign tourists, to whom the airline gives special consideration in the interest of attracting outside money into India.

However, the problems of providing seats on short notice are of such concern to Indian Airlines officials that they constantly promote long-term reservations. A new central reservations facility at New Delhi can generally confirm space 30 days in advance, but longer notice is preferred.

"We have set up our reservations system so that we can take a booking two years in advance if someone really wants to assure himself a seat," one spokesman said.

India does not enjoy the tourist volume of such places as Hong Kong, Tokyo or Europe. In 1962 the government recorded 1,034,000 foreign tourists, a slight drop from 1961 which was blamed on the border clash with China. Lack of capacity on Indian Airlines is frequently cited as lessening the country's appeal to international travelers.

"Few tourists care to spend 24 hr. on a train between Bombay and New Delhi when the Viscounts can fly it in 3 hr., and the Caravelles will make it in an hour and 40 min.," one official said.

But the aircraft are nearly always full, and are booked to capacity weeks in advance. Thus, internal transportation problems complicate the two other prime tourist deterrents—lack of hotel space and India's conservative policies toward alcoholic beverage.

"We need 600 more hotel rooms in Bombay and 1,000 more in New Delhi right now," one airline official said. "And how many tourists want to go through the process of obtaining a permit before they can get a drink?"

The hotels are usually filled with business and government personnel. But efforts to remedy the room shortage are progressing, with a new hotel already scheduled for construction on Nariman Point in Bombay. A liquor permit is readily provided at most government offices. But bars are few and far between in Indian cities, a situation that would be corrected only if the government eased its prohibition restrictions.

"A reduction in alcoholic consumption was one of the goals set up by the present government when it came to power," one spokesman said. "And it is practically the only goal that has been attained, so we can't expect them to abolish it."

India's minister of finance is apparently expressing a stronger interest in tourism as a revenue source, and moves to increase traveler appeal are expected. The nation is rich in historical lore, and it lies on the route between the tourist centers of Europe and the Orient.

But within Indian Airlines itself, taking care of current demand from the citizenry is of more immediate concern than tourist promotion. The need is for more aircraft, not more passengers.

The airline is a wholly nationalized enterprise, and its equipment procurement is tied directly to national restrictions on foreign exchange expenditures. To compensate for the imbalance between imports and exports, India carefully regulates the money it obtains from foreign sales. Rupees are kept in the country through a ban on all outside travel by Indians other than for business or government purposes, and the few pleasure travelers who can prove that their hosts are picking up the bill.

Monetary Exchange

Indian Airlines, as a result, cannot buy aircraft abroad unless a favorable deal is obtained on the monetary exchange. The Caravelles, for instance, were chosen because France agreed to give India a $60-million long-term loan. This move overrode the opinion of one of the carrier's influential directors, J. R. D. Tata, who felt that the Boeing 727 was the preferred airplane.

"We bought our F-27s from Fokker because a large part of the payment was accepted in jute, mica and other export commodities," an airline official said.

The Caravelle selection was preceded by a Russian bid to sell Indian Airlines the Ilyushin Il-18. The Caravelle selection was preceded by a Russian bid to sell Indian Airlines the Il-18. But the overhaul life of the Il-18's engines was only 300 hr. Nor was the carrier impressed by Russian offers to use special parts and workmanship that would raise the duration to 500 hr., since the Rolls-Royce Darts on Indian Airlines' Viscounts were already operating 3,000 hr. between overhauls.

Another plus factor for the Caravelle was that its Rolls-Royce Avons can be readily overhauled at Air-India's maintenance base at Bombay (AW Nov. 18, p. 41).

Acquisition of the Caravelles will help Indian Airlines reduce its 42-plane fleet of DC-3s as Viscounts are placed on regional routes. The carrier has been hampered by an inconvenient mixture of aircraft since 1953, when Indian Airlines was formed by consolidating eight financially defunct airlines with 99 aircraft of nine different types. Only within the last two years did it get rid of 12 Vikings and seven Herons, leaving the carrier now with four types of equipment.

The airline began with, as one official termed it, "a staggering accumulation of losses and lack of working capital." For six years after 1953 the losses continued as Indian Airlines maintained service to 71 points. However, slight profits have been attained since 1959, the largest surplus being $439,110 earned in Fiscal 1963.

Airport quality ranges from the relatively modern fields at Bombay, New Delhi and Calcutta to remote dirt strips such as at Leh, a Himalayan outpost. The DC-3s reach Leh's 12,000-ft.-high field through mountain passes while the passengers suck on oxygen tubes.

Such mountain flying experience paid off last year when Indian Airlines' total fleet was conscripted during the Chinese invasion. The airline's pilots, flying aircraft still bearing civil markings, shuttled troops and supplies to the mountainous battle area. All scheduled service was halted during the crisis.

Another unresolved problem is the limitation on night operations. Many of the airports served do not have adequate instrument facilities, making the carrier principally a daytime operator. The foreign exchange situation also hampers India's acquisition of navigation and airport aids.

The primary night activity is mail shipment, involving a special schedule in which four aircraft from Bombay, New Delhi, Calcutta and Madras converge near midnight at Nagpur, India's most central city. At Nagpur, mail for these four points is exchanged and arrives at its destination before dawn.

Lower Fare

The night air mail is barely a break-even proposition. Passengers on these flights pay 10% less than day fares, and the mail rate of 38 cents per ton kilometer hardly compares with the international average of $1.26. But the service gives India one of the fastest mail delivery systems in the world, and letters often are delivered before telegrams sent at the same time.

Indian Airlines also pays unusually high sales and excise taxes levied by the state and central governments on aviation fuel. Of the $11,760,000 spent for fuel last year, $5,586,000 was for taxes, and the tax rate will rise again next year. Consequently, about 32% of the airline's total revenues of $36,357,720 went for fuel. The carrier's international relative, Air-India, escapes this burden by purchasing much of its fuel abroad.

Some airline observers in India also feel that Indian Airlines' 10,314-member employe force is too large. It has grown by 3,000 since the airline was formed 10 years ago. However, no personnel reductions were allowed following the consolidation, partly because the strong All-India National Trade Union Congress is an affiliate of the existing political majority, the Indian National Congress.

This mandatory abundance of manpower has delayed efforts toward mechanization for such purposes as baggage and cargo handling. Ground equipment isn't seriously missed, however, since many stations receive only one flight a day, and India's low wage scale makes it more economical to use manpower.

Because of its related operational and cost problems, Indian Airlines' break-even load factor is 75.3%. This almost matches the annual load factor, which is not higher only because of lesser seat demand on short-haul routes far from the main cities. Trunk route load factors are 92%.

Like Air-India, the domestic carrier has a large engineering force. Those familiar with the carrier say its strongest points are maintenance and operations, as a result of its having adequate personnel.

At Calcutta, the piston engine and equipment overhaul base, 2,000 engineering personnel are employed. Another 1,000 are at New Delhi, where turbine maintenance is performed. Bombay, which has 900 engineering employes, will be the Caravelle base. The F-27's Dart engines, now up to 3,000 hr. between overhaul, are maintained at New Delhi, while the airframes are overhauled at Calcutta. The Darts on the Viscounts have a 3,500-hr. time-between-overhaul (TBO). DC-3s are overhauled at Hyderabad.

The 12 Viscounts fly a combined total of 2,655 hr. a year at an operating cost of about $378 an hour. The 10 F-27s, flying a total of 2,200 hr. annually, cost just under $200 an hour to operate.

Last year, Indian Airlines overhauled 159 of the Pratt & Whitney R-1830 engines on the DC-3s, 26 P&W R-2000s on the DC-4s, 33 of the Viscounts' Dart-510s and eight of the F-27s' Dart-511 engines. The F-27s entered service in mid-1962.

Cockpit Crews

Cockpit crews, most of them former Indian Air Force pilots, consist of 333 pilots and 120 flight engineers. Most crew training is performed in flight, although a British Redifon simulator is used for procedures practice by Viscount crews. The airline has 177 hostesses and stewards.

Indian Airlines is an International Air Transport Assn. member, and depends mainly on interline business for its foreign exchange reserves. It is general sales agent throughout India for Air-India, British Overseas Airways Corp., Iranian Airways, Iraqi Airways, Kuwait Airways and Trans-Canada Air Lines. It earns approximately $5 million annually from interline sales, the money being deposited in London through the IATA clearing house.

The carrier also provides contract assistance to Iraqi Airways and Nigerian Airways, supplying personnel for flying, engineering and accounting tasks.

INDIAN AIRLINES VISCOUNTS are overhauled at the maintenance facility in New Delhi. Carrier is currently operating 12 Viscounts over 2,600 hr. per aircraft annually.

Delta Income

Washington—Delta Air Lines last week reported a net income for October of $1,196,000, equal to 47 cents per share. Net income for the first four months of the company's fiscal year that began July 1 was $4,549,000, or $1.78 per share.

Operating revenues for the month of October were $17.8 million, compared with $16.4 million in the same month last year. Operating expenses were $15 million in October, 1963, against $14.4 million in the same month last year.

Load factor for the carrier in October was 59.57%, and for the first four months, 60.97%. Revenue passenger miles in October totaled 258 million and passed the billion mark during the first four months.

Airline Traffic—September 1963

(IN THOUSANDS OF DOLLARS)

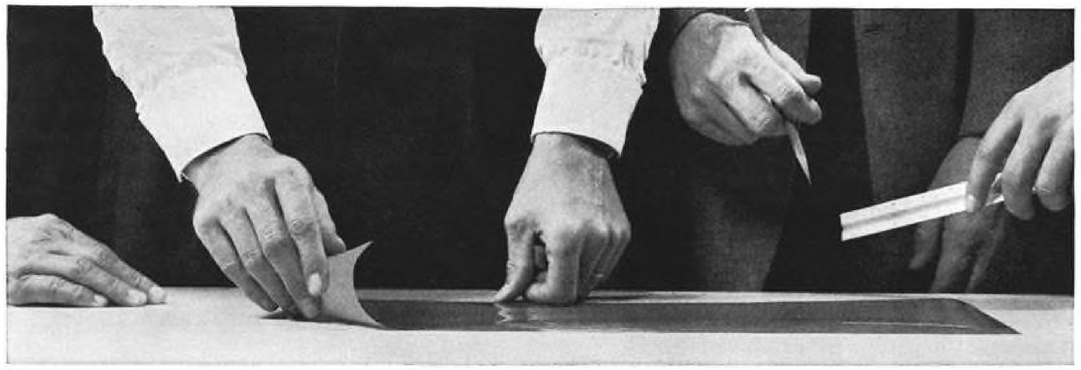
	Revenue Miles (000)	Originating Passengers (000)	Revenue Passenger Miles (000)	Revenue Passenger L/F (%)	Total Revenue Ton Miles (000)	Average Over-all Load (Tons)	Scheduled Miles (000)	Performance Factor (%)
DOMESTIC TRUNKS								
American	11,110	737.6	632,871	61.6	78,720	7.09	11,053	99.3
Braniff	2,555	212.6	105,621	55.4	11,992	4.69	2,541	98.9
Continental	2,315	148.7	106,210	51.6	11,873	5.13	2,340	98.2
Delta	4,934	382.6	237,951	59.1	27,191	5.51	4,973	98.1
Eastern	9,060	801.8	368,498	46.8	41,070	4.53	9,055	97.4
National	2,647	170.9	128,076	47.6	14,302	5.40	2,672	98.9
Northeast	1,259	98.3	36,387	38.0	3,727	2.96	1,367	91.4
Northwest	3,008	224.1	146,578	53.4	16,871	5.61	3,023	99.1
Trans World	8,554	491.5	474,820	55.0	55,023	6.43	8,523	99.7
United	15,902	1,061.8	765,401	55.4	90,677	5.70	15,876	98.1
Western	2,319	238.2	126,680	53.3	13,082	5.64	2,383	97.1
Domestic Trunk Total	**63,663**	**4,568.1**	**3,129,093**	**54.6**	**364,528**	**5.73**	**63,806**	**98.4**
INTERNATIONAL								
American	159	9.4	8,749	51.5	1,138	7.17	159	100.0
Braniff	268	9.3	11,917	46.6	1,651	6.16	272	98.6
Caribair	147	46.1	3,724	58.5	392	2.67	144	97.0
Delta	101	2.6	4,455	51.6	505	4.99	108	93.6
Eastern	1,065	46.1	67,741	47.5	6,844	6.43	1,088	96.3
Mackey	91	8.6	1,845	30.6	185	2.05	76	99.7
Northwest	1,065	25.1	75,283	60.4	11,089	10.41	868	99.1
Panagra	333	12.8	21,442	64.6	3,274	9.83	321	98.6
Pan American	10,263	418.4	744,476	58.9	101,813	9.92	9,657	98.5
South Pacific	27	0.5	1,320	51.2	136	4.98	27	100.0
Trans-Caribbean	450	20.4	45,611	60.1	4,451	9.89	289	100.0
Trans World	2,639	56.2	187,779	54.6	24,826	9.41	2,519	97.6
United	836	26.0	64,963	65.5	7,308	8.74	809	98.8
Western	183	9.2	14,125	74.2	1,515	8.28	183	100.0
International Total	**17,627**	**690.7**	**1,253,430**	**57.8**	**165,127**	**9.37**	**16,520**	**98.3**
LOCAL SERVICE								
Allegheny	991	97.8	19,488	42.5	2,135	2.15	977	98.8
Bonanza	498	43.3	10,964	57.9	1,091	2.19	498	99.5
Central	602	34.0	6,774	40.7	722	1.20	602	99.6
Frontier	1,092	49.5	13,904	37.8	1,502	1.37	1,094	99.0
Lake Central	566	40.5	6,539	40.6	718	1.27	565	99.1
Mohawk	999	104.1	21,621	50.4	2,244	2.25	989	98.8
North Central	1,183	98.2	17,880	44.5	1,954	1.65	1,165	99.9
Ozark	930	70.9	13,537	49.1	1,458	1.57	930	99.7
Pacific	435	46.1	9,956	54.4	991	2.28	442	98.2
Piedmont	928	71.4	16,207	45.2	1,692	1.82	931	98.7
Southern	789	51.4	9,817	38.7	1,040	1.32	770	99.8
Trans-Texas	640	35.5	8,352	41.2	876	1.37	644	98.1
West Coast	541	30.1	7,219	44.3	731	1.35	601	89.9
Local Service Total	**10,194**	**772.8**	**162,258**	**44.9**	**17,154**	**1.68**	**10,208**	**98.6**
ALASKA & HAWAIIAN								
Alaska Airlines	271	8.3	6,299	43.8	1,288	4.76	164	99.3
Alaska Coastal	154	10.1	835	57.5	101	0.66	117	93.4
Aloha	192	35.4	5,179	61.8	421	2.19	165	95.8
Cordova	96	2.0	266	47.9	139	1.45	35	96.9
Hawaiian	307	47.6	7,153	56.1	763	2.49	258	95.0
Kodiak	28	1.3	67	44.7	9	0.29	17	100.0
No. Consolidated	184	2.6	842	33.9	315	1.71	119	99.3
Pacific Northern	377	15.1	12,862	37.0	2,032	5.39	371	99.2
Reeve Aleutian	124	1.4	1,395	36.7	466	3.76	67	94.2
Western Alaska	20	0.3	20	46.5	3	0.17	15	96.4
Wien Alaska	316	4.0	1,212	31.6	486	1.54	138	95.6
Alaska & Hawaiian Total	**2,069**	**128.1**	**36,130**	**43.7**	**6,023**	**2.91**	**1,466**	**97.0**
HELICOPTERS								
Chicago	23	3.2	68	42.0	7	0.30	16	99.0
Los Angeles	64	15.2	599	47.1	64	1.00	70	91.4
New York	45	25.9	503	50.2	51	1.14	42	85.9
Helicopter Total	**132**	**44.3**	**1,170**	**48.0**	**122**	**0.93**	**128**	**90.6**
CARGO & OTHER								
Aerovias	Not Available							
Flying Tiger	959	3.5	14,548	79.6	15,978	16.67	297	100.0
Riddle	883	4.3	14,113	94.3	6,255	7.08	227	86.4
Seaboard	484	5.6	21,456	97.7	8,180	16.90	304	98.9
Slick	588	1.3	2,275	59.5	8,981	15.26	171	96.5
All Cargo Total	**2,914**	**14.7**	**52,392**	**88.7**	**39,394**	**13.52**	**999**	**95.9**
Industry Total	**96,599**	**6,218.7**	**4,634,473**	**55.1**	**592,348**	**6.13**	**93,127**	**98.3**

Prepared by Ray & Ray

Kodak reports on:

some less earthbound kinds of film . . . sweat in glass

Grosser than gossamer



Some of the advanced-type photographic film you see around these days is only .0025″ thick. See how flat it lies. Though still hopelessly grosser than gossamer, it offers in its thinness these advantages: much footage in little roll diameter, vast information-capacity for the volume, no afunctional plastic sneaking in as payload. And these disadvantages: an unaccustomed limpness, a disinclination to be pushed, an irresponsible response to edge-guiding. Since, therefore, intuitive notions based on personal experience with more earthbound kinds of films can mislead the designer of super-sophisticated cameras and other film-handling apparatus, he had better have a chat with us early in the doodling stage. He is allowed to play his cards as close to his chest as prudence demands.

Strictly in the sensitized-goods business are the gents he finds himself talking to in consequence of an inquiry to Eastman Kodak Company, Special Sensitized Products Division, Rochester, N. Y. They are happy, for example, to disclose the existence of a KODAK *High Definition Aerial Film* (ESTAR *Thin Base*) *with an Exposure Index of 1.6 but a resolving power of 200 lines/mm at test-object contrast of only 1.6:1. They can go on from there, either to more detail about that one or to other films. Ever hear of* KODAK PANATOMIC-X *Aerial Film* (ESTAR *Thin Base*)*? Or* KODAK PLUS-X *Aerial Film* (ESTAR *Thin Base*)*? Had never mentioned them in the ads, for some reason or other.*

Furthermore, it turns out that flat-lying .0025″ film is handy under certain conditions for recording galvo traces instead of pictures. Normally, of course, our paper serves this purpose. Imagine, however, a 40-trace recording that represents some big shoot. Each of those black lines may trace some individual breadwinner's hopes, fears, plans, and ambitions. He would be a pretty jittery boy by the time he sweated out his turn for a look at the record. That's why copies are made before anybody snags on to the original, perhaps as many copies as there are traces. Quality and speed of copying dictate film as the oscillographs' diet instead of paper on these grand occasions. The thinner the film, the longer the run before time out for a refill. The name of the film is KODAK LINAGRAPH Recording Film (ESTAR Thin Base).

A different gang works out the arrangements to get this product out where it will do the most good. Their *name is Photorecording Methods Division, Eastman Kodak Company, Rochester, N. Y.*

To make a laser, use a laser

As of this writing, alas, very few routine uses for lasers exist. As far as the eye can see, the present market is nearly all R&D. In this business, unlike some others we are in, product uniformity is hardly worth millions per annum. R&D customers have no objections if a KODAK Laser Rod shipped this week is quite a bit better than one shipped six weeks ago.

We don't make KODAK Laser Rods with the same tooling philosophy we use for KODAK INSTAMATIC Cameras. Each rod is individually handcrafted. This suggests tradition. There *is* a tradition of optical craftsmanship, and we even have it; but we do not go so far as to claim we have men who were taught how to fashion laser rods by their grandfathers. A six-month-old tradition in the laser craft is pretty hoary.

KODAK Laser Glass has acquired a much envied reputation in the last six months for optical quality. Optical quality is worth having in a laser rod, not so much for feelings of serenity it may induce in the owner as for minimizing beam divergence and internal losses. It is bought with chemical and glass-working sweat and in turn buys very low threshold in small rods and very high efficiency in big ones. Up to the time this ad was written, we had made them as long as 30 inches and had obtained efficiencies as high as 2¼%. Without sly tricks, we calculate efficiency as simply the energy in the capacitor bank, $\frac{1}{2}CV^2$, divided into what the calorimeter measures.

One item of special tooling we have found most valuable for maintaining optical quality in long rods and in more ingenious configurations that customers have devised. This gadget Grandpa never had in *his* optical shop. It is a helium-neon gas laser. Here, then, is one of the still very rare routine, day-in, day-out uses of a laser.* Day in and day out the handcraftsmen keep trotting over to it to use with or without Twyman-Green plates as a light source of fantastically long coherence length for interferometrically establishing optical parallelism of the two ends of a KODAK Glass Laser Rod. If the ends happen to be separated by a million or so wavelengths, it is no more trouble to see what touching-up is still needed than it ever was to check the Newton's ring pattern on an aerial photo-lens component through a test glass.

Correspondence on this subject is conducted by Apparatus and Optical Division, Eastman Kodak Company, Rochester, N. Y.

*And not even our own type!

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Vertical assault at 200 mph

Sikorsky's new CH-53A transport helicopter will be big, fast, and tough. It will provide the U.S. Marine Corps with its first all-weather, all-climate helicopter for vertical assault missions.

The powerful CH-53A will speed 30 troops or 8,000 pounds of cargo 115 miles at 170 mph—and return without refueling. On short missions it will transport 64 men or 16,000 pounds. It will carry a Pershing missile, 155 mm howitzer, or three-quarter ton truck. It will operate from any terrain and offers a watertight hull for emergency flotation. Under light-load conditions, top speed will exceed 200 mph.

An advanced rear-loading cargo system will permit one man to load a ton a minute. Prerigged external cargo can be picked up in flight without a ground crew.

The CH-53A is based on the proven technology of Sikorsky's twin-turbine S-64 Skycrane. First flight is scheduled for 1964.

Sikorsky Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION
STRATFORD, CONNECTICUT

SHORTLINES

► **Aeroflot,** Soviet-owned airline, has started proving flights on the new route between Moscow and Karachi (AW Nov. 25, p. 42). As of late last week, the exact course scheduled flights will follow had not been determined.

► **American Airlines** has proposed a reduction of 5 to 15% in first-class fares for medium- and long-distance trips, depending on the length of the trip. Long-haul fares will be given the greater reduction. American also proposes a 25% family fare discount to be applied on both first-class and coach tariffs, to be effective from Monday noon to 6 a.m. Friday.

► **British West Indian Airways** has ordered three Boeing 727 turbofan transports. Aircraft will be delivered in 1965 and will cost about $19 million including spares, parts and training expense. They will be operated on the carrier's Miami-Trinidad route.

► **Civil Aeronautics Board** Examiner Merritt Ruhlen has approved a proposed interchange agreement between Pan American World Airways and Delta Air Lines. Under the initial decision, through plane service would be operated between Delta's southern routes and Europe through the interchange of aircraft at Washington, Baltimore, Philadelphia or New York.

► **Eastern Air Lines** has petitioned CAB for authority to increase its Air-Shuttle fares between New York, Washington and Boston by $1. Increased costs stemming from additional monthly depreciation costs and from higher costs under a new contract with pilots are cited as reasons for the increase.

► **Seaboard World Airlines** will take delivery on one Douglas DC-8F turbofan all-cargo aircraft in June, 1964. Currently, the carrier operates seven Canadair CL-44 turboprop cargo transports.

► **Slick Airways** reported that commercial airfreight revenues for October were 120% greater than during September.

► **Trans Caribbean Airways** has reported a 28% increase in the volume of revenue passenger miles flown in October compared with the same month last year. Number of passengers carried increased 51% during the comparative periods, and air cargo ton miles rose 122.4%.

► **United Air Lines** has placed a $20,000 order for Ultipor ultra-fine filters for the hydraulic systems on its Boeing 720s. New filters eliminate the need for hydraulic system flushing.

AIRLINE OBSERVER

► U. S. scheduled airlines will install radar beacon transponders on all aircraft by 1966 to bring total investment in airborne radar equipment to $25 million. All jet aircraft, as well as a large number of turboprop and four-engine piston aircraft, have been equipped with transponders. New transponders will include side lobe suppression circuitry. Adapter units to permit automatic reporting to controllers will be installed later in coordination with Federal Aviation Agency installation of necessary ground equipment.

► **U. S. domestic trunklines have reported a $31,620,000 net profit for the first nine months of 1963, close to the estimated profit of $32 million predicted earlier by Aviation Week & Space Technology (Nov. 11, p. 34). In the same period last year, the industry reported a $6.3-million loss. Revenues for the 1963 three-quarters period were $1.8 billion, compared with $1.6 billion in the 1962 period. Operating expenses this year were $1.7 billion, compared with $1.6 billion for the same 1962 period.**

► Canadian political squabble over which aircraft Trans-Canada Air Lines should purchase for medium-haul requirements (AW Nov. 25, p. 39) was resolved last week when Prime Minister Lester Pearson announced that the government-owned airline would order six Douglas DC-9 transports at a cost of about $24 million. Ordinarily, announcements of this nature are made by an official of the airline or the Canadian government's Transportation Dept. Eventually, the airline will require about 30 of this type of jet transport, but chances are slight that new orders will be placed for the BAC 111 or the Sud Caravelle to appease factions that want these aircraft so that Canadair can share in their production in Montreal, where the unemployment level is high.

► **British Aircraft Corp. is pressing a weight reduction program on the Anglo-French Concorde supersonic transport. One move has been to remove the present galley in the aircraft mockup and substitute a more compact one. Company also is attempting to persuade purchasing airlines to accept three lavatories instead of four. Another project is aimed at fitting trays of packaged food into the backs of seats before flight to reduce further required galley room.**

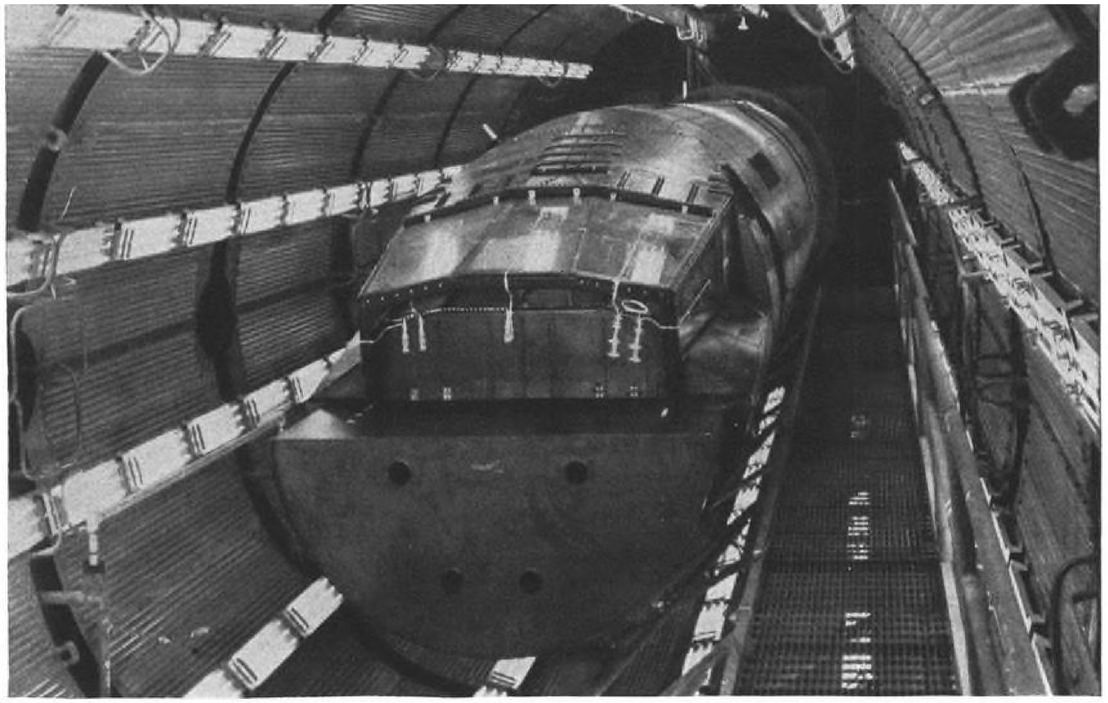
► United Air Lines/Sud Caravelle transports are being equipped with nosewheel tires that have rubber water deflectors molded into the tire walls. Deflectors prevent water and slush from being kicked up into the engines.

► **Australia has resumed negotiations with the U. S. for Tahiti-Los Angeles rights for Qantas Empire Airways. Renewed bid for the service was prompted by the recent Civil Aeronautics Board award of the route to Pan American World Airways (AW Nov. 18, p. 38). Earlier, Australia had quietly dropped its argument that Tahiti was included as an intermediate point on Qantas' transpacific route in the U. S.-Australia bilateral agreement.**

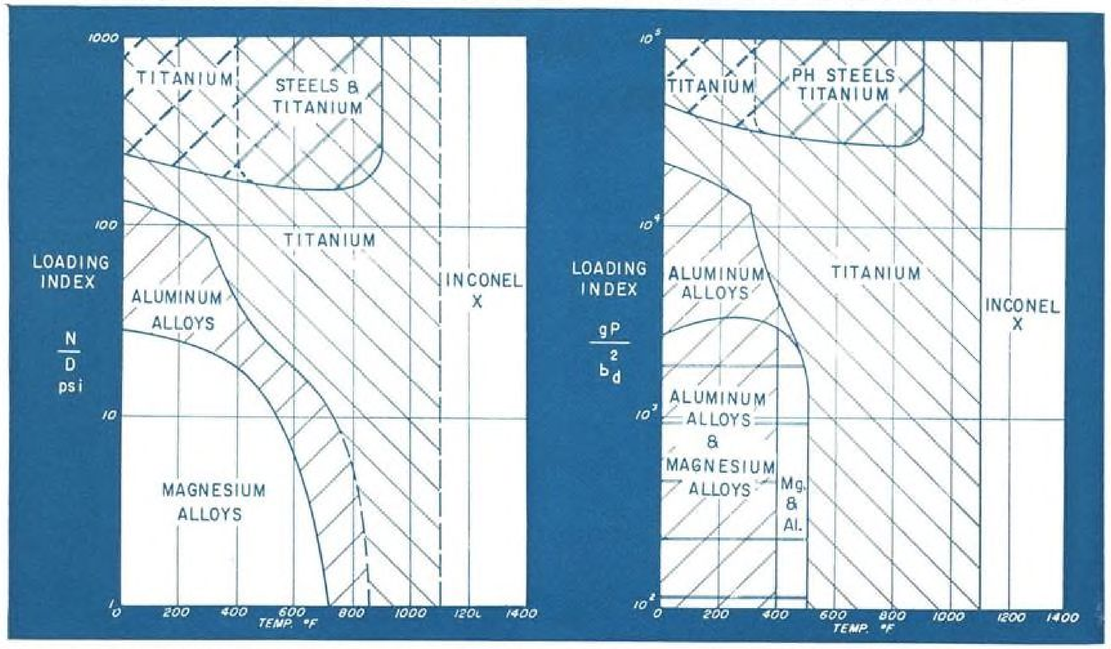
► Federal Aviation Agency has established a Procurement Information Office at its Washington headquarters. The office, to open Dec. 9, will furnish contractors information on what FAA is currently buying through advertised bids, and on items already purchased, including bidders' prices, discounts and delivery terms.

► **American Airlines last week presented the National Museum of Transport of St. Louis with a Douglas DC-7 transport, exactly 10 years after the aircraft was introduced on its New York-Los Angeles route in nonstop, scheduled service. A total of 338 of the DC-7s were delivered to the airlines by Douglas Aircraft Co. and about 175 are still in scheduled service.**

► Western Air Lines has been authorized by CAB to introduce Thriftair shuttle service between Los Angeles and Las Vegas beginning Dec. 1. Service will be inaugurated with five round-trip flights daily. One-way fare will be $11.43. At the same time, the CAB suspended a petition by Bonanza Air Lines for authority to introduce similar fares at off-peak hours. Board reasoned that load factors necessary to break even do not appear to be attainable.



MACH 3 TEST BODY of forward fuselage made of titanium is heat tested in environmental chamber at North American Aviation.



COMPRESSION LOADING INDICES (above) show the relative advantage of titanium over alternative aerospace materials for long cylinders (left) and for stiffened panels (right). Chart designations: N = loading per in.; D = diameter; g = number of cuts plus flanges; P = load; b_d = developed length of section. Up to 90% of SST airframe will be governed by tension or compression considerations.

Titanium's Future–Part 1:

Titanium Producers Seeking Major Role In Development of SST As Market Increases

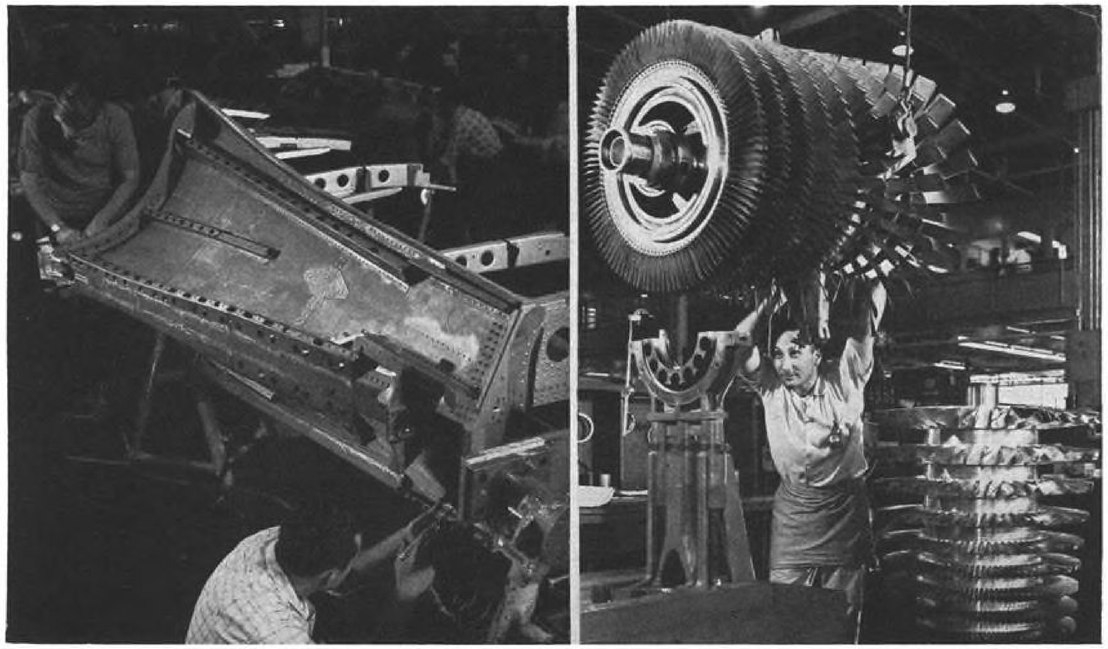
By Michael L. Yaffee

Titanium is riding a rising curve of acceptance in aerospace applications and is ready to reach for the biggest prize–the U. S. supersonic transport.

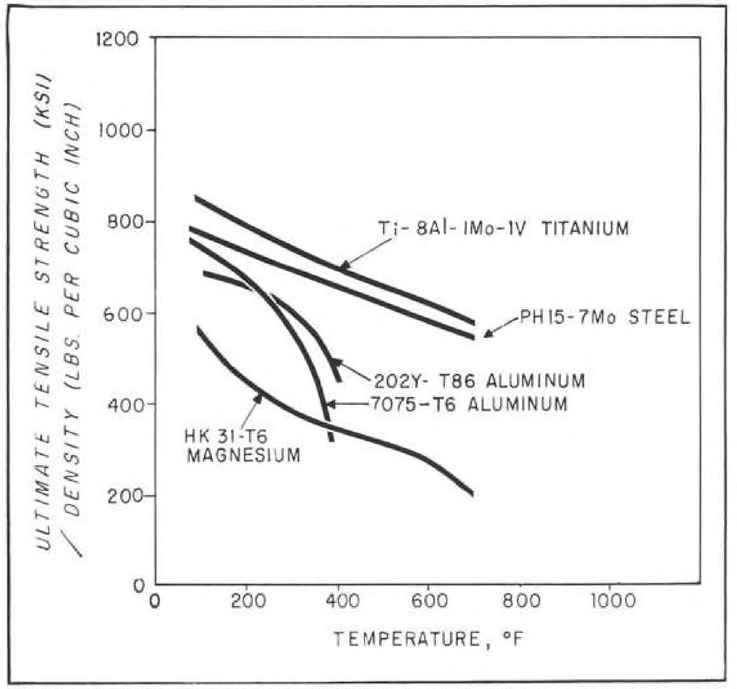
Titanium producers want a part–a big part–in the proposed supersonic transport program. Manufacturers are preparing proposals and making presentations to potential SST contractors. New titanium alloys are being developed and evaluated for the SST program. New titanium strip, sheet and plate fabrication facilities, vital to an SST program, are becoming available.

In a Mach 2.5-3 supersonic transport, engineers and metallurgists estimate that titanium could be the material for 60-90% of the airframe. For an individual airplane–based on what seems like a fairly realistic figure of 75%–this could mean as much as 80,000 lb. of titanium per airframe. To titanium producers, a going SST program could mean an increase of 33% in the projected market figures by 1970.

The question titanium producers are asking themselves is not whether a Mach 3 transport will use titanium but, rather, whether the U. S. supersonic transport will be designed to cruise at Mach 2 or Mach 3. If the vehicle is designed to fly faster than Mach 2.2, they–along with

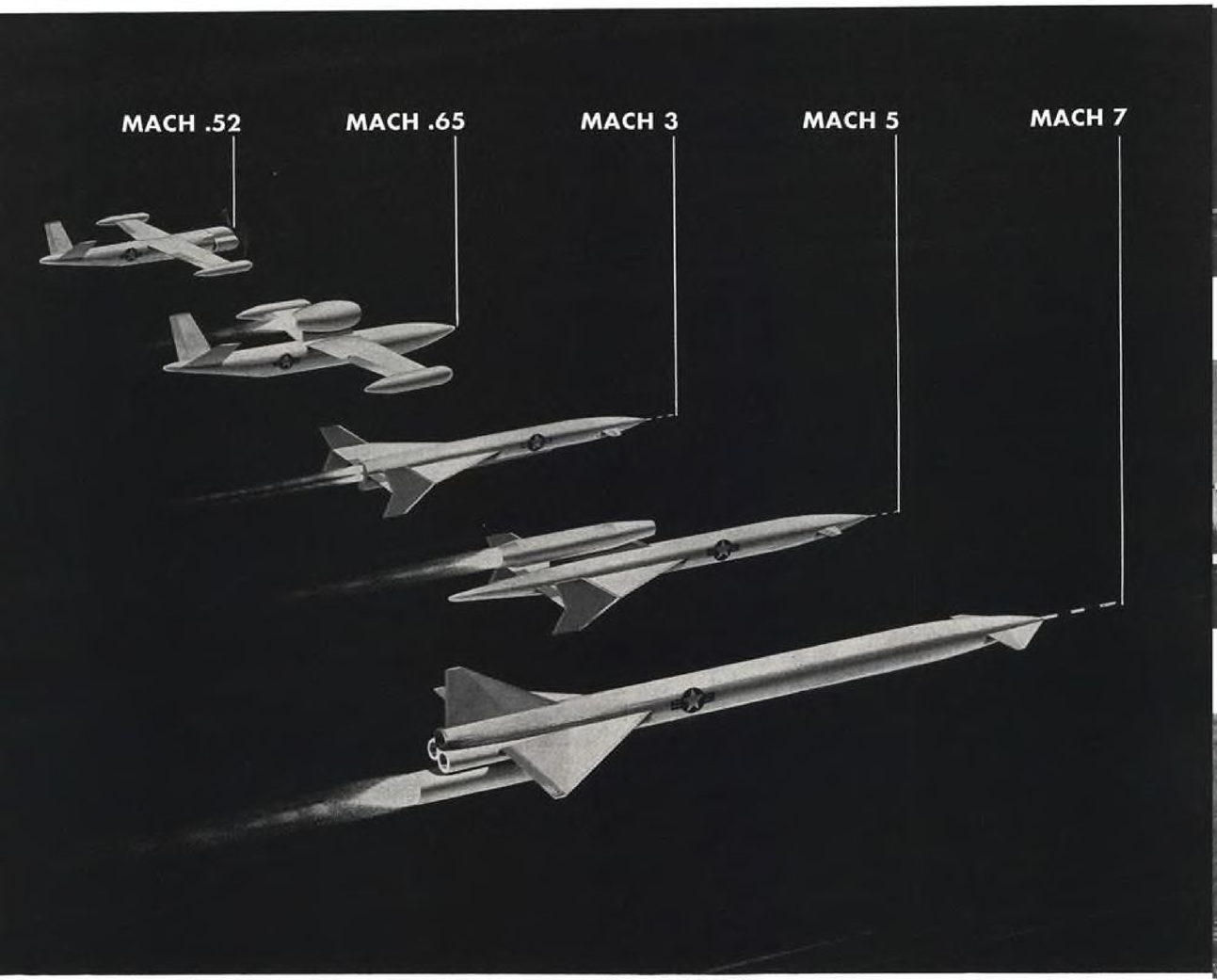


TITANIUM UNDERSIDE OF McDONNELL F-4B/F4C aft fuselage (above, left) uses Ti-8Mn for frame and skin and Ti-6A1-4V for longeron. Section is adjacent to the exhaust area and, despite heat shields, reaches operating temperatures of 700F. Blades, discs and spacers of Pratt & Whitney J-75 compressor section (above, right) are fabricated of Ti-6Al-4V titanium alloy. Almost every turbojet engine that has taken to the air has used some titanium, either in original or retrofit equipment.



TENSILE STRENGTH/WEIGHT COMPARISON of current aerospace sheet materials shows advantages of Ti-8Al-1Mo-1V alloy at temperatures of up to 700F. One disadvantage of titanium has been lack of adequate performance data for aerospace purposes.

Beech "Imaginuity" in missile systems



Now, what's beyond Mach 7?

Beech "Imaginuity" in missile target systems is finding out

How fast will tomorrow's missile target systems need to be? The answer: just as fast as the speediest enemy hardware—jets or missiles—that Free World gunners may have to shoot at. What will it take to provide these advanced missile systems . . . to turn "impossible" requirements into solid reality by the time they are needed?

Beech "Imaginuity" is already at work, seeking—and finding—the answers. The Beech AQM-37A (KD2B-1), now in line production for the U. S. Navy, is capable today of speeds above Mach 3 and can be flown at altitudes of 90,000 feet. It gives today's most advanced weapon systems a realistic challenge to their capabilities.

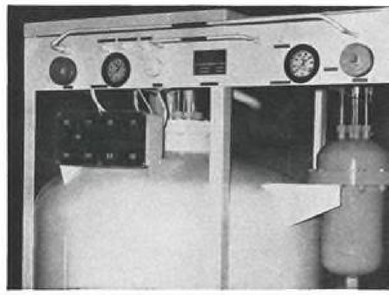
But, just as important, Beech has already designed a family of missile target systems for a wide variety of defense training missions, ranging from Mach .52 to Mach 7—and is now reaching out beyond that.

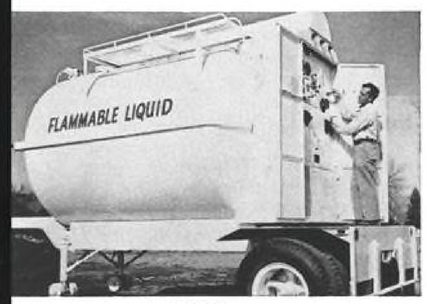
This kind of probing into the future, plus Beech "Imaginuity" in design, development, fabrication and testing has given Beech a head start on development of the advanced missile systems that will be needed for tomorrow's training and air defense requirements.

Other Beech Capabilities In Systems Management Include:

R & D . . .

Propulsion . . .


Auxiliary Power . . .



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LARGE MEMBERS, such as these titanium plates for the McDonnell Phantom 2 jet fighter, could be used throughout the airframe of a supersonic transport.

many aircraft structures engineers—are convinced that the SST will make extensive use of titanium.

Once aircraft cruise speeds pass Mach 2.2, aluminum is reduced to a limited number of applications. Between Mach 2.2 and Mach 3, equilibrium temperatures over most of the airframe range from approximately 450F to 650F. In this temperature range, the only materials that can provide the required long time strength properties are titanium alloys, the high strength steels and the super alloys.

Specifically, the National Aeronautics and Space Administration's special committee on materials research for supersonic transports reported (AW Nov. 19, 1962, p. 65) that the most promising materials for the airframe of a supersonic transport designed for a cruise speed of Mach 3 and an operational life of 30,000 hr. appear to be: AM 350, AM 355, PH 15-7Mo and PH 14-8Mo steels; Ti-8Al-1Mo-1V and Ti-6Al-4V titanium alloys; and Rene 41, Waspaloy and Inconel 718 super alloys. The committee cautioned, however, that these were interim conclusions requiring more research before final material selections can be made.

But if the NASA committee seems somewhat cautious at this point, many engineers and scientists are not.

"If Mach 3 is the right number," one structures engineer declared, "then titanium is the right material for 85-90% [by weight] of the SST airframe."

"A Mach 3 supersonic transport has got to be titanium," a metallurgist said, "it's the best material available for the job. But the problem is that it has become a political football, and people are afraid to use it where they should for fear of not getting the contract."

"There should have been a lot more titanium specified in the RS-70 and TFX airframes," another engineer said. "But the amount of titanium being used in the RS-70 is already more than they first figured on. It will be the same thing in the TFX when they find their steel airframe is getting too heavy to fly."

Weight is the nub of the many arguments favoring the use of titanium over steels and superalloys in a Mach 3 airframe. For the approximately 20% of airframe where titanium can't do the job because of heat and other factors, everyone is agreed that steels or super alloys will be needed.

"It is also expected that some aluminum will be used where high operational temperatures are not a limiting factor."

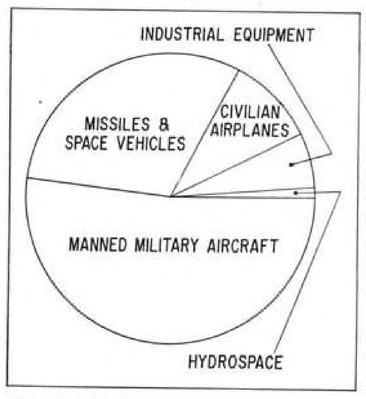
Titanium and its alloys now are being used or considered for applications where operational temperatures range from −320F to 1,400F. Some thought is being given to using alloys at −423F, while 1,400F is considered the upper limit of titanium structural applications and then for only very short times as might be suitable for certain missiles.

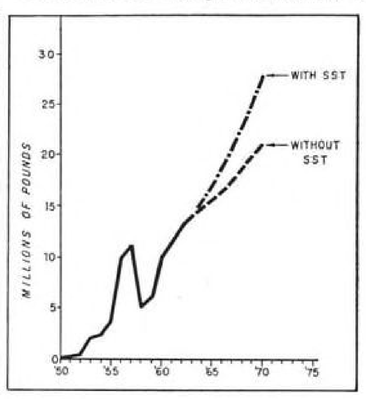
Many engineers however, believe 1,000F is a more realistic figure for short time applications and that 800F would be the upper limit for long time structural applications such as those that might be required in the airframe of a supersonic transport.

It is conceivable that new titanium alloys will be developed for short term service at 1,200-1,400F and adequate for extended use at 1,000F, but they add that these figures will probably prove to be the final upper limits for titanium structural use.

At 750F and beyond, creep is currently expected to be one of the principal, potentially limiting factors to long time service of titanium structures and components. Presently, however, there is no solid indication of how important creep deformation will be in the wings and fuselage of a Mach 3 transport. Nor is there creep data on the probable structural materials—steels, super alloys and titanium alloys—at the steady state creep rates and temperatures of interest in Mach 3 application.

NASA has awarded General Dynamics/Convair a contract to develop a machine to measure very low, steady state creep over long periods of time. The machine is expected to be ready early next year. USAF has awarded another contract to General Dynamics/Ft. Worth for tests on Ti-8Al-1Mo-1V, Ti-6Al-4V, AM 350, PH 15-7 Mo and René 41 to be carried out in conventional creep test machines simulating as





AEROSPACE APPLICATIONS CONTINUE to dominate titanium market. Currently, they are taking approximately 93% of the total titanium output (above, left). After being slowed in 1957 by government problems with the budget and by a cut back in production of manned aircraft, consumption of titanium is again on the increase and pushing toward possible record highs (above, right). Inclusion on a large scale of titanium in the proposed U. S. supersonic transport program would sharply increase production totals.

What is it that can travel over water, land, mud and ice and may make the wheel obsolete?

It's been called a "GEM" (for Ground Effect Machine). It's been called a "Hovercraft." It's been called an "Air Cushion Vehicle." And it's a little hard to say whether it flies low or rides high.

But Republic Aviation has just concluded a licensing agreement to develop, produce and sell these revolutionary machines that travel on a cushion of air over any kind of surface, wet or dry.

Gas turbine engines provide air cushion

One of the most publicized GEM's already built has done commuter service on a test basis, carrying 24 passengers across Dee Estuary on Britain's North Wales coast, over sandbars and shoals where no boat could operate. Called the VA-3, it's a 4-engine 12-ton version that can handle about 2 tons of cargo. It hovers 12 inches over the surface on a cushion of air provided by two of its gas turbine engines, while the other two provide propulsion.

A variety of high-speed go-anywhere craft for industry and the military

Similar but more advanced versions of the GEM are expected to operate easily at speeds over 150 mph. Republic's prototype model will be equipped to ride three feet off the surface to clear waves or obstacles, and further development will produce models that can clear six to eight-foot obstacles. Consider then, what the GEM's capabilities might be . . .

- ☐ As a military landing craft, thundering in from over the horizon and right up onto the beach to park and unload—
- ☐ As an offshore oil-rig tender, carrying drillpipe, supplies and personnel over tidewater marshes, mud flats and open sea with equal ease—and without any dock—
- ☐ As an airport or harbor vehicle for police and rescue work—
- ☐ As a high-speed arctic exploration craft, unhampered by snow or thin ice—
- ☐ As a general-purpose carrier for underdeveloped countries where good roads are few and far too costly.

How big a future

As yet, nobody is entirely sure what the GEM's total potential for the future really is. Finding out is a big part of Republic's job. Considering that it took man some millions of years to discover the wheel—and another 7,000 to learn how to do without it—that could be a pretty sizeable order.

Republic will develop and produce air-cushion vehicles in this hemisphere under a licensing agreement with Vickers and Hovercraft Development Ltd. of Great Britain. Republic Aviation Corporation, Farmingdale, Long Island, New York.

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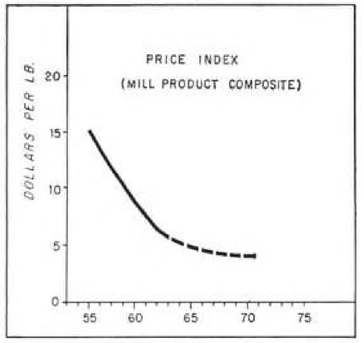

COMPOSITE PRICE of titanium mill products, continuing to drop with increasing production, probably will eventually level off at twice that of steel products.

closely as possible SST operating conditions.

There is also a paucity of information on the effects SST operating temperatures will have on the fatigue characteristics of the candidate structural materials. For example, Secretary of Defense Robert S. McNamara, commenting on the Boeing Co.'s proposed use of titanium in the wing carry-through structure of the TFX, said:

"The fourth evaluation report observed that data concerning the fatigue design properties of titanium, in the thickness Boeing proposed to use in the wing carry-through structure, is very limited, and that this raises the question of the advisability of using such thickness. The report further commented that the effect of temperature on structural details, especially in the aluminum-to-titanium splice, can be expected to be quite pronounced in producing metal fatigue, and the report concluded the Boeing fatigue test program showed lack of realism." (AW Mar. 25, p. 81).

NASA's Langley Research Center both in house and with various contractors, now has several fatigue tests under way or recently completed on the candidate structural materials:

- **Tension fatigue tests** of notched and unnotched specimens at 70F after exposure to 550F for various times up to three years.
- **Tension fatigue tests** at −110F, 70F and 650F.
- **Determination** of crack extension rates.
- **Measurement** of breaking strength in specimens after various amounts of fatigue crack extension.

Under contract to NASA, the Chance Vought Div. of Ling-Temco-Vought is carrying out fatigue tests on specimens containing representative welds and mechanical joints. Battelle Memorial Institute, also under a NASA contract, is evaluating Ti-8Al-1Mo-1V and AM 350 skin materials at 550F and under a steady 1g stress level.

While many of these tests are admittedly still at an early and inconclusive stage, metallurgists and structures engineers generally do not expect creep or fatigue to be limiting factors for the steels, titanium and super alloys under consideration for wing and fuselage structures in a Mach 3 transport where operating temperatures are not expected to exceed 650F. In jet engines or in certain parts of a Mach 4 airframe, when temperatures start pushing to 800F and more, fatigue and creep characteristics will be more critical and limiting, according to one designer.

If these conjectures prove correct and titanium alloys and the other candidate materials are not temperature limited up to 800F, then the next important consideration for SST designers involved in selecting suitable airframe materials is an evaluation of strength and density characteristics.

This is where titanium shows at its best. On the average, titanium is 42% lighter than the steels and super alloys at the same strength. Said Gene F. Erbin of Titanium Metals Corp. of America: "In compression loaded structures, material efficiency is not a linear function, but more frequently a squared or cubed function of the density."

Titanium alloys with yield strengths of approximately 175,000 psi. can't match the newer steels with yield strengths approaching 300,000 psi. on a pure strength basis. Except for certain specialized applications, however, there is little interest in these absolute numbers. Most of the interest today centers on strength-to-density ratios, and the magic number is 1,000,000 in. On this basis, titanium with a density of 0.163 lb./cu. in. and a yield strength of 167,000 psi. can out perform steels with a yield strength of 225,000 psi. and a density of 0.277lb./cu. in.

Titanium's comparative weight advantage, of course, is not an isolated factor. Loading conditions are an important part of the picture and will strongly influence design criteria and material selection for a specific aerospace vehicle. In the case of manned aircraft, tension and compression considerations will govern the design of most of the entire airframe, in varying amounts depending upon particular flight profile.

Design of 50-60% of the airframe of the proposed Mach 2.5 or 3 transport, for example, will be governed by tension considerations and probably 30% by compression. In one SST design which calls for a 91% airframe, 51% will be governed by tension loads and 40% by compression. Design of the rest of the airframe probably will be governed by special considerations such as acoustics.

From strictly an efficiency point of view, titanium appears superior in both compression and tension design to other

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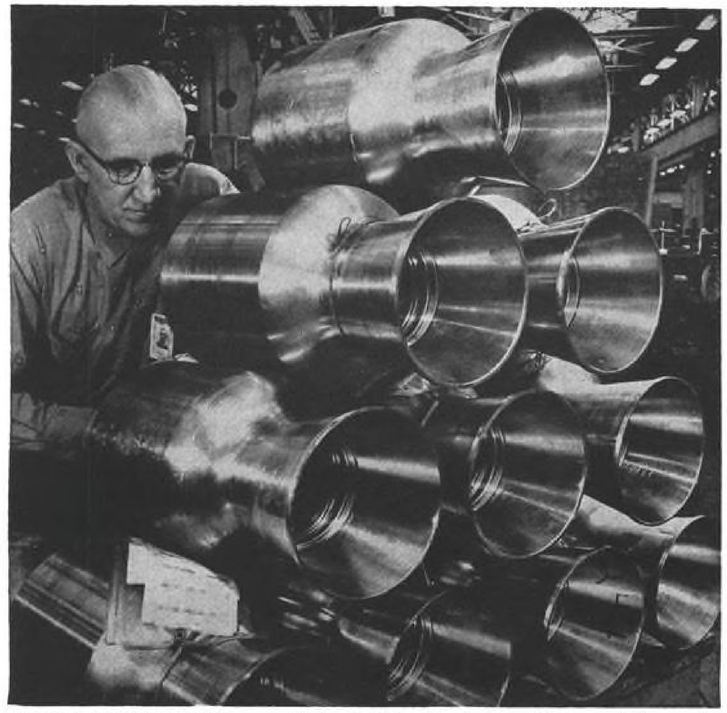

NOZZLES SHOWN ABOVE are made for the Davy Crockett recoiless gun. The nozzles, along with the rest of the guns, are fabricated of titanium.

materials over the temperature range anticipated for SST operations (see charts, p. 49).

One of the arguments against proposed applications of titanium in aerospace structures is the lack of adequate performance data on which to judge its reliability.

To the extent that it relates to the performance of an aircraft under Mach 3 operating conditions, this is a valid argument. It is also a valid argument against the use of the steels and superalloys under consideration for the SST, since these have not been used either in aerospace applications corresponding to those anticipated for a Mach 3 SST.

Use Increasing

On the other hand, titanium structures and components have been flying in aircraft and missiles since 1950. The conditions and environment admittedly have been different—in most cases, significantly so—from those anticipated for a Mach 3 SST. Nevertheless, the titanium companies claim it is worth noting that the amount of titanium being used in these aerospace applications has been steadily increasing and that, with the exception of the hydrogen embrittlement problem experienced in 1954 and 1955, no service-reliability problems with titanium have been reported by the aerospace industry.

Of all the arguments offered against titanium, the ones dealing with the material's relatively high cost have undoubtedly been the most effective.

There is no question that titanium is more expensive than steel. The price of titanium mill products has been dropping steadily since 1954 (see chart, p. 57) and will probably continue to drop slightly as consumption increases. But it is considered extremely unlikely that titanium will ever be able to match steel on a price basis.

This is granted by titanium producers. But they maintain titanium isn't looking for charity. It is paying and will have to continue paying its way wherever it is used. Comparisons based on product price or raw material costs, they claim, are not really meaningful to the aerospace industry. More to the point, they say, is the comparison between titanium costs and the savings made possible through use of lighter weight titanium components and structures.

The military may be willing to accept higher weights, provided the aircraft can get off the ground and perform its mission. The military also must, in addition, consider the problem of sonic boom damage caused among other things by overpressures which buildup with increasing aircraft weight.

Commercial transport operators, on the other hand, cannot afford to carry any unnecessary, nonproductive weight.

It is difficult to assign any specific values to projected weight savings because these will depend upon the particular aircraft. But the figures generally quoted range from $30 to $60/lb. of weight saved and figures as high as $100/lb. have frequently been cited. Against this must be balanced the additional cost of using titanium and the figures cited here range from $10 to $50/lb.

In one specific case, offered by the American Society for Metals Committee on Titanium, the cost of a particular air-to-air missile structure for a design temperature of 800F was estimated at 10% more if made of Ti-6A1-4V titanium alloy instead of 17-7PH steel. But the titanium structure would be 20% lighter than its steel counterpart. Saving a pound of weight the committee said, would thus require spending half the cost of manufacturing a pound of 17-7PH missile frame. "This might amount to $25, as an average figure, which would generally be an attractive price for weight saving," it noted.

Titanium Savings

In the case of the DC-8, Douglas Aircraft Co. estimates that the use of titanium led to a savings of almost 1,000 lb. in the airframe. On the basis of mail rates, this amounts to $525 for each coast-to-coast flight or $2,625,000 for the 5,000 flights each DC-8 would make based on an assumed seven year write-off period.

Another parameter that will be used in evaluating candidate SST material is corrosion resistance. The SST will encounter a salt air environment in operations from airport runways located close to the ocean and during the winter when salt is used to remove ice from runways.

The Federal Aviation Agency is interested in resistance both to general corrosion and to stress corrosion.

Seek More Data

Titanium is superior to the steels and super alloys in general corrosion resistance. Stress corrosion resistance is another matter and depends on the specific environment, stress level, and temperature. At elevated temperatures in the presence of salt, all the potential SST alloys are expected to prove susceptible to stress corrosion. Precisely how susceptible they are is not known at this time, and FAA is now trying to get more data on this subject.

One interesting comment on this subject came from Pratt & Whitney Aircraft which reported that its titanium alloy jet engine compressor blades, in operation since 1954, showed no evidence of stress corrosion cracking. P&W also reported that high velocity, high temperature air passing over the surface greatly reduces the susceptibility

of titanium alloys to salt stress corrosion.

Another factor that may enter the picture here is the use of protective coatings. NASA has awarded Southern Research Institute a contract to survey and test promising coating processes. Primary interest in coatings for the SST is to protect certain otherwise suitable non-stainless steels that would rust in operation, and to prevent discoloration on the fuselage and wings of an SST made with stainless steels and titanium alloys.

More Studies Needed

Fracture toughness is another question. In its initial screening program, the NASA supersonic transport materials committee carried out notch tests on small specimens to get information on the relative toughness of candidate materials. Then it decided that more notch-toughness studies were needed on larger and more complex specimens. Douglas Aircraft Co. was given a contract to perform fracture-toughness tests on 8-in. wide specimens with center fatigue cracks at temperatures ranging from −110F to 1,400F. Variables studied in this test include crack length, strain rate, thickness and exposure time at 650F.

As things now stand, titanium alloys appear to offer superior crack tolerance or fracture toughness at room temperature conditions. At elevated temperatures, fracture toughness of titanium alloys is yet to be determined over prolonged periods but is expected to remain acceptable for SST applications. In all probability, the cold worked super alloys will show the best crack toleration at elevated temperatures.

Of all the arguments advanced against titanium, availability is perhaps the least troublesome, according to Ward W. Minkler of Titanium Metals. Ti-6A1-4V, one of the two leading titanium alloys of interest to the SST program, is readily available in the quantity that would be required. The newer, creep resistant 8A1-1Mo-1V, developed specifically to have high strength at elevated temperatures (its short time strength and toughness are very good over the SST operating regime from −80F to 650F), is not yet available on the same quantity basis as the older alloy but is expected to be by the time the supersonic transport program gets under way.

While titanium producers say availability of titanium alloys in the forms required for fabrication of a supersonic transport is also assured, a lot of aerospace engineers indicate they are not willing to accept this assurance until they see the required product forms. Titanium, they point out, has lost more than one job because it couldn't produce the required strip sizes or offer the desired honeycomb shapes when needed.

Today, titanium is still limited in regard to the availability of strip (coiled sheet) sizes. The aerospace industry is asking for titanium strip in widths up to 36 in. and 48 in. and in thicknesses down to 0.008 in. and 0.010 in. with surface condition, thickness tolerances, flatness and camber of the coil stock considerably improved over present practice.

Currently, three titanium companies are producing 36-in.-wide strip and one, Titanium Metals, is now readying a mill that will be capable of fabricating 48-in.-wide strip with improved tolerances, flatness and camber. This new mill is expected to be in operation in 1964.

Processing Difficulty

Weight-saving honeycomb construction is still a problem for titanium fabricators. One of the problems in making titanium honeycomb stems from the inability to roll high strength alloys down to foil thicknesses. Another comes from the lack of suitable alloys which will retain high strength characteristics at elevated temperatures in the thin foil gages demanded.

Processing difficulty (and accompanying high costs) offers another obstacle to titanium foil production. Titanium is more limited than aluminum or steel in the amount of reduction that can be accomplished in each pass through the rolling mill and accordingly requires more frequent heating between passes.

A number of lightweight titanium constructions have been developed as possible alternatives to honeycomb sandwiches. One of these is an all titanium, roll bonded sandwich structure, developed by Battelle metallurgists, that could prove valuable in aerospace applications. Where it is difficult or impossible to form other titanium sandwiches, says Battelle, the roll bonded sandwich can be twisted or bent into complicated shapes. It is expected to be an economic process.

Metallurgical Bond

In the Battelle operation, two titanium plates are separated by a number of titanium ribs all running in the same direction. The voids between the ribs are filled with steel. Hot rolling produces a metallurgical bond between the titanium ribs and cover sheets and at the same time rolls out the assembly to more than twice its original area. The sandwich is then formed into the desired shape, and afterwards the steel filler between the ribs is leached out.

The disadvantage of the design is that all the ribs have to run parallel in order to provide continuous paths for the leaching of the steel and, accordingly, rolling is unidirectional following the layout of the ribs. This means that the structure is not as strong as a cross-ribbed structure would be. Nonetheless it is regarded as a significant advance in titanium structures, particularly for those aerospace applications whose loading is expected to be unidirectional.

Greater Springback

Manufacturers have complained for many years about the difficulty, or impossibility, of forming titanium alloys. Actually, according to the titanium companies, titanium alloys are no more difficult to form than the high strength steels and super alloys.

One of the problems in the past was that fabricators were trying to work titanium on equipment originally designed for steel. Another problem is that all materials—the newer steels and super allows as well as titanium—designed to have strength at elevated temperatures are inherently more difficult to work.

In the case of titanium, the combination of low modulus of elasticity and high yield strength leads to greater springback from forming compared to aluminum and steel. The increased springback is more difficult to compensate for in tool design, says the American Society of Metals Committee on Titanium, because variability of springback at a high strength level is more likely to result in an out-of-contour part than variability at a low strength level. For titanium work, dies have to be carefully designed, according to a NASA metallurgist. Titanium cannot be thrown into a conventional aluminum or steel forming operation.

But now fabricators have gained experience with titanium. They have designed or modified equipment to handle it. To compensate for its high yield strength, they are using greater loads and higher temperatures in forming operations. As a result, says TMCA's Minkler, titanium alloys are being formed and forged as easily as any other comparable high strength metal. At the same time, new titanium alloys are now under development that are expected to prove even easier to roll and form than in the past.

Titanium alloys still require more and closer process control than steel and other metals, says an Air Force metallurgist, and the titanium processing equipment is more limited than that available for steel. The largest ingot that can be turned out in a titanium furnace, for example, is only five tons. Nor does the titanium industry have the large heat treating furnaces that the steel industry has. This would be more of a hindrance to missile manufacturers than to SST contractors.

Optimistic Outlook

Comparative lack of forming facilities is not expected to prove a limiting factor in the selection of titanium for future Air Force programs as now projected, according to Air Force metallurgists.

Moreover, the Air Force metallurgists are generally optimistic about titanium's future and believe the metal will make more progress this time in aerospace applications than it has in the past. There is more experience now in working with titanium, they point out. It has advantages as an engineering material that would virtually force its acceptance in aerospace applications—if there were no cost factor involved.

At one time, welding difficulties were another problem titanium fabricators had to face. Among other things, they had to use complex and costly purge chambers to guard against contamination and embrittlement by interstitial elements such as oxygen, nitrogen, hydrogen and carbon. Today, care still has to be exercised in the welding of titanium, but welding is no longer considered much of a problem.

Comparatively simple equipment is used to provide inert gas protection of the weld. And titanium spot welding techniques are the same as used for stainless steel.

(This is the first of two articles on the applications of titanium in the aerospace industry. The second article will appear in a subsequent issue of Aviation Week & Space Technology*).*

PROBLEMATICAL RECREATIONS 199

If a number is added to its reversal and the process repeated with the result, a number will eventually be obtained which reads the same backward and forward. For a certain two-digit number this process must be repeated more than ten times to arrive at a palindromic number. What is this number? *—Contributed*

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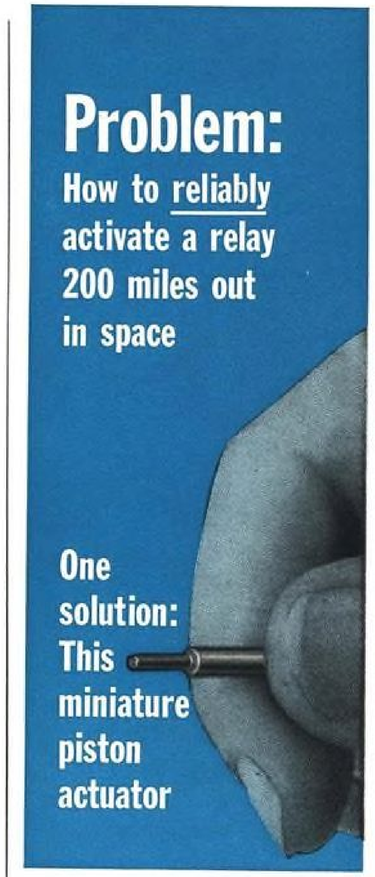

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PRODUCTION BRIEFING

Wolverine Diesel Power Co., Detroit, Mich., will manufacture small gas turbines for Air Force M-32 A-60 aircraft ground-support vehicles under a $1.1-million contract from Garrett-AiResearch, Phoenix, Ariz.

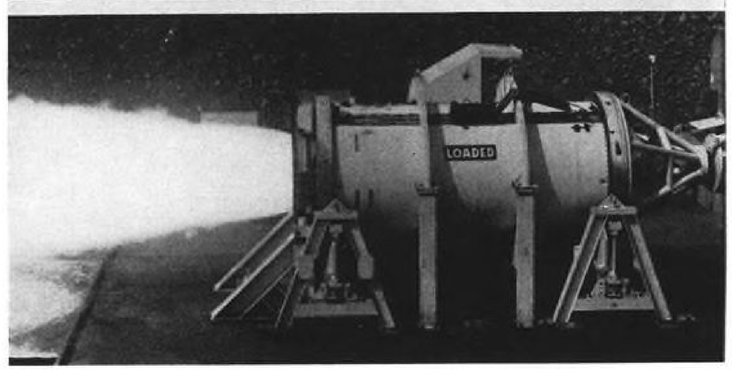
Martin Co.'s Denver Div. has awarded Gulton Industries, Inc., Metuchen, N. J. contracts totaling more than $685,000 for amplifiers and transducers for Air Force's Titan 3 launch vehicle. The transducers—high-impedance accelerometers—and audio frequency amplifiers will be used to condition signals from Gulton-supplied piezo electric accelerometers and microphones. The signals are then fed to the Titan 3 telemetry system to collect data on missile vibrations.

Fifty-five Dassault Mirage 3 supersonic interceptors have been delivered to the Israeli Air Force on an order totaling 72 aircraft. The size of the order was disclosed recently in a published breakdown of Dassault's production. The aircraft carry the designation Mirage 3CJ and are armed with French Matra air-to-air missiles.

Rolls-Royce Conway R.co 42 Mk. 540 bypass engine for Vickers VC.10 four-jet transport was certified last week by British Air Registration Board at 20,370 lb. thrust for takeoff. A version of the Conway 42, the Conway 43, rated at 21,825 lb. takeoff thrust, is under development for the Super VC.10 transport.

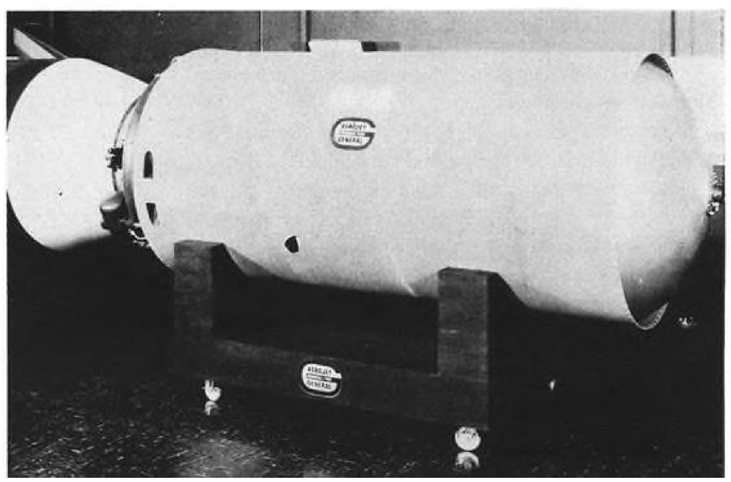
Olin Mathieson Chemical Corp. will produce monomethyl hydrazine (MMH) for National Aeronautics and Space Administration under a $500,000 contract awarded through the Air Force. MMH is a one-component fuel with a −62.3F freezing point which can also be used as a replacement for the 50-50 mixture of anhydrous hydrazine and UDMH (unsymmetrical dimethyl hydrazine). Fuel will be produced in Lake Charles, La.

Sperry Rand Corp.'s Univac Div., St. Paul, Minn., will deliver 11 Model 1218 computer systems to NASA for use in the Gemini and Agena programs under terms of a $2-million fixed price contract currently under final negotiation. The computers will be delivered to manned space flight tracking network stations for operation by July, 1964. The system will summarize space-to-ground telemetry and prepare data for final processing in more elaborate com-



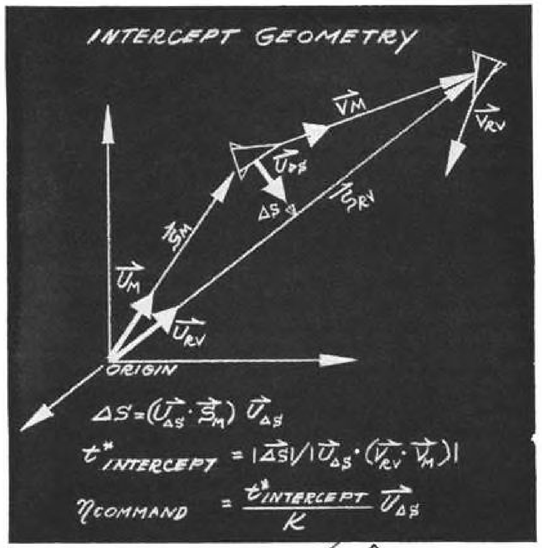
New Minuteman Stage Has Single Nozzle

New second stage solid propellant motor for Wing 6 Minuteman, successfully flown from Cape Canaveral Nov. 13, is shown (above) loaded on transporter and undergoing test firing at Aerojet-General's solid rocket plant, near Sacramento, Calif. New motor uses a single fixed nozzle in place of the four movable nozzles on earlier design, and has liquid injection thrust vector control. New nozzle throat is submerged into the stage. Exit plane is nearly equal to diameter of the chamber. New nozzle is simpler in over-all design, and has carbon throat like earlier nozzles. Note slots in skirt of full-scale model (below), which are openings for back-to-back nozzles in the roll control system. Diameter of the new motor is 52 in., compared with 45 in. for earlier version. Second stage length remains the same.



ENGINEERS/SCIENTISTS

WORK ON PROBLEMS LIKE THIS...



WITH ASSOCIATES LIKE THESE...

Mr. E. P. Williams (left) is Chief of the Aeromechanics Branch, Advance Missile Technology. He directs efforts in the Flight Mechanics, Aerothermodynamics, Aerodynamics and Nuclear Effects Sections. Mr. Williams was among the Douglas engineers who went with the Rand Corporation when it became independent of Douglas in 1948. He became head of Aerodynamics at Rand and specialized in hypersonic aerodynamics and glide rocket research and engineering.

Mr. J. L. de Grandpre (right) is Douglas Study Director for the USAF Foreign Technology Division, Analysis and Synthesis of Military Space Systems. Previously he was Director of the Advanced Computer Program Development Section within Advance Missile Technology. Earlier, he was engaged in systems analysis and flight simulation work in Canada.

...IN THIS PROFESSIONAL ATMOSPHERE

The Douglas Advance Missile Technology Department is a professional community charged with the responsibility of evolving new concepts which contribute to the technical superiority of the nation.

It combines research and advance design functions in a self-administered unit having the atmosphere of a small, highly qualified engineering organization. But it also has the advantage of having at hand the vast support functions and facilities of a major aerospace company. Its studies are tempered by the scientific critique of its research groups and the realism required by the knowledge that eventually "hardware" end products are involved.

AN INVITATION. Key openings are now available for qualified professionals with experience and/or advanced degrees, particularly in the disciplines of aerodynamics, communications, guidance and control, flight mechanics, fuzing and arming, and operations analysis. We invite you to look into them by writing (please include resume) to the following address:

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puter centers in Goddard Space Flight Center, Greenbelt, Md., and Manned Spacecraft Center, Houston, Tex.

Space-Defense Div. of American Optical Co. has been awarded a $1.8-million Air Force contract for delivery of seven mobile cinetheodolite systems to Air Force Missile Test Center at Patrick AFB, Fla. The contract will be carried out by the J. W. Fecker operation in Pittsburgh, Pa. The cinetheodolites are electronic and optical telescopic tracking equipment for measuring and observing the flight path of both guided missiles and high-speed aircraft.

Consolidated Systems Corp., Monrovia, Calif., will design and develop a radarscope recording camera for the General Dynamics F-111 (TFX) fighter under a $400,000 contract from General Electric's Light Military Electronics Dept. The camera will photograph the image on the radarscope directly through a window in the back of the indicator's cathode ray tube. In addition to the image, the camera will indicate and record time signals on each frame.

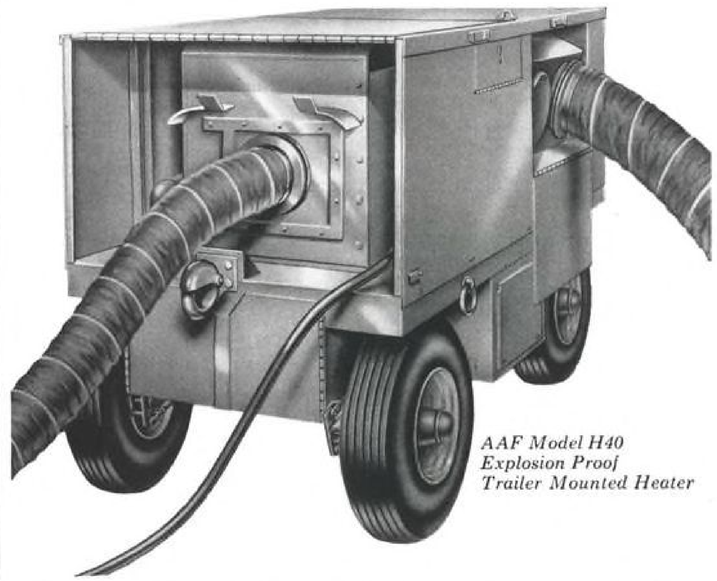
MSA Research Corp., a subsidiary of Mine Safety Appliances Co., has completed a one-year design, construction and start-up program on a plant at Callery, Pa., to produce high-purity potassium, cesium and rubidium metals. The facility is designed for quantity production of these metals with purities of 99.99%.

Air Force Flight Test Center, Edwards AFB, Calif., will expand its computer laboratory with the addition of an Electronic Assocs. Inc., HYDAC 2400 computer system. The Air Force contract with the company is in excess of $600,000.

Doughboy Industries' Televiso Electronics Div., Wheeling, Ill., will produce 1,000 aircraft receiver-transmitters for the Navy and Coast Guard under a $1-million contract.

Fairchild Stratos Corp., Hagerstown, Md., will sponsor research in subsonic aeronautics at Princeton University. Princeton's Dept. of Aeronautics Engineering will investigate and test new flight concepts, including non-rotary wing vertical and short takeoff and landing (V/STOL) aircraft. Fairchild Stratos will support studies related to new flight concepts, including wind tunnel and prototype tests when they are needed.

FIRST EXPLOSION PROOF VENTILATING PORTABLE HEATER



AAF Model H40 Explosion Proof Trailer Mounted Heater

NEW AAF ENVIRONICS ACHIEVEMENT Now in production for the Air Force and available in quantity for purging jet fuel tanks, supplying heated air in situations of extreme fire and explosion danger. Designed for use in Class I Group D atmospheres, Class I Division I hazardous locations. Triple over-riding controls limit temperature of all heated parts. Unit is grounded against static electrical buildup, and exposed surfaces are coated to prevent ferrous sparks. Ventilating air blower is fabricated from non-sparking materials throughout. Designed to meet Mil-E-4970 Environmental and Mil-H-27507 Performance specifications.

The new H40 is rated at 100,000 btu/hr at –20° F, with a ventilating air output of 600 cfm at 12 in. wc, 1150 cfm free flow. Discharge air temperature can be manually selected from 0° F to 200° F. Heater operates entirely on 220/440 vac, 3-phase, 60-cycle electric power.

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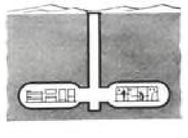


Developed by the engineers who created Minuteman's environment control system. With contract for Wing I accomplished, AAF and its subcontractors are now completing installation on Wing II, Ellsworth AFB, S. D.

PROGRESS REPORT ON HYBRID ROCKET MOTOR DEVELOPMENT AT UTC

■ Hybrid rocket motors, which commonly use high-energy solid fuel and liquid oxidizers, offer the potential of very high performance coupled with simplified on-off capability and modulated thrust. Hybrid motors could be important for a variety of tasks ranging from large segmented booster engines — alone or in clusters — to tiny attitude control units for space vehicles and propulsion back-packs for spacemen.

■ Hybrid motors offer certain specific advantages: they have higher I_{sp} (specific impulse) than either solid propellant motors or current storable liquid rocket engines; only one oxidizer flow valve is involved, therefore hybrids can be built that are easier to handle than liquid engines — easier to throttle, start and stop, even in space; they come in smaller, less complicated packages than comparable liquid fuel engines, because more than half the "plumbing" is eliminated; and a hybrid engine will operate normally regardless of chamber pressure, initial grain temperature, or cracks, flaws or voids in the grain.

■ Because the hybrid's fuel is separated from its oxidizer, it is much more economical to produce and is safer to handle than propellants which already contain an oxidizer. Large hybrid grains can easily be segmented for transportation to assembly site. And clusters of hybrids could be "idled" at low throttle to permit pre-flight inspection prior to liftoff.

■ UTC has been interested in hybrid rocket motors since the company's formation — a long time on the aerospace clock. Over a year ago, UTC test-fired a 10,000-pound-thrust hybrid motor at its huge Development Center at Coyote, California. The success of this test spurred follow-up studies at UTC, which ranged from literally thousands of small-bore stability firings to prolonged (over 600 seconds) duration tests.

■ On company-funded programs, as well as under Navy, USAF and ARPA contracts, UTC has designed, built, and tested a variety of hybrid rocket motors. A year ago, state-of-the-art hybrids were plagued with uneven burning. Now smooth, stable combustion has been achieved.

■ A space-storable hybrid motor which UTC designed for upper-stage applications has demonstrated higher I_{sp} than any storable rocket propulsion device yet tested in the 1000-pound thrust range.

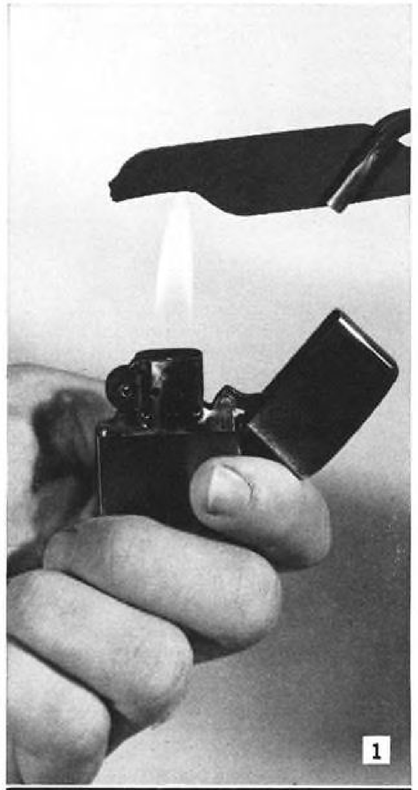
■ UTC's extensive research, development, and test facilities both at its Sunnyvale headquarters and at its sprawling Coyote Development Center are manned by widely-experienced scientists and management personnel. They have the finest modern equipment at their disposal, as well as the talent and resources of the entire Center. Moreover, the support of the parent company, United Aircraft, is a real asset to UTC.

■ Hybrid motors are not expected to replace either solid or liquid propellant rocket motors now in use. Advanced assignments that impose limitations beyond the design of current systems will determine the hybrid's future role. They form the natural bridge between UTC's activities in space-storable liquid propellant rocket engines and its solid propellant rocket motor program, which includes the role of prime contractor for the first stage of USAF Titan III C.

UNITED TECHNOLOGY CENTER

SUNNYVALE, CALIFORNIA

DIVISION OF UNITED AIRCRAFT CORPORATION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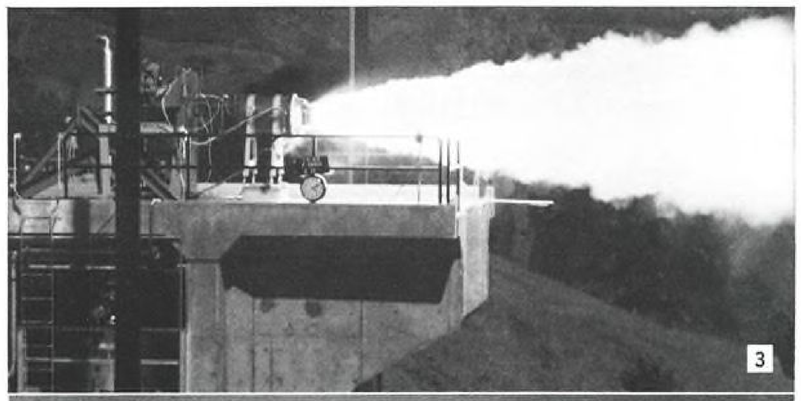
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1. HYBRID FUEL DOGBONE is exposed to bare flame, yet will not burn. It will ignite hypergolically when oxidizer is applied. Because there is little danger of inadvertent ignition, processing and handling problems are greatly reduced for hybrid motor grains.

■

2. STEADY BURNING, shown in bottom photo, is possible now with UTC's advanced fuels. Top photo shows uneven burning which cost hybrids up to 25% of potential energy as recently as two years ago.

■

3. 10,000-LB.-THRUST HYBRID rocket motor was fired at UTC's huge Development Center near Coyote, California, early in 1962. This fully successful firing culminated early research and gave powerful impetus to a continuing hybrid program at UTC.

■

4. VERY HIGH PERFORMANCE fuel and oxidizer provide this segmented 5" hybrid rocket motor with over 800 lbs. of thrust in a recent test firing.

■

5. 12-INCH HYBRID MOTOR undergoes one of a series of firings in the 1,000-lb. thrust range. Numerous tests show that even major cracks in the surface of the grain have no effect at all on combustion because the hybrid's active combustion zone is away from the surface of the grain.

■

6. SMALL HYBRID TEST MOTOR is an off-the-shelf item at UTC. More than 10,000 firings without failure show its reliability.

SKMR-1 HYDROSKIMMER is built by Bell Aerosystems to be rugged enough to withstand a State 3 sea.

Aviation Week Pilot Report:

Seaplane Rating Aids Hydroskimmer Pilot

By Larry Booda

Buffalo—It is a matter of debate whether the Bell Aerosystems SKMR-1 Hydroskimmer ground effects machine (GEM) is flown or driven, but for this AVIATION WEEK & SPACE TECHNOLOGY pilot there is no doubt that it is flown.

This vehicle, being developed under a Navy Bureau of Ships contract, operates on an air cushion at altitudes ranging from 12-24 in. It has an aircraft cockpit, and aerodynamic rudders control direction at higher forward speeds. Aerodynamic lift fans create the air cushion, propellers furnish forward and reverse thrust, and a stick controls attitude in both pitch and roll axes.

More important, reactions of an aircraft pilot, particularly one with seaplane experience, are highly desirable when high speeds are attained. And Bell has assigned aircraft test pilots, rather than boat handlers, to the project.

Despite the features that resemble those of aircraft, SKMR-1 embodies hull design and ruggedness principles of hydrodynamic craft that permit it to operate in relatively rough water.

The Hydroskimmer, which passed its acceptance trials in August, is a research and development craft. It is not a prototype for later production, because the Navy intends to investigate the entire operating regime before committing itself to the expense of production.

The idea of air cushion vehicles is not new, but the possibilities of a GEM of relatively large size are still unknown. The Navy has potential requirements for such a vehicle in anti-submarine warfare, and the Marine Corps, for whom the Navy procures weapon systems, sees it as a possible amphibious landing craft that could be beached and move inland. Bell has studied an alternate commercial configuration, which would carry 60-75 passengers on inland waterways.

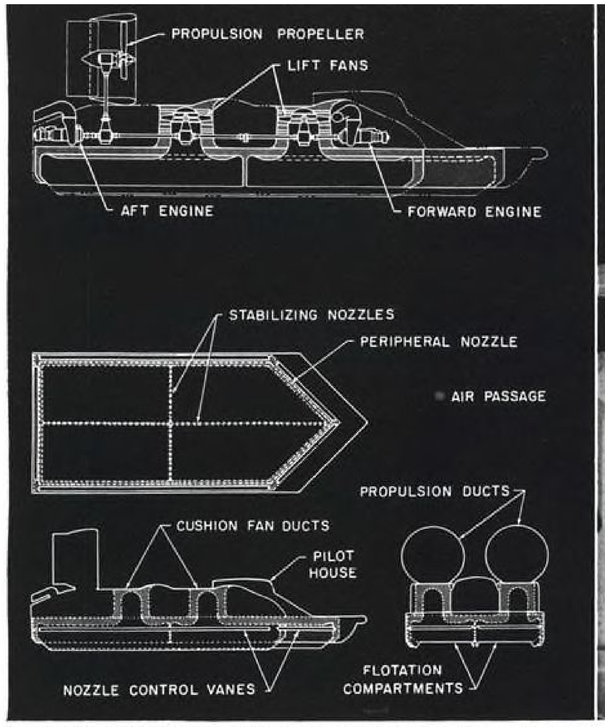
SKMR-1 is 65.5 ft. long, 27 ft. at the beam and 23.5 ft. high at the top of the shrouds of the ducted propellers. With fuel for an hour's operation and carrying six persons, it will gross more than 45,000 lb. and will ride the air cushion 24 in. above the surface of land or water. It can be loaded with more fuel or payload up to 75,000 lb. At that weight it would ride 12 in. above the surface.

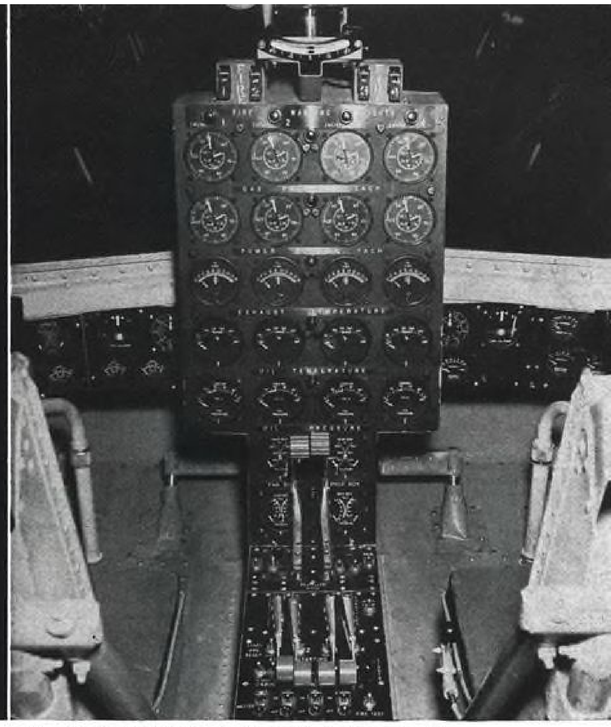
Bell signed a Phase 3 agreement with the Navy late in September to conduct two months of testing that will help the Navy write specifications for future GEMs. In the first part of the tests, the craft will be operated without extension of the ducts that guide the air from the lift fans downward around the periphery of the vehicle and then 45 deg. inward to create the air cushion.

Trunks will be added for the second part of the tests. These trunks are made of flexible, semi-rigid material. They will be rigid enough to guide the air down from the source, yet flexible enough to give when they encounter waves or ground protuberances, thus enabling the vehicle to ride 3-4 ft. in the air.

In addition to the peripheral nozzle, the vehicle has stabilizing nozzles that run fore and aft and from side to side, dividing the underside of the craft into four compartments, which form the main structural element. The total air cushion area they enclose is 1,225 sq. ft. The stabilizing nozzles take 2% of this area and peripheral nozzles, 5%.

There are four lift fans, one fore and one aft on each side. The lift fans are interconnected with the ducted propeller on the same side. Two Solar Saturn marine free shaft gas turbines using JP-5 fuel and rated at 1,080 hp. each at 1,800 rpm. furnish the power for each





FOUR LIFT FANS (diagram, left) are mounted one fore and one aft on each side. Cockpit (right) is similar to that of an aircraft.

side. They turn the 169-lb. cushion fans which are 6.5 ft. in diameter. The fans, built by General Dynamics Electric Boat, are made of glass fiber. Variable pitch guide vanes permit the air flow to be adjusted.

The 10 ft. dia. three-bladed aluminum ducted propellers are manufactured by Hamilton Standard.

Attitude is controlled by the action of butterfly valves around the peripheral nozzles. By moving the stick, the airflow is slightly changed to produce nose-up and nose-down and side-to-side movements.

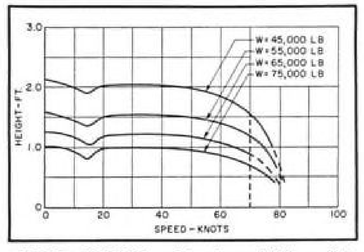
Structural specifications for the SKMR-1 are such that it can operate in a state three sea, which describes a 7-10-kt. wind and slightly breaking wavelets and whitecaps. It is capable of withstanding pressures of 60 psi. at the bow. The basic structural material is aluminum, with the exception of the superstructure, including the cab, which is made of glass fiber, and the deck, which is a balsawood core faced with aluminum. Light structural weight has been achieved by using aircraft construction techniques for the main elements.

Most of the load is carried by the four flotation compartments and connecting members. The lower surface consists of integrally stiffened aluminum extrusions. The lower surface is fabricated from stiffened skin panels extending the full length of each compartment between the beams. Transverse framing varies between 19 and 27 in. depending on local loads. There are flotation compartments fore and aft, each separated into smaller sections by full depth watertight bulkheads. The bow is attached to fittings at the top and bottom of the forward flotation compartment.

Lift fans, pylon trusses and propellers, engines and cabin are truss-mounted through the horizontal air passage to the beams and frames inside the hull.

The Saturn engines were designed specifically for marine use and have been used by the Navy to power small boats and emergency electric generators. Engine mounts are redesigned to conserve weight; and oil tanks are designed to aid de-aeration so that less oil need be carried.

Engine air is fed from the air cushion fan plenum chamber through a York Demister which separates water from the air. Some efficiency is lost because of temperature rise in the engine compartment, but this is more than offset by the supercharging effect of the cushion fan air and relative air dryness.



SPEED, HEIGHT and load capabilities of the SKMR-1 are shown in graph, above.

JP-5 fuel is stored in four 400-gal. tanks. This is enough fuel to provide 4 hr. of operation at maximum power—1,800 rpm. The tanks are arranged so that there is a minimum of shift in the center of gravity as fuel is used.

The engine compartments are equipped with a fire extinguishing system operated from the cockpit.

The Hydroskimmer can be operated equally well from either left or right seats, although the project pilots prefer the right side because the propeller pitch indicators are on that side, and they give the operator a display of the amount of forward, reverse or differential thrust he has applied.

This pilot sat in the left seat, with Allard G. Russell, director of flight research, occupying the right seat for the demonstration ride. The site was a small hangar on Buffalo Port Authority waterfront land a short distance from the downtown part of the city. Bell operates the SKMR-1 and a smaller company GEM, the Carabao, from the facility.

Weather conditions the day of the ride were ideal for demonstrating the ruggedness of the vehicle. The wind was blowing steadily at 30 kt. from the south, which made it nearly parallel to the breakwater-enclosed harbor. The waves inside the harbor were about 1 ft. higher while the whitecapped waves on Lake Erie outside were 2 to 3 ft. high.

SKMR-1 was taken from the hangar to the ramp outside by an oversize

straddle truck specially designed for the job. The ramp is the same as a seaplane ramp with a gradual slope into the water.

The vehicle is boarded from a portable stairway wheeled to the rear of the center platform. In walking the length of the platform, you first pass under the ducted propellers and then past the engine and fan housings on both sides. A single door leads to the cockpit area which BuShips prefers to call the pilot house.

Rear Compartment

Instrumentation and communications equipment is installed in the rear compartment of the cockpit area. In the cockpit itself, the two pilot seats flank a control pedestal. To the rear on each side are seats holding six persons, each provided with a safety belt.

The pilot and copilot seats are about 2 ft. from the side windows. The forward windows are large and equipped with heavy duty wipers.

A single instrument panel runs vertically along the centerline under the windshields. From top to bottom the instruments are: four gas-producer tachometers, four power turbine tachometers, four exhaust temperature gages, four oil temperature gages, four oil pressure gages, fan and propeller gear box temperature gages, inclinometer, magnetic compass and indicated air speed. A horizontal display on the pilot's side contains propeller pitch, Doppler ground speed indicator, a turn and bank indicator and a gyrosyn compass indicator.

Center Pedestal

The center pedestal has electric switches, four handles for power control and two handles for controlling propeller pitch.

The Doppler speed indications come from two 45-deg. depressed, police-type radars, one pointing to the wake and the other to the side. Doppler is necessary because the indicated air speed is useless for navigation when going upwind or downwind. The side-looking radar provides translation, or skidding, speeds.

The vehicle is started automatically with available battery power. There has been no hot start of the Saturn engines in the history of the SKMR-1.

No attempt has been made to soundproof the cockpit area, as would be done in production craft. As a result the inside noise level at full power is 105 db., and ear protectors are worn by the passengers.

Pilots and engineer are protected by their earphones.

In this research vehicle, the four power levers are operated on pilot voice command by the engineer, who can reach the pedestal from the lower deck level behind the flight deck. Careful power adjustments are necessary because engine governors are not installed. A production craft would have them, permitting one-man craft operation.

As power is applied the craft rises. Forward motion is imparted to the craft by moving the two propeller pitch levers forward. Speed down the ramp is 25 to 30 kt. so that spray will not be kicked up in front.

Forward Propulsion

When propeller pitch is moved forward, power for forward propulsion is taken from that applied to lift. Speed is gained rapidly. On four runs made by this pilot, backstopped by Russell, the ground speed averaged 63 kt. downwind and 54 kt. upwind.

In making a standing start, spray envelopes the vehicle, and the only visibility is through the wiped portion of the windshield. Back stick pressure is exerted to raise the nose as forward pitch is applied. The spray disappears immediately. At speeds over 25 kt. spray is completely aft of the vehicle.

As speed is gained the stick is eased forward. The ideal attitude at high speeds is nose down, giving the feeling of a toboggan ride. The over-all flight effect is that of taxiing a seaplane with the hull riding high in the water while planing on the step.

Entering turns is uncomfortable for an aircraft pilot because there is a great deal of skid, although some banking can be done with the stick. Maximum performance turns are done with pronounced skids. Deliberate rocking of the craft with the stick was tried. The air cushion damps out any overcontrol so that no part of the craft digs in.

Turns while stopped but hovering are made with a minimum of differential propeller pitch. Settled in the water, however, full differential pitch and added power over idle are needed to turn.

Russell took the craft through the harbor entrance into Lake Erie to demonstrate its capabilities in rough water. There was considerable bucking and spray but the vehicle still achieved 40 kt.

The sea state was considerably higher than the design limit, but the air cushion effectively smoothed the waves under the craft.

Approach to the ramp was made at 25 kt. with the strong wind on the starboard quarter. The climb up the ramp was made at the same speed, and engine stopping and rundown was rapid.

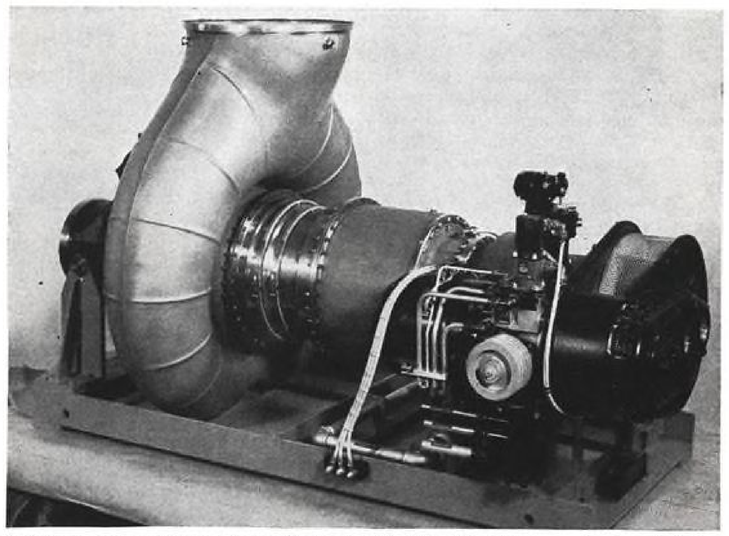
Check Lists

The checkoff lists used for the Hydroskimmer are simple and can be accomplished in less than 1 min.

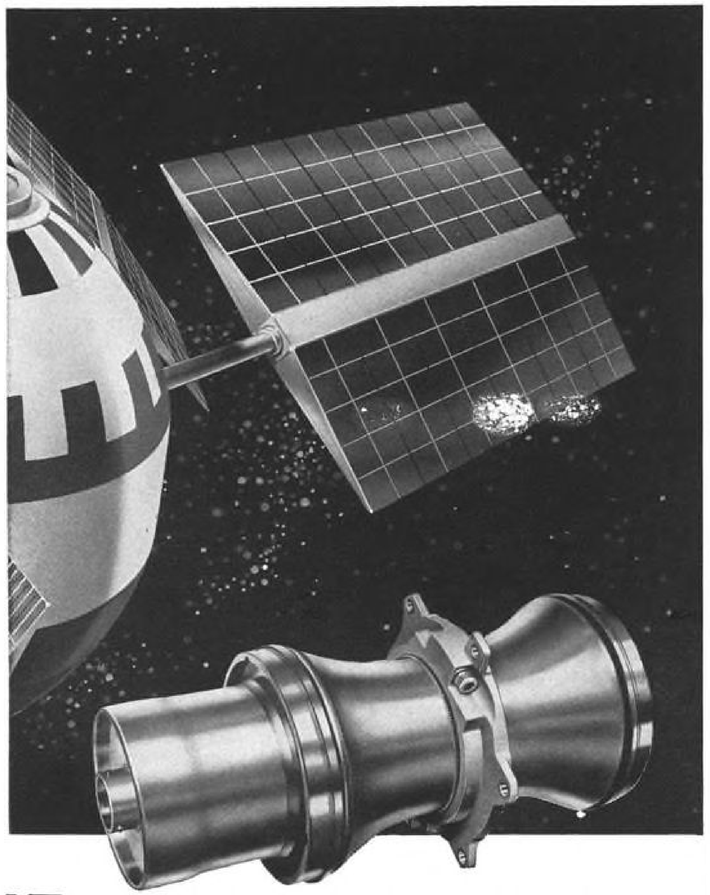
BuShips wants to fill gaps in its knowledge with the SKMR-1, specifically in the areas of rough water control, stability, maneuverability, structures, spray and noise.

It will also provide a craft to evaluate the air cushion vehicle concept for military applications to hasten acceptance of these vehicles as military craft.

Requirements for crew training will also be evaluated. Non-aircraft pilot personnel can be trained to operate the craft, but they will have to receive considerable indoctrination in operating the Hydroskimmer at higher speeds in restricted areas, when quick reactions are



POWER FOR LIFT FANS and propellers is furnished by Solar Saturn marine free shaft turbine engines. Two engines on a side power the interconnected two fans and propeller on that side. Engines burn JP-5 fuel. De-aeration of oil permits use of smaller oil tanks.



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necessary. Reaction times needed are comparable to that required for aircraft takeoffs and landings, rather than operation of surface vessels.

The most attractive features of the Hydroskimmer from the military standpoint are high speed, ability to operate at zero draft, amphibious capability and large load-carrying capability when compared with a helicopter.

The general rule of thumb applied to GEM vehicles is that they can "fly" at one-tenth of their diameter. A 200 ft. diameter vehicle, for example, could travel 20 ft. over the surface. By applying such developments as trunks or skirts, the proportion can be made smaller. Some engineers say that it can be reduced to one-fifth as the state of the art progresses.

The Navy will have to settle an internal division of opinion regarding GEMs and hydrofoil craft, which ride out of the water on foils. The hydrofoils have been in development much longer and commercial hydrofoils are operating many places in the world. Ground effect machines are relatively new and will need considerable time for testing and evaluation.

The original development contract for the SKMR-1 amounted to $2 million. This paid for the construction and flight test program through acceptance. Two additional contracts were signed in September. One, for testing the vehicle with direct ducting, amounts to $224,473. It was completed in November. The second contract, for $200,000, covers testing with the trunks installed and will be completed in December. At that point, the craft will be turned over to the Navy for testing in Chesapeake Bay.

The Navy's Bureau of Weapons is administering the contract for the Bureau of Ships. The plant representative is Lawrence J. Cummings. The BuShips project officer is Lt. J. R. Gauthey.

Project manager at Bell is Anthony E. Mirty. The chief test pilot is David W. Howe.

Mooney Sales Backlog

Mooney Aircraft, Inc., is starting its 1964 sales year with a backlog of approximately $4 million, absorbing production through February, 1964. Sales in the next year of the Kerrville, Tex., company's three four-place models are expected to establish a new Mooney record of approximately $9.5 million in factory net billings, compared to approximately $6.5 million for 1963.

Next year, 600 units are scheduled to be produced, compared with 502 in 1963.

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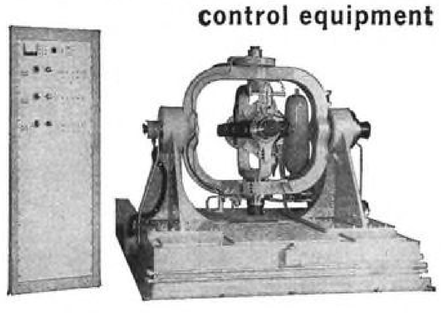

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Russians Seek Boost For Private Aviation

Russia's aviation enthusiasts are calling for relaxation of government regulations and less red tape to encourage the design, construction and testing of experimental aircraft by individuals or Soviet aero clubs.

Requests are also being made in the USSR for authorization of "tourist aviation" which would be roughly comparable to private flying activity in Western nations.

Russian aircraft designers A. S. Yakovlev and O. K. Antonov have urged the government to drop some of the many rules that now present almost insurmountable problems for experimental aircraft builders. Antonov has been especially emphatic in supporting a greater degree of freedom for aviation enthusiasts.

Yevgeny Loginov, chief of the Russian airline, Aeroflot, also has expressed approval, in principle, of amateur aircraft design activities. But he favors continued strict government supervision of construction and tight control of test flights.

Gloomy Future

The Soviet magazine Tekhnika Molodezhi reports that a number of experimental aircraft have recently been built and illegally tested in the USSR, but adds that their future is not bright.

"Main difficulty is that we haven't organized and legalized air tourism," the magazine noted. "Consequently, any amateur aircraft building project either dies before birth or is doomed to wither away. The sky is closed to it."

Among the experimental aircraft built or being developed in Russia are a single-place autogyro weighing 550 lb. and powered by a 28-hp. motor; a two-place, "tourist" autogyro with a 57-hp. motor; midget helicopters, including a strap-on model, and lightplanes.

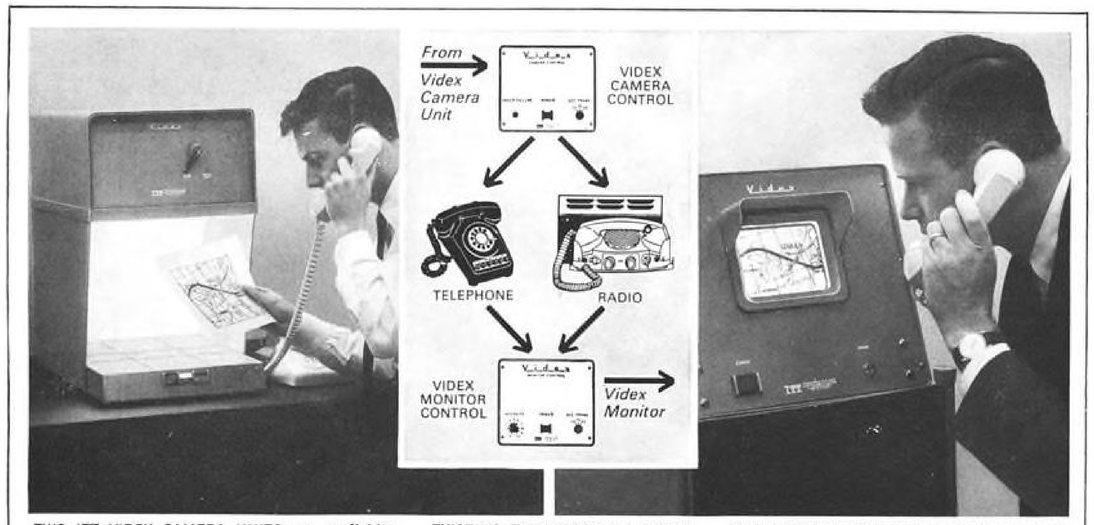
Original Lightplane

The fate of an original lightplane built by three amateur designers and named the "Leningradets" (Leningrader) illustrates the problems encountered by Soviet experimental aircraft enthusiasts.

The "Leningradets" is a high-wing, single-place monoplane, 16 ft. long and with a 23-ft. wing span. Weighing about 880 lb., it is powered by a 60-hp. engine and can fly at 75 mph.

According to Tekhnika Molodezhi, the "Leningradets" has excellent stability, is practically spin-proof and has a record range for its weight class.

But the head of the Leningrad Aviation Sports Club, which is under the jurisdiction of the USSR's huge, semi-



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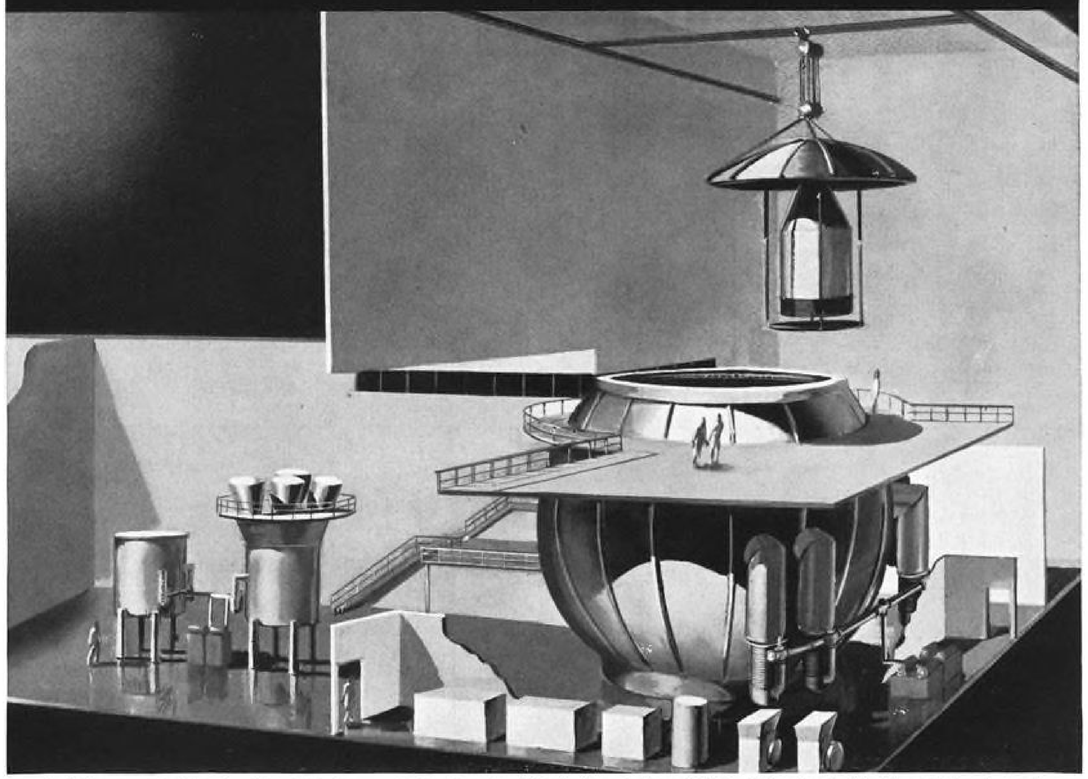

Artist's concept of Douglas Aircraft Environmental Test Center. Sketch shows test model of vehicle attached to lid and being lowered into 39′ Stokes chamber. To the left are two Stokes "5 x 5s." One is shown with the solar simulator now being designed for it.

The Stokes Space System Department has been named prime contractor for the design and installation of three new space environment simulation chambers, key elements in Douglas Aircraft Corporation's privately financed Space Systems Center at Huntington Beach, California. The largest and most technically advanced space-test laboratory on the West Coast, the Center will be an integral part of Douglas' Missile and Space System Division.

The largest chamber, 39 ft. in diameter, will be capable of testing fully assembled vehicles scheduled for manned flight. It will be used in the Saturn program, and in the development of lunar and planetary probe vehicles. The Stokes systems will represent the most advanced state-of-the-art on completion, and are designed for updating to even higher simulation parameters in the future. Stokes units similar to these are now achieving vacuums in the 10^{-10} Torr. range. High-speed cryopumping on all three chambers at 20°K will assure the attainment of true orbital vacuums, even under high gas loads. Stokes has assigned CryoVac, Inc. the design, fabrication and installation of cryogenic systems, and named Pittsburgh-Des Moines Steel Company to furnish and erect the large steel sphere.

A deciding factor in the selection of the prime contractor was Stokes' experience in designing and building large, first-of-a-kind space test facilities, such as those installed at G.E.'s Space Technology Center. Another was Stokes' related background in space vacuum and cryogenics, as represented by General Electric's and Goddard's SES and DTC systems. To this experience, Stokes adds its long and successful history in the development of large-scale industrial equipment utilizing ultra-high vacuum, thorough engineering design and coordination, fabrication facilities, and field erection service . . . an integrated, start-to-finish capability unique in the entire area of space environment simulation. **Space Systems Department, F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.**

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military DOSAAF organization (Voluntary Society for Assisting the Army, Air Force and Navy), ordered that the craft be impounded and that nobody be allowed near it.

Shortly thereafter, the Central Committee of DOSAAF sent a letter to the chairman of the USSR Council of Ministers' State Committee for Aviation Technology, Comrade P. V. Dementyev.

In the letter he said:

"The 'Leningradets' airplane, as shown by its flying characteristics, can be used successfully by DOSAAF to establish a distance record for planes in the first weight category. We request you to authorize us to put the 'Leningradets' in flying condition, compile the necessary technical documentation for it, and carry out flight tests."

Still Impounded

But, Tekhnika Molodezhi noted, the plane remained impounded. The magazine added:

"Why? It turns out that it is subject to the regulation which provides that scientific-research organizations must test three finished copies of new aircraft at ultimate loads—one copy to be tested to destruction in the strength laboratory, and the second and third copies to be thoroughly flight tested. (This is similar to the regulation covering new Russian commercial transports and other large aircraft.)

"But can amateur, experimental aircraft builders themselves be expected to build the three copies required for the tests? Surely the trials could be limited to testing one copy of the 'Leningradets' at 67% of the ultimate load provided in the standard specifications.

Destruction Tests

"If the plane passes these tests, fine. It simply isn't necessary to go further in destruction tests. If it doesn't pass the 67% test it means the design is faulty, and the craft isn't suitable for production."

Tekhnika Molodezhi said it talked with A. Makelnikov, head of the Leningrad Aviation Sports Club, to see if he could help the builders of the "Leningradets." Makelnikov replied:

"The USSR Air Code says that all aircraft must undergo testing by the scientific-research institutes and get a license.

"We have looked at the 'Leningradets.' It's a good plane.

"Flight tests were made in it despite the regulations. True, I didn't fly it. They would have had my head if I had done so. We are all for airplanes such as this, although everything must be done legally."

Tekhnika Molodezhi said that Makelnikov was so afraid of repercussions from above that he refused to provide

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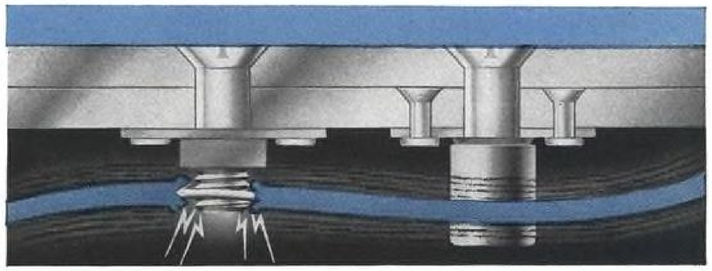
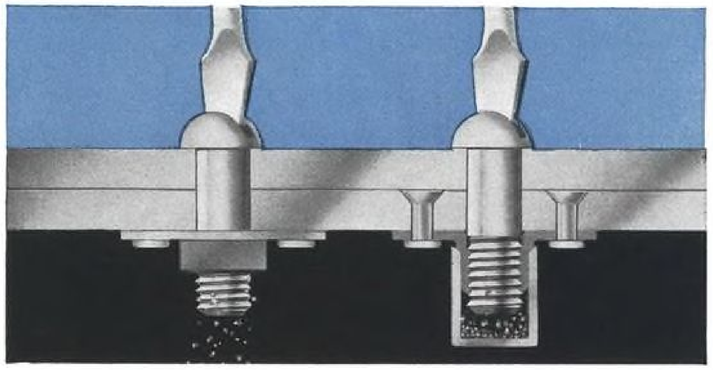


Above—Boots capped locknuts increase assembly reliability under conditions of vibration by preventing the abrasive removal of insulation from wires near protruding bolt threads.

Below—Boots capped locknuts provide protection for delicate exposed circuits by effectively trapping metallic flakes or other fallout resulting from assembly of screw and nut.



Other advantages—Boots capped locknuts prevent damage from over-length screws, provide liquid seal in tanks, give neat appearance, make possible ease of inspection when provided with probe hole and protect threads from galling in high temperature and corrosive atmospheres. A-286 stainless types have low magnetic permeability. Write for literature which describes types and wide ranges of regular and miniature sizes.

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a parachute for the amateur test pilots who flew the plane "illegally."

Makelnikov said: "I don't have the right to provide a parachute. What if the plane should crash?"

"That," Tekhnika Molodezhi commented, "is iron-clad logic for you. The illegal flights were made anyway, and nothing happened. But if trouble had developed which required use of a parachute, Makelnikov's conscience would have been 'clear.'

"So now a guard walks back and forth in front of a shed with locked doors. It contains the 'illegitimate' airplane which, specialists assert, could easily set a world record. Both the plane and the record are being well protected."

156-in. Solids Adapted To Multiple Purposes

Adaption of 156-in.-dia. solid-propellant motor segments as building blocks to create multi-purpose launch vehicles has been suggested to Air Force and Defense Dept. officials. Feasibility demonstrations of the 156-in. motor currently are being conducted by Thiokol Chemical Corp. and Lockheed Propulsion Co. for the USAF Space Systems Div.'s Program 623A.

The presentation to USAF and the Defense Dept., made by Lockheed Missiles and Space Co. planners, outlined three basic configurations to meet categories of a weapon system booster and a standard launch vehicle.

• **Three-stage arrangement.** Its first stage would have a 156-in.-dia. center segment plus two end caps, or closure pieces. The second stage would be comprised only of two end caps, each containing propellants. The third stage would use a storable liquid propellant. This vehicle could boost a 30,000-lb. payload to a target approximately 6,500-naut. mi. away.

Cost of the vehicle is estimated at about $4 million.

• **Three-stage configuration**, using first and second stages as in the vehicle above, would have an Agena D as the third stage. This vehicle would be capable of lofting a 30,000-lb. payload into a 100-naut. mi. polar orbit. Cost also would be about $4 million.

This three-stage configuration also is presented as an economical space booster to fill the gap between the Atlas Agena, with an 8,000-lb. payload capability, and the Titan 3, which is planned for a capability of up to 28,000 lb. The argument is that for this gap range the cost with the 156-in.-Agena combination to put a pound of payload into orbit would be substantially less than with Titan 3. However, 120-in. motor segments, now under development by United Technology Center for the Titan 3, also could be combined to loft payloads in that range.

• **Four-stage configuration** would incorporate two 120-in.-dia. strap-on solids as the first stage, the two bottom 156-in. stages of the three-stage vehicles described above—as the second and third stages, respectively—and an advanced Agena as the fourth stage. Its payload capability would be about 42,000 lb. for a 100-naut. mi. polar orbit. Vehicle cost is estimated at about $6 million.

Soviet Claim of Polaris Equivalent Questioned

London—Soviet Union has a force of fleet ballistic missiles but it is doubtful whether Soviet claims that it has developed an equivalent to Polaris can yet be taken literally, according to the Institute for Strategic Studies.

The Institute, in its fifth annual report on the military balance between Western and Eastern powers, said Soviet defense policy has changed little in two years but the slow build-up of intercontinental ballistic missiles is continuing. It would appear, the Institute continued, that deployment of medium-range ballistic missiles has now reached completion.

Defense expenditures have increased slightly, due to emphasis on research and development, and the Institute said it is notable that the USSR is continuing procurement of medium-range supersonic bombers "which are clearly expected to continue in service for the foreseeable future."

There are also a number of policy developments which indicate a change of emphasis, and to some extent, force levels.

Increasing influence of officers with a scientific background is the most important.

The Institute claims that the test ban treaty is likely to inhibit Soviet development in the one field where the USSR is inferior to the U. S.—the production of very low yield nuclear weapons. The report contended:

"The treaty may inhibit the anti-ballistic missile program; but it would appear that the Soviet Union has resigned itself to a period without any effective defense against missiles and believes that the same will be true of the United States.

"This resignation seems to be a part of the general Soviet approach to the present strategic confrontation: it appears that the Soviet authorities are debating future policy in terms of their own resources and of the current strategic controversies within NATO before they decide whether any large reorien-

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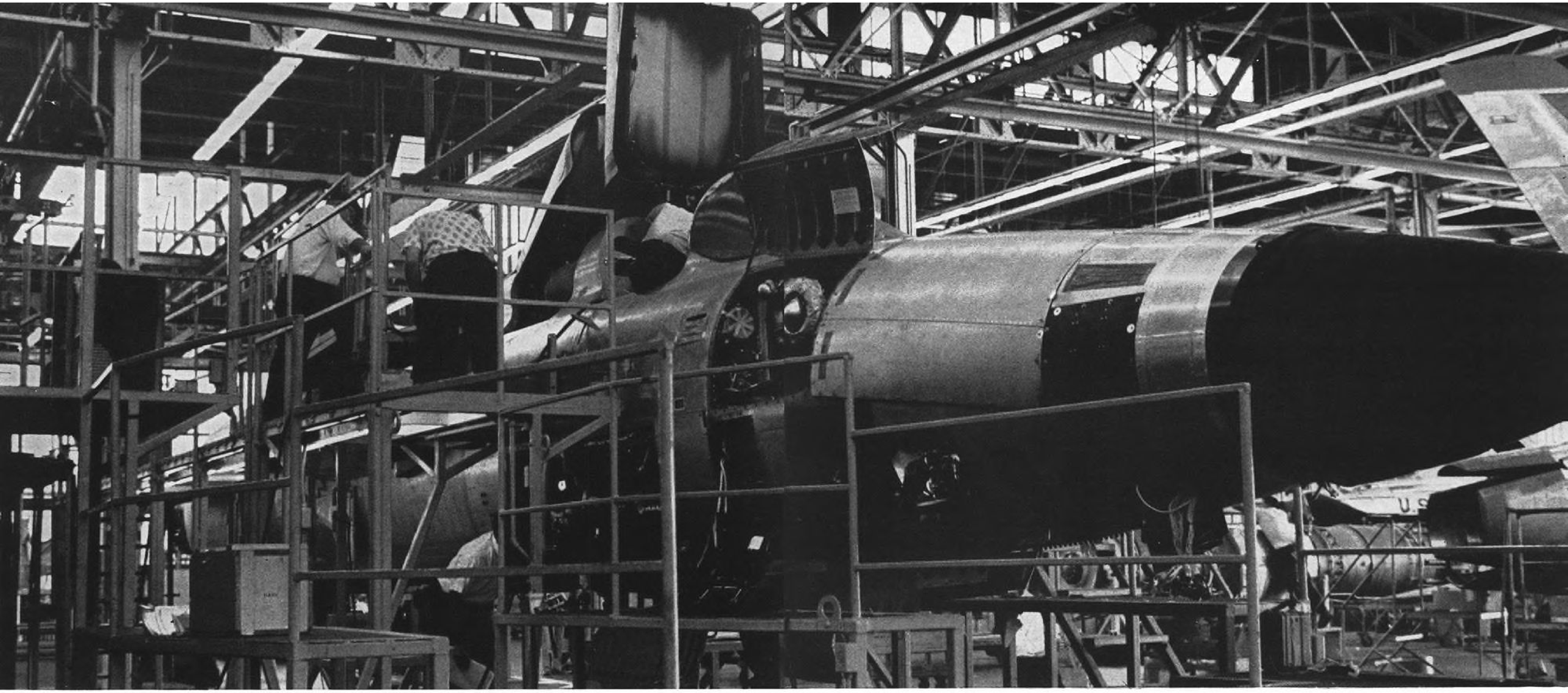

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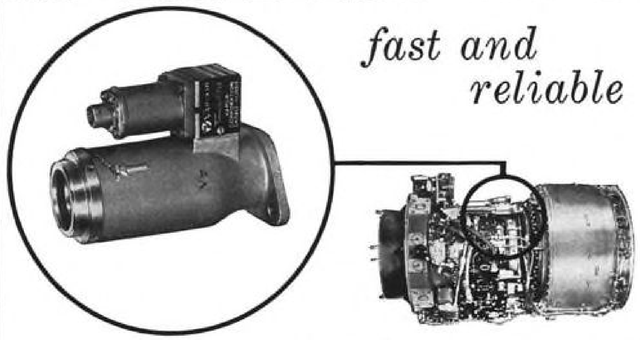

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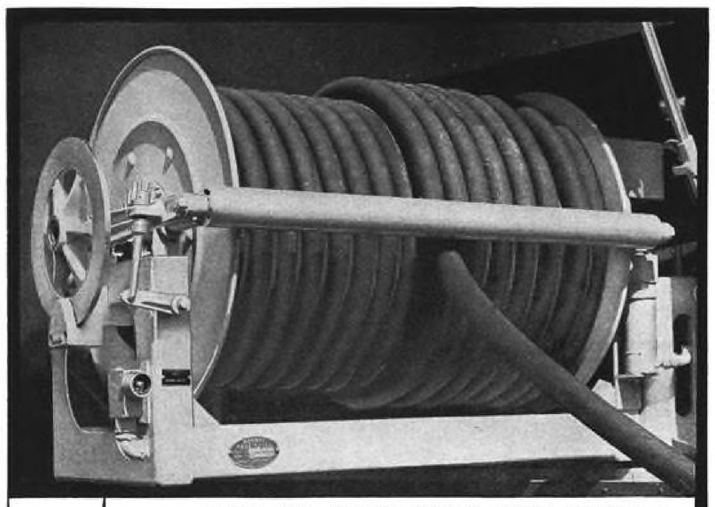

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tation of their own policy is necessary."

The Soviet defense budget for 1963 shows an increase of about 4% over the preceding year, to about $15.4 billion.

Since this does not reflect costs of space or defense research, the Institute thinks a more realistic figure is about $34 billion.

The Soviet Union now has about 100 operational ICBMs but it is not known how many are second generation, using a storable liquid fuel. A number of ICBM sites now have been hardened, but the policy relies to a great extent on concealment and active defense measures for protection.

MRBM Force

Its MRBM force also has been stabilized by the Soviet Union at 750 deployed, to deal with strategic and semi-tactical targets in Western Europe, Great Britain and in the Far East. An intermediate range ballistic missile force in which the weapon has a two-stage, liquid-fueled engine with a range of 2,100 mi., is still building up. Soviet missile forces are now under command of Marshal Krylov.

In the Soviet Air Force, operational strength is now 12,500 aircraft organized into five components: a long-range strategic bomber force, tactical fighters and bombers, fighter interceptors, the land-based fleet air arm and the air transport force.

The strategic strike force breaks down this way:

- **70 Tu-20 Bear turboprops** now able to carry a large winged missile, and four-jet Bisons. The Bisons also can carry large winged missiles.
- **1,000 twin-jet Tu-16 Badger** medium bombers in addition to about 400 Badgers assigned to the Naval Air Force for ship attack.
- **Supersonic medium bomber,** the Blinder, now coming into service with a long-range air to ground missile. It probably is a replacement for the Badger.

Soviet Bombers

In tactical ranges, the USSR has about 3,000 bombers. The Flashlight B with a transonic capability and range of 570 mi. has entered service, and a follow-on, the supersonic Firebar A, is now operational.

For the fighter command, the Institute says that the MiG 23 Flipper may now also be in service, with a top speed of about Mach 2.5.

According to the Institute, the USSR now has 20 nuclear-powered submarines and at least 30 missile-carrying subs with a strategic role in the Arctic and Far East fleets. It is not known what proportion of these can launch while submerged.

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Firms' Reports Show Sales, Earnings Gain

Selected year-end and nine month-fiscal reports from major aerospace companies show, with few exceptions, an over-all gain in both sales and earnings during the year.

United Aircraft Corp. had sales of $942.5 million and earnings of nearly $15.2 million—equal to $2.20 a share of common stock—for the first nine months of the year. During the same period last year, United Aircraft had sales of $887 million with net earnings of $12 million, equal to $1.72 a share of common stock.

The order backlog, including government letters of intent, declined from $1 billion on Sept. 30, 1962, to $975 million on the same date this year.

NAA's Report

North American Aviation's senior vice-president and treasurer, R. A. Lambeth, said net income for the company, including wholly-owned subsidiaries, totaled nearly $41.2 million on sales of $1.868 billion for Fiscal 1963, which ended Sept. 30. That was a 14% increase in sales and a 21% increase in earnings over those of the preceding fiscal year.

North American's order backlog dropped from $1 billion on Sept. 30, 1962, to $949 million on last Sept. 30, Lambeth said.

Lockheed Aircraft Corp.'s Board Chairman Courtlandt S. Gross and President Daniel J. Haughton reported the firm's ratio of earnings to sales for the nine months ending Sept. 29 rose from 2.1% for the 1962 period to 2.4%. Sales increased 9% from $1.260 billion for a comparable 1962 period to $1.375 billion for the first three quarters of 1963.

Lockheed Profits

Nine-month profits this year totaled $32.6 million. Gross said that it was the best in Lockheed's history and a 23% increase over last year's nine-month profits which were in the amount of $26.5 million.

Per-share earnings for the first nine months of 1963 were $3.07, compared with $2.55 per share for the same period last year. According to Lockheed, more than half of its business is under incentive contracts with an opportunity to improve profits through improved performance.

The company says that the outlook is favorable for 1963 sales in excess of $1.9 billion.

The company's funded backlog on Sept. 29 was $1.6 billion, compared with the company's backlog of $1.5 billion the year before.

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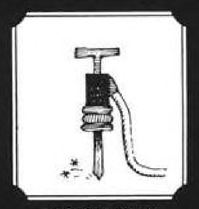

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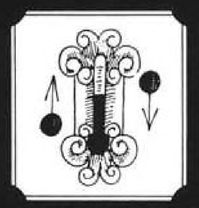

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dated net earnings for the nine months ending Sept. 30 were nearly $4.8 million excluding a non-recurring $600,000 special charge relating to years before 1961.

Profits for a comparable period last year were $4.75 million.

Sales for the nine-month period were $204.1 million this year compared with $184.8 million for a comparable period last year.

Due to the non-recurring expense this year, per share earnings totaled 93 cents for both periods.

Other Reports

Other nine-month reports of aerospace companies showed:

• **General Dynamics Corp.** earned $41.9 million, equal to $4.19 a share, on sales of $1.036 billion for the first nine months of the year. Comparable figures last year showed General Dynamics with $34 million, or $3.40 a share, earned on sales of nearly $1.5 billion.

• **Boeing Co.** showed a net profit of $14 million, or $1.75 a share, on sales of $1.314 billion for the first nine months. Last year, nine-month earnings were $21.6 million, or $2.70 a share, on sales of $1.268 billion. Earnings to sales ratio for the 1963 period was 1.07 compared with 1.70 the year before. Boeing President William M. Allen blamed R&D and other costs associated with the the 727 short-to-medium haul transport and the Model 107 helicopter programs for the drop in earnings. Order backlog rose from $1.62 billion on Sept. 30, 1962, to $2 billion on that date this year.

• **Republic Aviation Corp.** and subsidiaries show earnings on Sept. 30 of $4 million, or $1.43 a share, on sales of $269.2 million.

Comparable figures for the company for last year show $3.4 million, or $1.19 a share earned on sales of $187.8 million.

Sept. 30 order backlog stood at $337 million.

Fairchild Earnings

• **Fairchild Stratos Corp.'s** earnings for the nine months which ended Sept. 30 reflect earnings in the second and third quarters which offset the $1.3 million deficit reported for the first quarter (AW Sept. 9, p. 85). Fairchild Stratos reports nine-month earnings of $178,000 on sales of $42.8 million compared with 1962 nine-month totals of $2.2 million earned on sales that amounted to $50.5 million.

The company said its effort to capture an increasing part of the missile and space market has raised its order backlog to 40% of its total business compared with 5% of its total business two years ago.

Star Track: 263′ of precision by Philadelphia Gear

One of the largest and most precise radio telescope antenna gear tracks ever produced is nearing completion now at Philadelphia Gear. It will measure 84′ in diameter; 263′ in circumference.

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CAB Accident Investigation Report:

Ditched DC-7C Is Evacuated Successfully

A Northwest Airlines DC-7C, N 285, was ditched near Biorka Island, Sitka Sound, Alaska, on Oct. 22, 1962, about 2052 GMT[1]. All 95 passengers and 7 crew members successfully evacuated and were quickly rescued. No serious injuries were reported.

The flight was operating as Military Air Transport Charter Flight No. 293 en route from McChord Air Force Base, Tacoma, Wash., to Elmendorf AFB, Anchorage, Alaska. While cruising at an altitude of 20,000 ft. No. 2 engine lost power. Remedial measures failed, the propeller oversped and the engine seized. Attempts at feathering failed and the flight radioed a declaration of emergency and started descent toward Sitka Sound, Alaska. Other futile attempts were made to feather as the No. 2 engine became dangerously hot and shed parts. The captain elected to ditch. Passengers were moved aft and away from the plane of rotation of No. 2 propeller, crew members issued ditching instructions, and occupants and flotation gear were readied. The aircraft was put down skillfully under favorable conditions of weather and sea during daylight, and all occupants were quickly in liferafts. Previously alerted marine craft were nearby and took all hands aboard. Amphibious rescue aircraft were also close by. The aircraft sank in water 250 ft. deep in about 24 min.

The Board determines that the probable cause of the accident was an uncontrollable overspeeding propeller due to failure in the blower section of No. 2 engine.

INVESTIGATION

A Northwest Airlines DC-7C, N 285, operating as Military Air Transport Service Charter Flight No. 293, was ditched in Sitka Sound, Alaska, about 1 mi. off Biorka Island, on Oct. 22, 1962, at 2052 GMT. There were no fatalities, and no serious injuries were reported to Board personnel by any of the 95 passengers or by any of the 7 crew members.

The flight was planned nonstop from McChord AFB, Tacoma, Wash., to Elmendorf AFB, Anchorage, Alaska. The crew consisted of Capt. Vinton R. Hanson, Check Pilot Francis H. Kellogg, First Officer Earl C. Perry, Flight Engineer Donald E. Hackett, Steward Richard D. Chinnock, and Stewardesses Ruth E. Fullerton and Kathryn E. Ollinger.

The crew arrived at the Seattle-Tacoma International Airport early in the morning of Oct. 22. They planned the flight, checked the weather at the company's dispatching office, and reviewed ditching procedures at this airport. The crew then went by taxicab to McChord AFB.

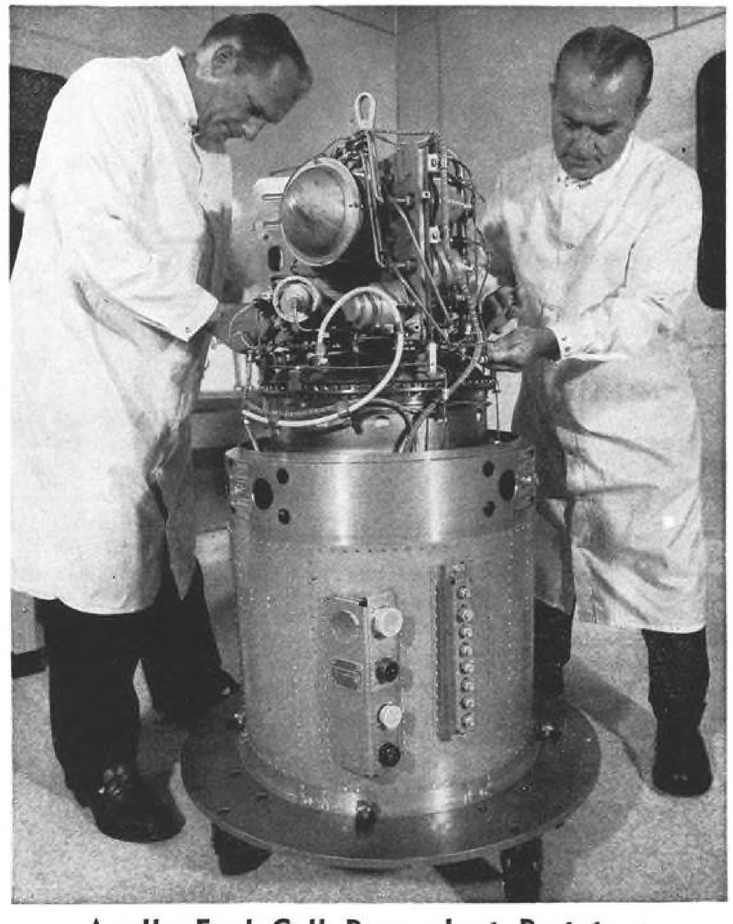
At McChord the captain filed an Instrument Flight Rules (IFR) flight plan requesting a cruising altitude of 14,000 ft. and indicating an estimated flight time of 5 hr. and 16 min. The gross weight of the aircraft was computed as 125,340 lb. (maximum permissible for takeoff was 127,070 lb.) and the center of gravity was located within prescribed limits.

Flight Engineer Hackett conducted a preflight inspection of the aircraft. The engine pre-takeoff checks indicated that the powerplants, including the propellers, were functioning satisfactorily.

Takeoff was at 1658, and the aircraft was climbed continuously to its planned 14,000-ft. cruising altitude. Cruise power was established and the aircraft proceeded on course.

Approximately 2 hr. after takeoff and some 40-50 mi. past Sandspit, British Columbia, the flight encountered light to moderate icing conditions in clouds. Induction system icing caused fluctuations in the Brake Mean Effective Pressure (BMEP) and Manifold Pressure (MAP) gauge readings of all engines, and ice collected on the airframe. Use of carburetor alcohol proved adequate to cope with the engine icing. However, because of the ice accumulation on the airframe, Sandspit Radio was asked for weather information. Sandspit replied that other aircraft had reported ice at 8,000 to 10,000,

[1] All times herein are Greenwich Mean based on the 24-hour clock.



Apollo Fuel Cell Powerplant Prototype

Prototype fuel cell powerplant for the Apollo mission is checked by technicians of Pratt & Whitney Aircraft, developing the system for the Space and Information Systems Div. of North American Aviation, Inc., prime contractor for NASA's command and service modules. Optional fuel cells also will supply on-board electrical needs for LEM. White and black plug-like attachments on lower casing appear to be electrical and fluid interfacings.

Marine Aviator of the Year

COLONEL MICHAEL R. YUNCK

For his contributions to Marine Aviation as a pilot, as Pacific Missile Range Liaison Officer, and Air Group Commander, Colonel Michael R. Yunck has been named recipient of the Alfred A. Cunningham Award as Marine Aviator of 1963.

The award was earned through Colonel Yunck's demonstration of professional skill and resourcefulness directed toward the advancement of Marine Aviation in these areas:

- **Phantom II Data Link / Airborne Tactical Data System Development**
- **Bullpup Missile Control System Development**
- **Development Tests with Phantom II for Short Airfield Tactical Support Operation**
- **Hawk Battery Training Facility Activation**
- **Development of an Improved Supersonic High Energy Climb Schedule for the Phantom II**
- **Development of "Low & Slow" Fighter Tactics for Limited War and Helicopter Escort**
- **As Pilot, Accomplished the Longest Non-Refueled Phantom II Flight on Record**

Colonel Yunck is the second recipient of the Cunningham Award given by the First Marine Aviation Force Veterans Association. Last year, Marine Lt. Colonel John H. Glenn earned Marine Aviator of the Year honors for his three-orbit flight in a McDonnell Mercury Spacecraft.

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14,000 and 16,000 ft., light ice at 18,000 ft. and no ice at 20,000 ft.

Upon receipt of this information, at 1944, the flight requested a change of altitude to 20,000 ft. This was approved, the engines were placed in high blower, and climb was started. Shortly thereafter Maximum Except Takeoff (METO) power was used because of ice on the aircraft. During its 1952 report by the Domestic Annette Intersection, a compulsory reporting point, the flight reported its altitude as 20,000 ft. At this time the flight was still in the clouds.

Immediately after reaching 20,000 ft. the flight engineer started adjusting settings for cruise power. He changed the settings for No. 1 engine, then No. 4, and was about to start on No. 2 engine when it lost power. This loss of power was initially from 172 BMEP to 80 and then to 50, the lower limit of the indicator. However, the ignition analyzer showed no breakdown in combustion. Believing the trouble was due to carburetor icing, the flight engineer and the co-pilot applied alcohol and heat, first separately, then together, but these actions were ineffective. Since the other engines were operating normally the flight engineer then used emergency fuel enrichment to restore power in the No. 2 engine. This action also was ineffective, and at this time he observed the No. 2 propeller starting to overspeed. This happened an estimated 30-60 sec. after the initial power loss. He immediately tried to feather No. 2 propeller, but it would not feather. The overspeed reached about 3,300 rpm. at this time according to the engineer, and 3,400 rpm., according to the captain. The time was 2004 and the aircraft was then about 127 mi. west of Annette Island Airport and 121 mi. south-southeast of Sitka. Power was reduced, the aircraft was slowed to 150-155 kt., and engine rpm. maintained at 2,600 in order to minimize the overspeed condition.

During continued attempts to feather the No. 2 propeller the oil quantity dropped rapidly and the normal oil supply was depleted. Oil was then transferred from the auxiliary tank and this was similarly depleted. Subsequently the rpm., BMEP, fuel, and oil pressure gauge readings dropped to zero; however, the propeller continued to rotate. The captain immediately reduced power and placed the aircraft in a descent in order to be near the water in the event immediate ditching became necessary.

Meanwhile, First Officer Perry was making radio calls on the emergency frequency of 121.5 mcs. He received answers which were "cluttered," so he made MAYDAY calls four or five times to clear the emergency frequency and described the flight's predicament. He and the captain conferred on the heading to be flown and decided to head for the southern tip of Baranof Island, some 70 mi. distant. The first officer gave the captain the proper heading. The aircraft, still descending and still in the overcast, was turned to that heading.

The first officer continued to monitor flight progress, using radar and other aids. He also made numerous radio calls including contact with a Pacific Northern Airlines flight, Sitka radio, and Coast Guard.

At an altitude of about 6,000 ft. the water surface first became visible. At 4,000 ft. good visual contact was established with the water. Descent continued until the aircraft was about 500 ft. above the surface. The flight passed the southern tip of Baranof Island and continued toward Biorka Island, in Sitka Sound, at that altitude.

Many radio contacts were made by the first officer to determine weather conditions at the nearest airport or suitable landfall which the aircraft might reach while maintaining the low altitude required for the anticipated imminent ditching.

Upon nearing Biorka Island the captain remarked to the first officer that the nose section of No. 2 engine was cherry red and throwing off metal particles. Other crew members also observed this condition. The captain immediately ditched the aircraft on a heading of 300-330 deg. and at a speed of about 95 kt. The first officer had fully extended the wing flaps and turned off all electrical power when the aircraft was 15 or 20 ft. above the water. The time of ditching was 2052.

Initial water contact was smooth and was quickly followed by two impacts, the first light, the second heavier. The aircraft quickly slowed to a stop and floated high in a smooth sea with no visible damage other than bent propeller blades.

The 2000 weather observation by the Coast Guard Cutter *Sorrel*, standing by at the ditching site, showed in part an overcast of nimbostratus and stratus, visibility less than 7 mi., wind calm, temperature 47F. The 2200 *Sorrel* observation showed a stratocumulus overcast, visibility less than 20 mi.,

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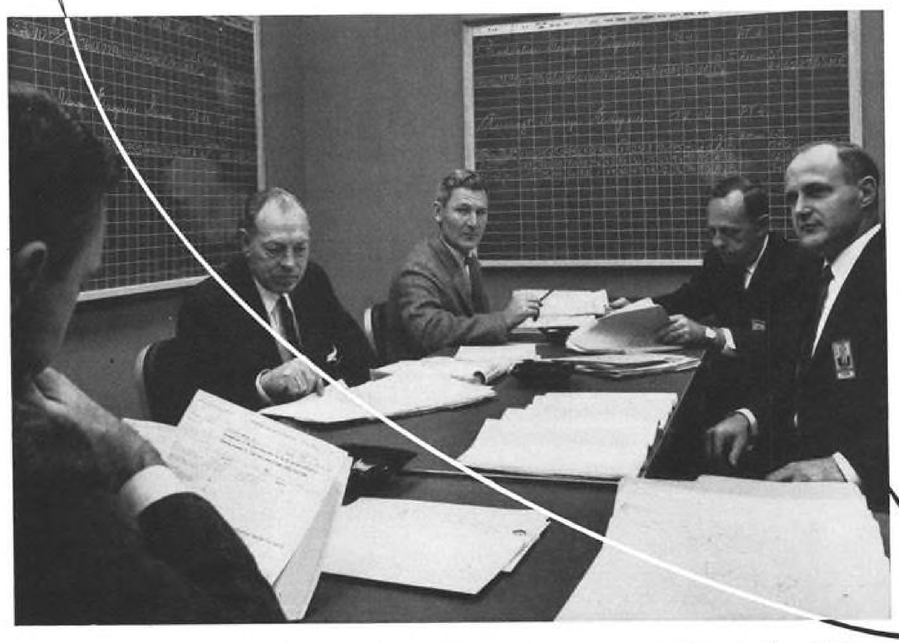

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wind calm, temperature 53F, sea water surface temperature 56F, moderate swell from the west, calm or slight sea. The aircraft sank in an estimated 24 min. in water 250 ft. deep at position 56 deg., 52 min., 48 sec., North 135 deg., 20 min., 20 sec., West.

Preparations for Ditching

Detailed preparations were started when the captain told the steward to prepare for ditching and continued until the actual ditching, about 45 min. later. Recognizing that No. 2 propeller might separate from the engine and penetrate that area, the steward and both stewardesses had 28 passengers move out of the first five rows of seats on the right and the first six rows on the left. These persons were seated in unoccupied seats or on the floor between seats, off the aisle and facing sideways. The seven children aboard were fitted with children's lifevests and distributed strategically, for optimum assistance in leaving the aircraft. All other passengers, as well as the three cabin attendants, wore lifevests. Backs of seats were raised. The passengers were instructed to remove all sharp objects from their persons. These, along with loose objects such as food trays and other galley equipment, arm rests which had been removed from the seats, carry-on baggage, etc., were stowed out of the way so as not to impede evacuation. Passengers were rehearsed in folding their arms and bowing their heads into or toward pillows, blankets or coats in their laps, and told to do this upon signal, just prior to touchdown. Passengers seated near emergency exists were instructed in the method of opening the exits and launching liferafts. Further, the passengers were cautioned not to take such emergency action until advised.

The aircraft carried five 20-man liferafts in the cabin and one 10-man liferaft on the flight deck. Four of the 20-man liferafts were placed for expeditious use and their static lines secured to nearby seats. One was placed at each of the two aft overwing exits, one at the main cabin door, and one at the aft right emergency exit door. The fifth 20-man raft was berth-stowed overhead opposite the galley. The steward again went to the flight deck and informed the crew that the cabin was "fairly well secured." He returned to the cabin and made final checks on the preparations. Check Pilot Kellogg entered the cabin from the flight deck and was followed by Flight Engineer Hackett, as the aircraft started down. The steward used the cabin public address system to tell passengers to assume proper ditching positions and to remain that way until told to get up.

Evacuation

The captain and the first officer, who were alone in the cockpit, launched the 10-man liferaft through the right-hand cockpit window when the aircraft came to rest. Before the captain left he looked in the cabin and saw that everyone had gotten out except one stewardess, who was just then leaving.

When the airplane struck the water the resulting decelerative forces caused the berth-stowed 20-man liferaft and food trays to become dislodged and fall. However, these forces did not cause personal injuries to the aircraft occupants. A few minor injuries were incurred during the actual evacuation.

The check pilot, who had previously gone to the cabin, had taken a seat opposite the main cabin door. He helped launch two liferafts through this door, one of which had been placed there and the other which had fallen from where it had been berth-stowed overhead opposite the galley. He assisted people into them and then boarded the second of the two.

The flight engineer, who also had gone to the cabin, did not have time to take a seat and remained crouched and braced against the galley during the ditching. He assisted in launching the first raft from the main cabin door, helped people into it, and boarded it himself.

The steward and both stewardesses directed and helped cabin occupants to launch the other three 20-man rafts. People who went out through overwing exits stood briefly on the wing before transferring to liferafts. Others evacuated the airplane through the floor level emergency exit door at the aft right side of the cabin. Only a few persons were immersed.

Water depth in the cabin was reported as reaching "knee deep" or "2 ft. deep." Difficulties during evacuation included a partial and brief cluttering or blocking of exits by people, debris, and ropes attached to rafts. Passengers and crew members reported four instances of being unable to find the knife carried on rafts to cut the static line.

Pocket knives were quickly used and tossed from one raft to another.

By 2057, 5 min. after ditching, all occupants were in six rafts; only one raft did not have a crew member in command. There

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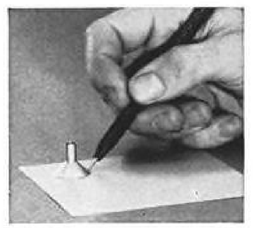

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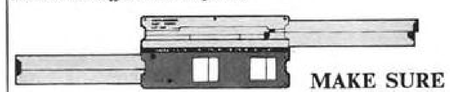

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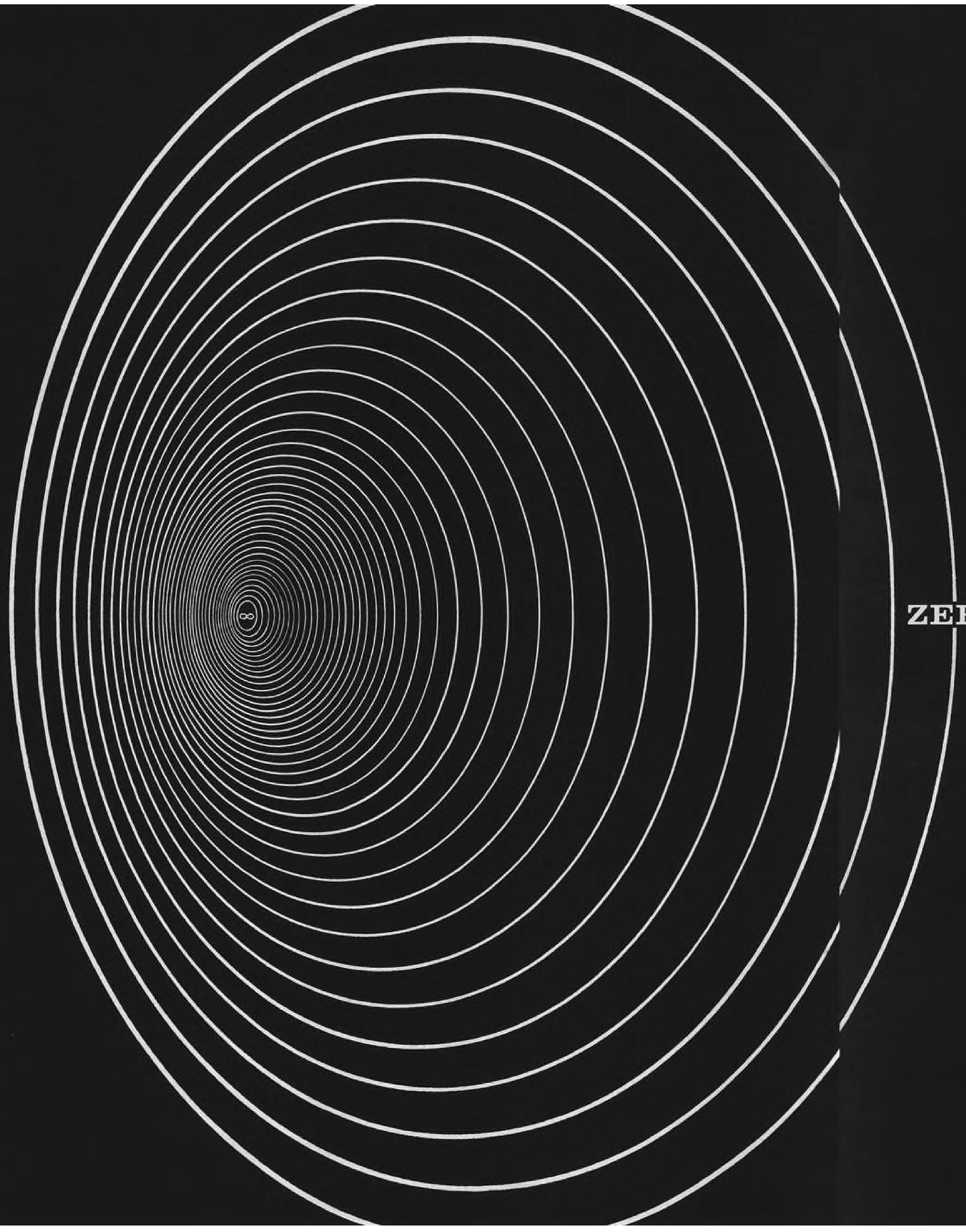

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were two people, captain and first officer, in the 10-man raft, and 29, 28, 18, 15 and 10 persons respectively, in the five 20-man rafts. Within another 20 min. all had been transferred to the FAA launch Fedair I which was standing by with radioed knowledge of the impending ditching. All occupants were then retransferred to the Coast Guard Cutter Sorrel and taken to Sitka. The Sorrel docked there at 2310 and occupants were immediately admitted to the Mt. Edgecumbe Hospital for observation. There were no apparent serious injuries.

Because the failed No. 2 powerplant was not recovered, investigation centered on examination of maintenance records and the observed behavior of this powerplant during the emergency. A detailed review of all such records, of the aircraft and of all four powerplants, showed compliance with FAA requirements as well as with company procedures. No. 2 powerplant and all its components had been operated less than the prescribed limits since overhaul. However, this was the first airborne use of high blower since overhaul. No other significant item appears in the maintenance or operational records of this powerplant.

Analysis

The successful ditching at sea of the DC-7 and the evacuation of all 95 passengers and 7 crew members without injury is, under any circumstances, an outstanding feat. In addition to the skill of the pilots, the efficiency of the ditching is attributable to several factors. These were virtually ideal conditions of wind and sea, crew familiarity with ditching procedures, ample time (some 45 min.) to make ready both the flotation equipment and the passengers, and finally, the military passengers' receptiveness and responsiveness to orders.

Although no serious consequences resulted, there were two matters during the preparation for ditching and evacuation which warrant mention in this report. One, Northwest Airlines provided distinctively colored life jackets for the crew members to make them readily recognizable by passengers. However, the passengers were not advised of this distinction. The other was difficulty experienced in obtaining knives to cut the lanyards tying the rafts to the sinking airplane. Although these lanyards are designed to break as the airplane sinks, knives are provided in pockets on the raft. In this instance it was necessary for passengers to use their personal knives.

Nearest Airport

Investigation disclosed that emergency radio communications between the aircraft, other aircraft, FAA ground stations, and the Coast Guard had been handled expeditiously and cooperatively.

Investigation also disclosed that adequate flotation gear, both lifevests and liferafts, was available.

At the time of the initial trouble the nearest airport with a suitable runway was Annette Island Airport, some 127 mi. distant on a direct easterly course. To proceed to Annette Island Airport the flight would have been required to maintain a minimum altitude of 4,000 ft. in order to clear 3,500-ft. mountains on Prince of Wales Island which was on the direct course. Even if it had been possible to maintain this altitude with the reduced power and the propeller windmilling, the flight would have had to proceed for a short period of time over mountainous terrain which would have precluded a successful emergency landing if such became necessary. To descend to the 500-ft. altitude desired by the pilot in order to provide for expeditious ditching would have required a circuitous route south of Prince of Wales Island, thus increasing the distance by some 40 mi. This course would also have required that the descent to visual flight conditions be made back through some of the icing conditions that the flight had attempted to avoid. The crew did learn that the weather at Sitka, 121 mi. distant when trouble started, was good, and proceeded there despite Sitka not having an airport, but merely seaplane facilities. Gustavus Airport, some 95 mi. beyond Sitka, had good weather and it was the captain's intent to continue there if possible. This was precluded by the rapid deterioration of No. 2 powerplant with attendant fire and structural hazard.

The crew initially diagnosed the large power loss as resulting from carburetor ice, and carried out the ice elimination procedures. The aircraft had been experiencing induction icing for some 2 hr. and the airframe was also carrying considerable ice at the time of the engine trouble, so it was logical for the crew to assume that the initial power loss was caused by induction icing.

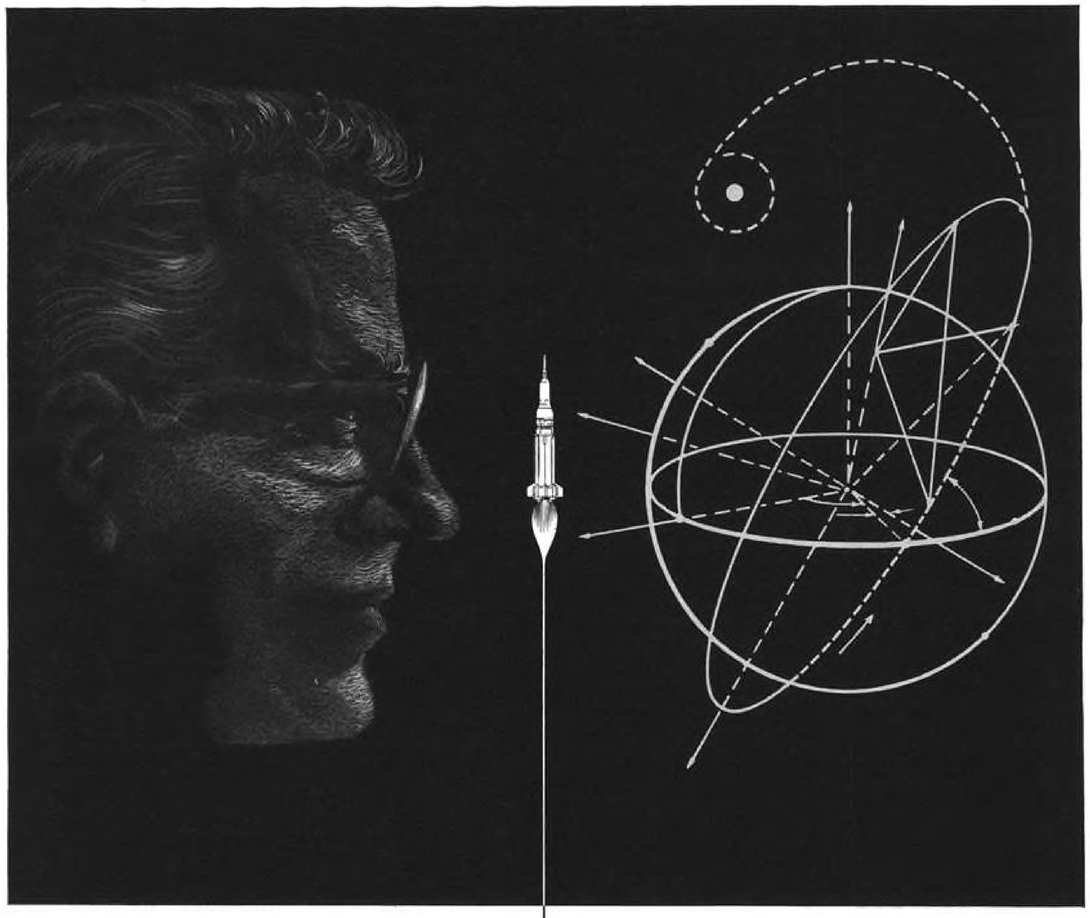
The crew estimated that the period of time from the initial power loss to the overspeed was approximately 30 to 60 sec.

Immediate Feathering

The sequence of events of the malfunctioning of the No. 2 powerplant assembly indicates that a failure occurred to components in the two-speed supercharger drive assembly. Failures in this assembly result in sudden and large losses of power as most of the supercharging effect in the engine is lost. Associated with this type of failure, the BMEP and manifold pressure drop suddenly, with the manifold pressure indications returning to ambient pressure; however, the BMEP will continue to drop to the low limit of the indicator, as happened in this instance. If the propeller is not feathered immediately, numerous metal particles are quickly circulated with the oil through the engine, damaging many bearings, bushings and other parts.

A failure of this type dictates fast and accurate diagnosis and immediate feathering of the propeller. However, the previous indications of induction icing made it unlikely that the crew would initially suspect failure in the supercharger section since, due to the similarity of these symptoms, the initial indications of such a failure would also indicate that the engine was experiencing induction icing.

The failure in the No. 2 engine started with the loss of BMEP from 172 to 80 and finally to 50, the limit of the indicator. This indicates that the drives in the supercharger gear train were becoming disengaged, probably due to failure of bushings and/or gears. Metal particles generated by these failures would cause failures of the accessory drives and their bushings and they would cease to operate. This is substantiated by cockpit indications of the loss



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If you have a degree and experience in one or more of the disciplines listed on the page opposite, investigate the potential of a career with Chrysler.

Send your resume, in complete confidence, to Section A-1, Personnel Department, at the location of your choice:

P. O. Box 26018, New Orleans 26, La.
P. O. Box 857, Huntsville, Ala.
800 Astronaut Blvd., Cape Canaveral, Fla.

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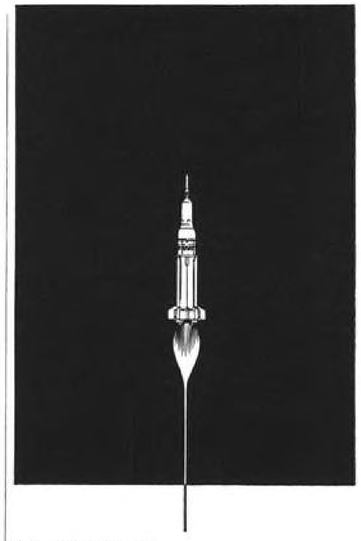

Immediate openings in:

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Aerothermo Mechanics (aerodynamic testing, analysis, stability and air loads; wind tunnel model design; heat-transfer studies; thermodynamics of power systems and cryogenic storage; aerothermo research in theoretical gas dynamics and computer programs.) Flight Mechanics (trajectory analysis, optimization and staging, guidance and control, orbital and space rendezvous mechanics, evaluation of overall performance, launch and separation dynamics, celestial mechanics, elastic body feedback stability, elastic body wind response and dynamic analysis.)

ELECTRICAL and ELECTRONICS

Electromechanical design of space vehicle equipment for power distribution and switching, control and measuring networks; electrical design of power supplies, voltage and current regulators and inverters in low power range; cable and harness design for space vehicle, check-out and launch equipment, perform load studies, prepare environmental, acceptance and qualification test specifications complying with MIL-Specifications and Standards, and prepare and interpret design criteria.

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Design, development and launch site operations in the areas of: propulsion, propellants and pressurization systems; guidance and navigation; mechanical and ground support equipment; electrical and electronic systems.

PROGRAMMERS

Analog Computation (structural dynamics, aero and astro dynamics, control and guidance systems and closed loop hardware simulation.) Digital Computation (information retrieval, data reduction, scientific computation in trajectory analysis, aerodynamic heating, structural and vibration analysis aerodynamics.) Digital Programming to generate large-scale data processing control system.

RELIABILITY

Develop analysis methods and techniques; perform analysis in electrical, mechanical, electromechanical, structural, propulsion, systems and other areas; prepare logic equations for use in the Math Model and to reflect changes in system logic; analyze and evaluate test procedures, and histories of test, pre-flight and flight data for computation of reliability attainment factors; provide design support and recommend engineering changes.

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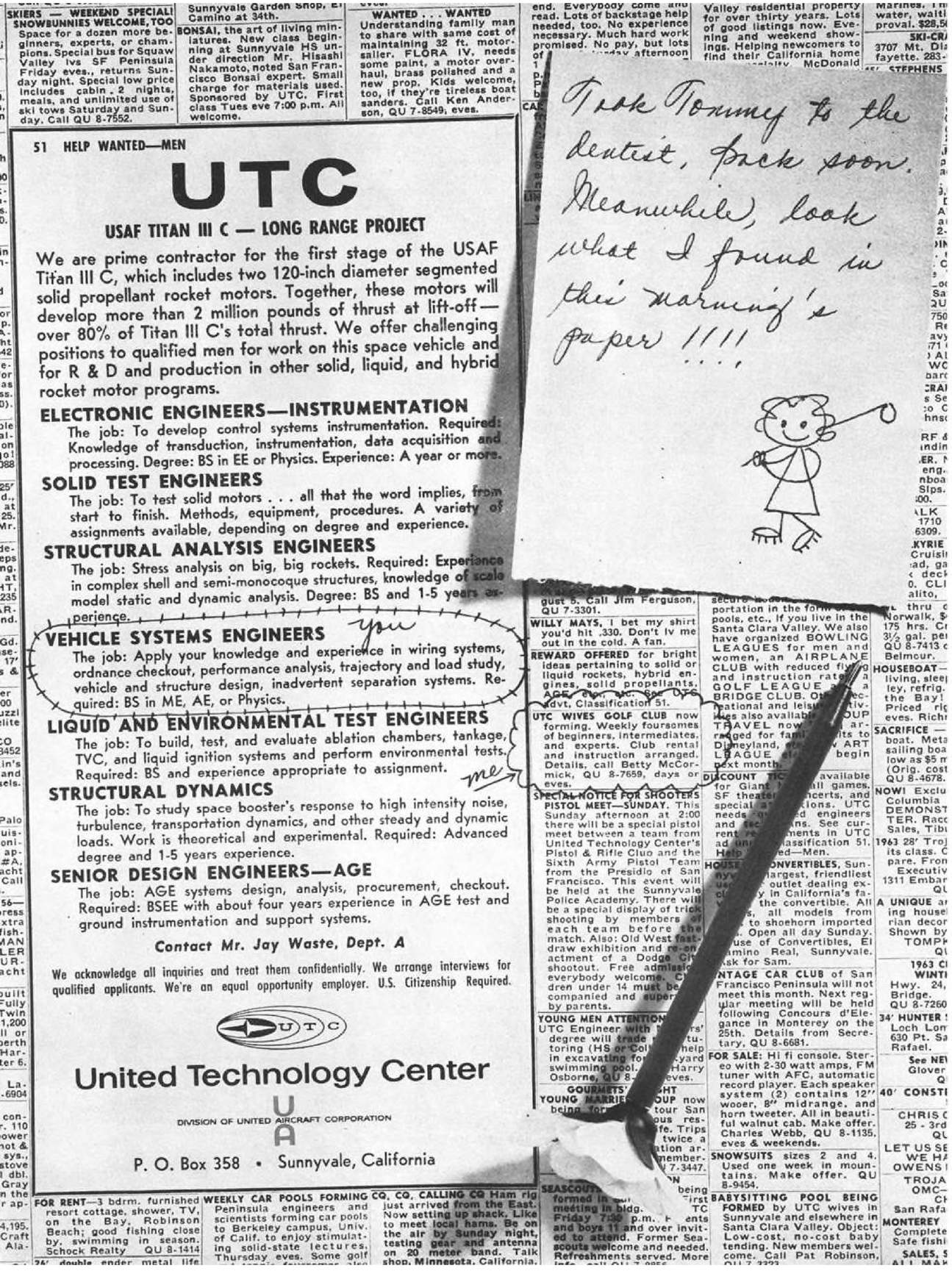

LIFE IN GEORGIA

Southern Couple Comes Home to Bright Future

By: Doris Lockerman
Atlanta Constitution Columnist

Every time the young Thomas F. Roberts of Huntington Woods, near Marietta, Georgia have a chance, they plant trees—maples, dogwoods, magnolias, oaks.

"Then we stand there and try to imagine what they will be like 20 years from now. That tells you how we feel about this place, and our future here."

Tom Roberts met his dark-eyed wife, Martha, when he was a student of mathematics and physics at North Carolina State in Raleigh and she was a Hollins College girl. North Carolina was part of the surge of the New South. As students, they could feel the pace, the promise of the region.

Doris Lockerman

"So, in a way we came home to Georgia when we got the chance." Martha Roberts speaks quietly. "We feel now we are in the heart of everything. We had been so far away in Seattle, Washington."

The Roberts live in one of the dozens of charming small developments that have sprung up in the rolling shaded countryside only a few minutes away from the Lockheed-Georgia plant, a few fast miles to the north of burgeoning Atlanta. Their house has three bedrooms, two baths, a spacious kitchen family room. It is furnished with mellowly beautiful antiques, heirlooms from a discriminating set of grandparents.

Their street is peaceful. The nearest house nestles snugly in a copse of trees, almost hidden from them. Their back yard sweeps toward more woods, with space for play and gardening and outside dining.

"We have never wanted to be closed in," Mrs. Roberts says in explanation. "Robbie is 5. Ruthie is 2. They need playmates, but we respect our privacy and that of our neighbors too. And we are not very close."

Tom Roberts, 30, is a research engineer in Lockheed's Instrumentation division. Martha, 27, has a flair for homemaking and motherhood. She drives Robbie three miles to a private kindergarten where he is becoming adept, among other things, at Spanish. Ruthie is in the tea party stage.

"There is such variety here we feel we will never be tired of it. And change, too, in the business and political climate. We want to be part of this region's progress."

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.

of manifold pressure, fuel pressure, and oil pressure. Furthermore, the ignition analyzer showed no firing by the magneto. The contamination by the initial failure would cause failure of the master rod bearings and reciprocating assemblies. The contamination would also interfere with normal propeller governor action and the propeller would begin to overspeed.

The loss of all normal and emergency oil can also be related to the initial failure in the supercharger drive assembly. The metal contamination would result in failure of the oil pump drives and bushings and the oil would not be returned to the oil tank. Further, the propeller oil transfer bearing in the nose case would similarly begin to fail and the oil being supplied by the auxiliary pump would accumulate in the engine and thus not be available to feather the propeller.

Inability to feather the overspeeding propeller resulted from metal particles in the propeller governor and its by-pass valve as well as a possible failure of the oil transfer bearing and seals. This prevented the routing of the high pressure feathering oil to the propeller pitch changing mechanism.

The propeller assembly installed on the aircraft was equipped with an rpm. sensitive pitch lock mechanism which prevents a propeller from uncontrolled overspeeding. It is evident that the pitch lock did prevent a severe overspeed and the likelihood of catastrophic damage to the aircraft.

Probable Cause

The Board determines that the probable cause of the accident was an uncontrollable overspeeding propeller due to failure in the blower section of No. 2 engine.

By the Civil Aeronautics Board:

ALAN S. BOYD, Chairman
ROBERT T. MURPHY, Vice Chairman
CHAN GURNEY, Member
G. JOSEPH MINETTI, Member
WHITNEY GILLILLAND, Member

SUPPLEMENTAL DATA

Investigation

The Civil Aeronautics Board was notified of the accident at the time of occurrence. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958.

The Carrier

Northwest Airlines, Inc., is a Minnesota corporation with its principal office in Minneapolis, Minn. The corporation holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Federal Aviation Agency. These certificates authorize the carrier to engage in air transportation of persons, cargo and mail over the route involved.

The Aircraft

The aircraft was a Douglas model DC-7C, serial No. 45204, and carried FAA identification N 285. It was manufactured Apr. 5, 1957, and at the time of the accident had a total operational time of 17,175:30 hr. Maintenance had been current and in compliance with FAA requirements.

The four engines were Wright R-3350 model 988TC18EA4 and the propellers

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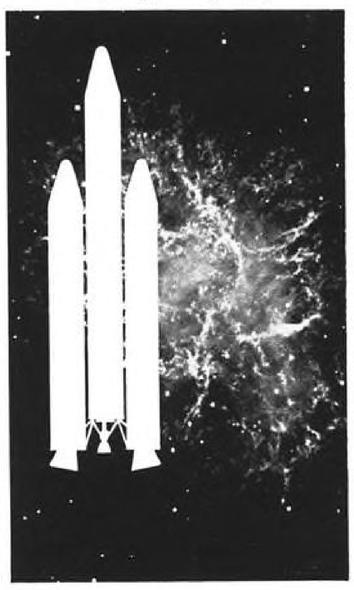

This announcement appears as a matter of record only.

Eastern Air Lines, Inc.

$22,000,000

5⅜% Convertible Junior Subordinated Notes due 1983

These securities have been placed with institutional investors by the undersigned.

$45,000,000

5¼% Promissory Notes due 1967

The undersigned have acted as advisors to the Company in negotiating with institutional investors the agreements pertaining to these securities.

$80,000,000

5¼% Promissory Notes due 1971

$90,000,000

4.15% Promissory Notes due 1974

The undersigned have acted as advisors to the Company in connection with the renegotiation of the terms of these securities.

Kuhn, Loeb & Co. Incorporated

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November 19, 1963

were Hamilton Standard model 34E60-355-P7. Maintenance of powerplants and components had been current and in compliance with FAA requirements. The No. 2 engine and its propeller had operated 202 hr. since overhaul.

Capt. Vinton R. Hanson, age 48, had a total of 15,772 hr. of piloting time, of which 1,579 had been in DC-7s. He was properly certificated, rated, and checked for the subject flight. His rest period, prior to the start of the flight, was in excess of 24 hr. Capt. Hanson had received his last company training in ditching June 22, 1962.

First Officer Earl C. Perry, age 37, had a total of 12,579 hr. of piloting time, of which 1,925 had been in DC-7s. He was properly certificated, rated, and checked for the subject flight. His rest period, prior to the start of this flight, had been in excess of 24 hr.

Flight Engineer Donald E. Hackett, age 48, held a Flight Engineer Certificate. He had flown a total of 11,590 hr., of which 3,126 had been in DC-7s. His periodic and equipment checks were current and he had rested for 24 or more hours prior to the start of this flight.

Capt. (Check Pilot) Francis H. Kellogg, age 44, had a total piloting time of 13,374 hr., of which 948 had been in DC-7s. He was also properly certificated, rated, and checked for this flight. His rest period, prior to departure, had exceeded 24 hr.

All three cabin attendants, Mr. Richard D. Chinnock and Misses Kathryn E. Ollinger and Ruth E. Fullerton were properly qualified for their duties.

SST Control Needs

Washington—Series of simulated supersonic transport flights converging on the busy Los Angeles area has indicated that operation of such aircraft will create new control problems during takeoff and climbout because of greater speeds and faster climb.

National Aeronautics and Space Administration and Federal Aviation Agency cooperated in the flight tests, in which a North American A5A made 21 simulated supersonic transport flights. The flights disclosed:

- **Pilots flying supersonic transports** will have to be given more advance notice of changes in flight procedures, such as holding instructions and altitude changes.
- **In-flight weather advisories** are more important, because changes in outside temperature and pressure greatly influence the times and distances required to accelerate from subsonic to Mach 2 flight.

Flight tests included climb to 30,000 ft. at subsonic speeds; level flight at 50,000 ft. at Mach 1.7, or about 1,120 mph.; letdown at 340 mph.

The A5A was used in simulated flights from NASA's Flight Research Center at Edwards, Calif., because the aircraft has almost the same thrust-to-weight ratio as the supersonic transport at altitudes to 50,000 ft.

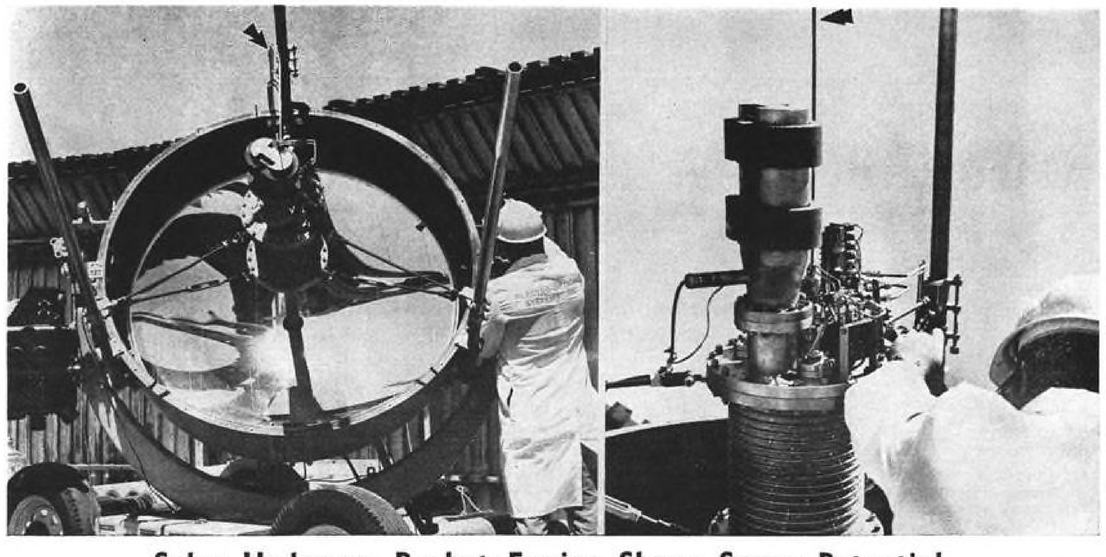
Aerospace Firms Report Compensations

Washington—Following is a list of aerospace industry directors and officers with 1962 salaries above $30,000, and their stockholdings, as they were reported to the Securities and Exchange Commission:

SPERRY RAND CORP.—D. L. Bibby, assistant to the president, director, president-Remington Rand Div., $75,000 salary, 2,170 shares of common stock; **G. M. Bunker,** director (elected Apr. 29, 1963), 5,000 shares of common stock; **N. B. Frost,** director and general counsel, $55,000 salary, 10,017 shares of common stock; **I. J. Harvey, Jr.,** director, 1,082 shares of common stock; **K. R. Herman,** executive vice president and director, $115,000 salary, 29,539 shares of common stock; **C. G. Holschuh,** executive vice president and director, $104,000 salary, 8,261 shares of common stock; **General D. MacArthur,** chairman of the board, director, $68,600 salary, 1,830 shares of common stock; **B. F. Pope,** director, 440 shares of common stock; **H. F. Vickers,** president and chief executive officer, director, $225,000 salary, 155,856 shares of common stock, 5,834 shares of common stock held in reversionary trusts established by Mr. Vickers prior to May 24, 1963; **H. Landsiedel,** director, vice president-Remington Rand Div. (resigned Feb. 1, 1963), $53,000 salary. All salary figures are for the fiscal year ending March 31, 1963. All stock beneficially owned as of May 24, 1963.

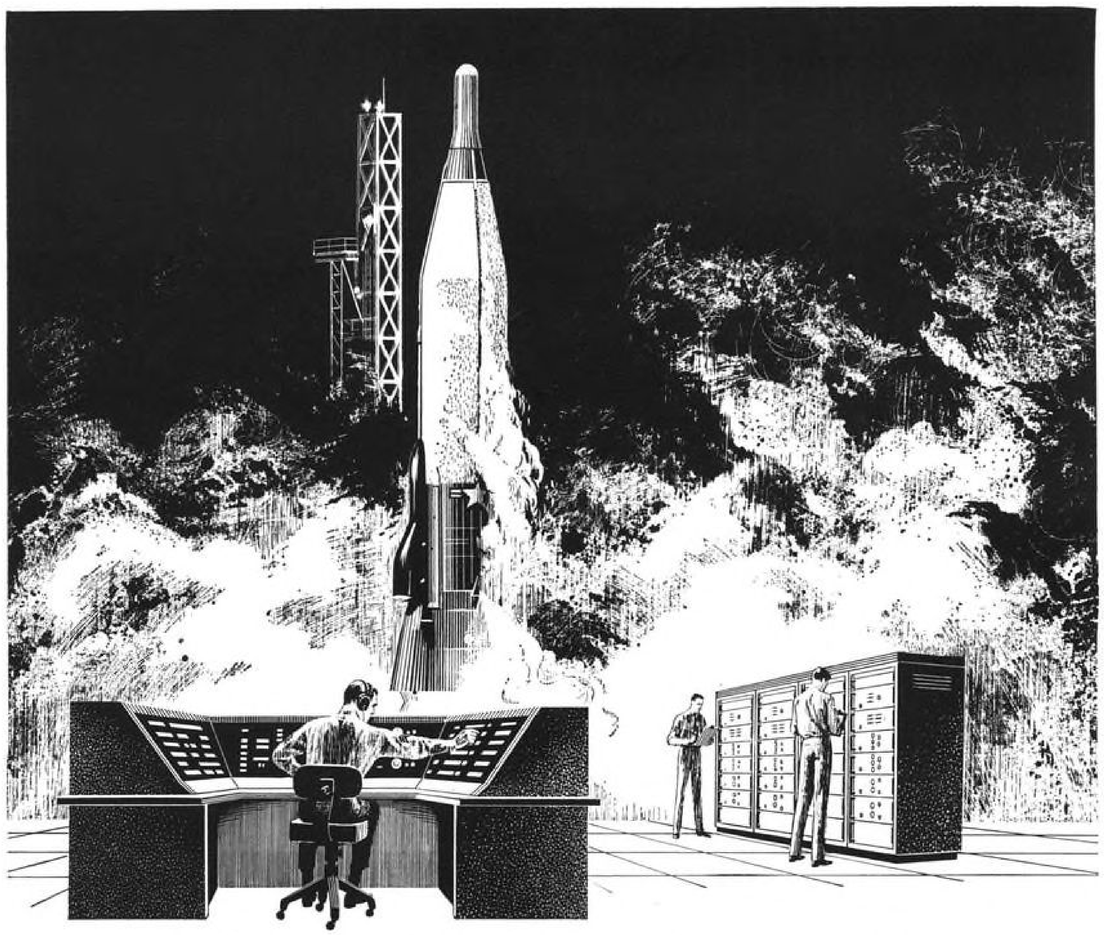
WESTINGHOUSE ELECTRIC CORP.—F. R. Denton, director, 2,000 shares of common stock; **E. V. Huggins,** executive vice president, director, $102,853 salary, 5,252 shares of common stock, 686 shares of common stock contingently awarded as incentive compensation for 1962; **J. J. McCloy,** director, 200 shares of common stock; **G. G. Main,** vice president and director (elected April, 1962), $75,111 salary, 3,300 shares of common stock, 823 shares of common stock awarded contingently as incentive compensation for 1962; **R. Milliken,** director, (elected November, 1962), 100 shares of common stock; **M. W. Cresap, Jr.,** president, chairman of executive committee, director, $151,507 salary, 8,785 shares of common stock, 1,372 shares of common stock contingently awarded as incentive compensation for 1962; **E. Hopkinson, Jr.,** director, 400 shares of common stock; **G. A. Price,** chairman of the board, director, $103,200 salary, 10,050 shares of common stock; **J. W. Reeves,** director, 400 shares of common stock; **J. M. Schiff,** director, 25,000 shares of common stock; **D. Anderson,** director, 1,000 shares of common stock; **K. R. Bendetsen,** director, 200 shares of common stock; **J. K. Hodnette,** executive vice president, director, $113,711 salary, 10,136 shares of common stock, 2,058 shares of common stock contingently awarded as incentive compensation for 1962; **H. S. Kaltenborn,** vice president and assistant to the president, director, $84,853 salary, 450 shares of common stock, 686 shares of common stock contingently awarded as incentive compensation for 1962; **T. S. Peterson,** director (elected October, 1962), 200 shares of common stock; **E. O. Boshell,** director, 800 shares of common stock; **E. D. Brockett,** director, 100 shares of common stock; **A. W. Jones,** director, 1,000 shares of common stock; **W. A. Patterson,** director, 200 shares of common stock; **D. C. Burnham,** vice president $82,071 salary, 1,262 shares of common stock contingently awarded as incentive compensation for 1962. All shares awarded as incentive compensation are contingently payable after retirement. All stock beneficially owned as of Jan. 15, 1963.

WESTINGHOUSE AIR BRAKE CO.—E. J. Hanley, director, 100 shares of common stock; **H. B. Higgins,** director, 390 shares of common stock; **E. Hodge, Jr.,** director, 500 shares of common stock; **A. K. McCord,** director and president, $109,800 salary, 400 shares of common stock; **F. L. Magee,** director, 100 shares of common stock; **H. A. May,** director, 7,840 shares of common stock; **J. A. Mayer,** director, 100 shares of common stock; **E. A. Walker,**



Solar Hydrogen Rocket Engine Shows Space Potential

Solar hydrogen rocket engine, which may be useful for low-thrust, relatively high specific impulse space applications (AW Dec. 17, 1962, p. 34), such as changing the orbit of a synchronous satellite or providing continuous propulsion for a solar probe, shows a potential of approximately 800 sec. specific impulse. The engine, developed for USAF's Rocket Propulsion Laboratory, Edwards AFB, Calif., by Electro-Optical Systems, Inc., Pasadena, Calif., has generated thrust under 1 lb. It consists of a lightweight solar collector, which focuses sun's heat into cavity absorber containing a refractory metal heat exchanger through which circulates liquid hydrogen supplied by a storage and feed system. The gas absorbs heat, expands and is expelled through a nozzle to provide thrust. Larger models of test system, shown above (left), when used with 40 to 50-ft. collector rather than 5-ft. collector, might generate 10 lb. of thrust, according to Electro-Optical. Closeup of vacuum chamber enclosing propulsion-heat exchanger is at right. Arrows in both photos point to the thrust nozzle.



Marquardt needs electronic engineers

Marquardt's latest assignment in the missile trainer-simulator field is to develop and produce the Atlas E and F missile launch crew procedure trainers for the Air Force Ballistic Systems Division. The new Marquardt trainer represents another advance in simulation technology since it is a completely solid-state digital system. It will accurately simulate all operational procedures — from alert to launch — and will encompass the complete spectrum of malfunctions. The Marquardt systems will be used at various SAC bases to train missile combat crews who are required to operate, maintain, and control the Atlas.

Marquardt's advanced capability in trainer technology is also exemplified in other military applications, including the T-10 navigator trainer for B-52 bomber crews, T-4 manual aircraft control and warning site trainers, T-8 trainers for 412L automated air defense systems, and trainer-simulators for the GAM 77 (Hound Dog) and GAM 72/A (Quail) missiles.

Expanding programs, coupled with continuing company-sponsored research and state-of-the-art contracts, are responsible for the new assignments now open at Marquardt. Opportunities presently exist for experienced engineers and scientists who want to affiliate with a dynamic company, well diversified in electronic systems, as well as control systems, airbreathing propulsion, and aerospace research.

Select senior personnel highly qualified in any of the following areas, will find rewarding opportunities at Marquardt: Electro-Optical Systems; Digital Systems Analysis and Logical Design; Advanced Analog and Digital Simulation Systems. Please write in confidence to Mr. Fred Clark at the address below:

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POMONA DIVISION

THE Marquardt CORPORATION

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director, 200 shares of common stock; **R. O. Yearick**, director, 3,020 shares of common stock; **L. E. Walkley**, vice president-operations, $72,875 salary; **R. H. Wood**, vice president and general counsel, $49,290 salary.

All stock owned as of Feb. 7, 1963.

THE GOODYEAR TIRE & RUBBER CO.—**R. B. Anderson**, financial consultant and director, $39,600 salary; **R. DeYoung**, president and director, $152,008 salary, 2,103 shares of common stock allotted as deferred incentive compensation remuneration for 1962, 36,500 shares of common stock; **R. P. Dinsmore**, research consultant, director, 15,079 shares of common stock; **S. DuPrie**, vice president, director, $73,397 salary, 976 shares of common stock allotted as deferred incentive compensation remuneration for 1962, 3,272 shares of common stock; **J. B. Hall**, director, 384 shares of common stock; **V. Holt, Jr.**, executive vice president and director, $108,826 salary, 1,277 shares of common stock allotted as deferred incentive compensation remuneration for 1962, 2,856 shares of common stock; **H. L. Hyde**, executive vice president and director, $108,826 salary, 1,277 shares of common stock allotted as deferred incentive compensation remuneration for 1962, 30,771 shares of common stock; **G. P. MacNichol, Jr.**, director, 105 shares of common stock; **J. A. Martino**, director, 204 shares of common stock; **J. P. McWilliams**, director, 3,000 shares of common stock; **W. A. Patterson**, director, 339 shares of common stock; **R. G. Payne**, director, 1,609 shares of common stock; **C. F. Stone**, director, 3,217 shares of common stock; **E. J. Thomas**, chairman of the board and chief executive officer, director, $195,638 salary, 3,005 shares of common stock allotted as deferred incentive compensation remuneration for 1962, 57,743 shares of common stock; **R. V. Thomas**, president of subsidiary, director, $47,370 salary, 450 shares of common stock allotted as deferred incentive compensation remuneration for 1962, 12,245 shares of common stock; **J. C. Virden**, director, 339 shares of common stock; **J. W. Wright**, director (elected Feb. 12, 1963), 100 shares of common stock. All shares allotted as deferred incentive compensation remuneration for 1962 are contingently receivable after retirement, pursuant to the terms of the company's key personnel incentive profit sharing plan.

All stock beneficially owned, directly or indirectly, as of Jan. 15, 1963.

HELIO AIRCRAFT CORP.—**E. B. Berlinrut**, director, 5,150 shares of common stock; **L. L. Bollinger**, president, treasurer, director, $33,174.11 salary (under an employment contract between the company and Mr. Bollinger, Mr. Bollinger shall receive a commission of 1% of gross sales up to a maximum of $3,000,000 and ½% of gross sales over $3,000,000, up to a maximum of $5,000,000, with the maximum annual commission being $40,000. Gross sales for Helio Aircraft Corp. for the year ending Dec. 31, 1962, amounted to $2,706,891. Helio Aircraft Corp. maintains a life insurance policy

CAREER OPPORTUNITIES in GUIDANCE AND CONTROL SYSTEMS

Corporate Systems Center, where the diverse capabilities of United Aircraft Corporation are focused upon the development of complex aerospace systems, has openings for several senior level engineers in its Guidance and Control Systems Program.

The advanced systems that we are developing will play major roles in the success of America's space program. Because of the complexity of these systems, engineers of many disciplines are required. To the qualified applicant, these openings offer many opportunities for advancing professionally.

ELECTRO OPTICAL GUIDANCE ENGINEER will derive the parameters of the electro-optical subsystem, prepare subsystem specifications and provide technical liaison for subcontracted equipment. Requires a broad background in design and development of precision instruments for missile and space applications.

VEHICLE FLIGHT CONTROL ENGINEER to perform analysis and synthesis of control systems for boost, orbital, and re-entry vehicles. Work will include establishment of system requirements; digital and/or analog simulation of non-linear and adaptive control system; preparation of preliminary design and specifications. Candidates with electronic design experience desired but not required.

ELECTRONICS DEVELOPMENT SUPERVISOR responsible for directing engineers evaluating aerospace electronic systems (telemetry, data links, etc.) and guiding the development of this equipment and its integration into a complex system. Familiarity with laboratory and flight testing of airborne systems desirable.

COMPUTER DEVELOPMENT SUPERVISOR responsible for directing engineers, evaluating the design and developing aerospace digital computers. Candidates must be capable of technical leadership in the design and application of digital computers, peripheral systems, software, etc.

THERMODYNAMICS-HEAT TRANSFER ENGINEER for the optimization and design of space vehicle environmental control systems, and thermodynamic and heat transfer analysis. Responsibilities include all modes of heat transfer, in solids, single phase and two phase fluids, radiation heat transfer, and aerothermodynamics.

ELECTRONICS ENGINEER to develop advance circuits for gimballess inertial guidance system. Should have experience in the design of transistor pulse circuits and video frequency circuits, transistor circuits at DC and audio frequencies, and feedback amplifiers.

ELECTRONICS SPECIALISTS experienced in the design and development of amplifiers, power supplies, digital circuitry, and familiar with microminiturization interference problems, the effects of radiation, and reliability analysis.

SENIOR DESIGN ENGINEER to direct the design and analysis of complex structures associated with advanced satellite and missile payloads. Should be proficient in application of analysis methods and original electromechanical design.

These positions offer excellent starting salaries with periodic salary reviews. Among the many employee benefits we have is a fully reimbursed graduate study program.

We invite you to submit your resume to Mr. L.M. Chapelle, UAC Corporate Systems Center, 1690 New Britain Avenue, Farmington, Connecticut — an equal opportunity employer

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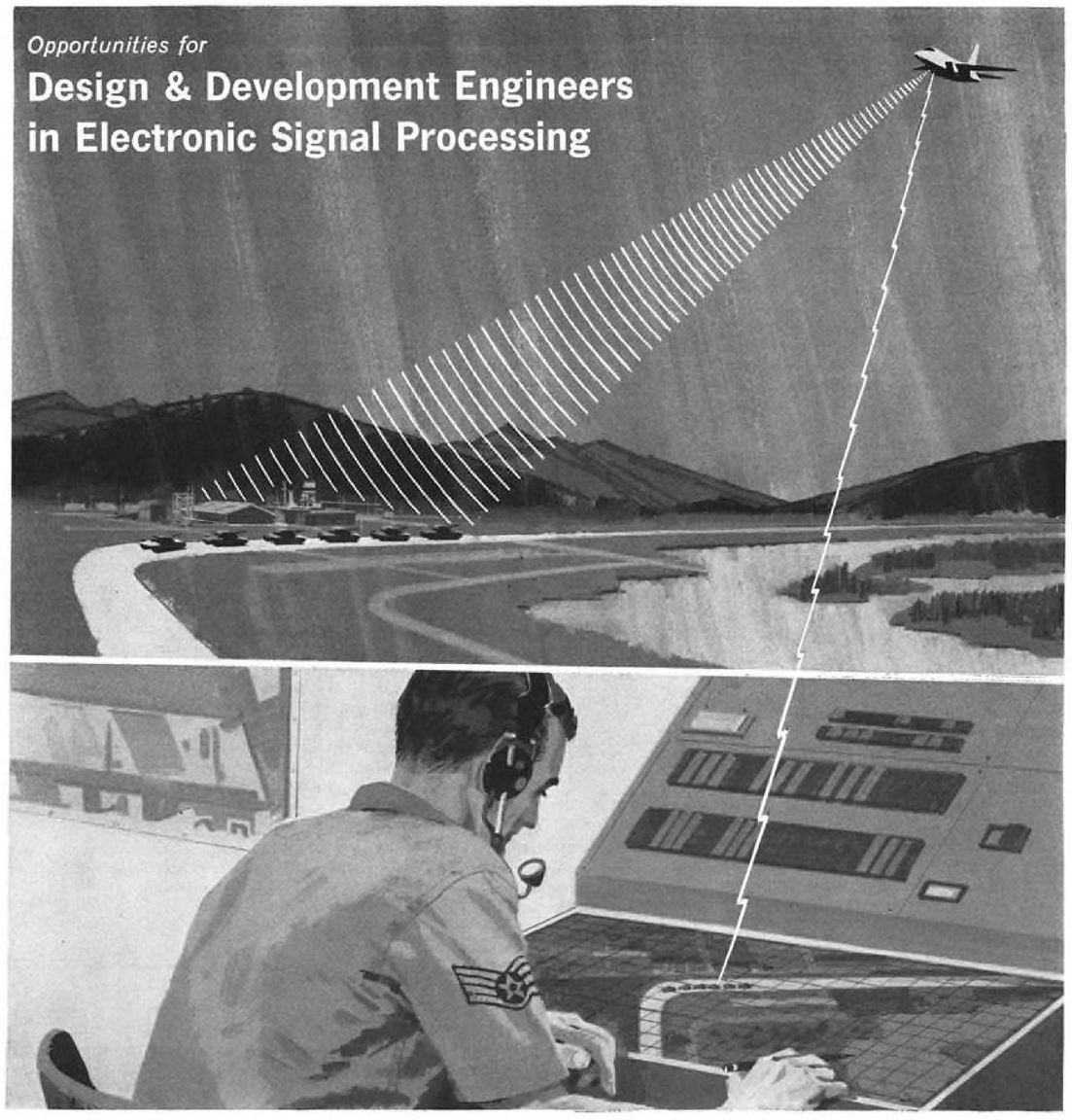
Opportunities for

Design & Development Engineers in Electronic Signal Processing



Design and development activities in the field of Electronic Signal Processing are rapidly expanding today at HUGHES Aerospace Divisions.

Development of systems utilizing advanced correlation and matched filter techniques for *High-Resolution Radar, Acoustic Detection & Classification* and *Pulse Doppler Radar* is being accelerated.

Specialists in Signal Processing, Circuit Design, Mechanical Design, Packaging Design, Performance Analysis and Project Engineering will be interested in the outstanding assignments now available.

Graduate engineers with experience in wide-band video amplifiers; high-resolution cathode ray tube circuits and applications (including ultra-linear sweep, gamma correction and dynamic focus); high-voltage power supplies; low-jitter timing circuitry; high-speed analog sampling circuitry; precision film transports; ultra-high speed film development; scan conversion systems; synthetic array radar systems; imagery recording, or similar fields—are invited to submit resumes.

For immediate consideration please write:

Mr. Robert A. Martin
Head of Employment
HUGHES Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 50, Calif.

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in the amount of $100,000 on the life of L. L. Bollinger, of which Helio Aircraft is the owner and pays the premium. In the event of Mr. Bollinger's death, this policy is payable to Mr. Bollinger's wife or children), 24,313 shares of common stock, 182 shares of preferred stock; **G. M. Bond,** director, 850 shares of common stock; **C. E. Ford,** director; **W. M. Joy,** director, 5,000 shares of common stock; **R. B. Kinnach,** executive vice president, director, 1,000 shares of common stock; **O. C. Koppen,** director (resigned effective Dec. 14, 1962), 12,516 shares of common stock, 80 shares of preferred stock; **C. A. Reinstrom,** chairman of the board, director, 6,200 shares of common stock; **L. Stewart,** director (2,178 shares of preferred stock and 74,821 shares of common stock owned, as of Dec. 31, 1962, by the McNally Pittsburgh Manufacturing Corp., of which Mr. Stewart is an officer). All stock beneficially owned as of March 31, 1962.

LEAR SIEGLER, INC.—**F. L. Anderson,** director, 49,877 shares of common stock; **M. L. Bengtson,** director, 9,756 shares of common stock; **J. G. Brooks,** chairman of the board and chief executive officer, director, $90,000 salary (under the terms of his employment agreement with Lear Siegler, Inc., Mr. Bengtson is entitled to receive severance pay upon termination of his employment in an amount determined by length of service and other factors. In the event of his death during employment or retirement at age 65, he or his estate will be entitled to receive $25,000 annually for a period of ten years), 32,176 shares of common stock (includes shares held in a family trust), $5,203 amount accrued in company contributions during fiscal year ending June 30, 1962, under the profit sharing and retirement plan; **P. S. Fogg,** director, $33,015 shares of common stock; **P. M. Hamilton,** director, 37,922 shares of common stock; **A. G. Handschumacher,** president and director (elected chairman of the board of Lear, Inc., in March, 1962. At the merger of Lear, Inc., with and into Siegler Corp. on June 5, 1962, Mr. Handschumacher was elected president of the company and a member of the board of directors), $80,000 salary (under terms of his empolyment agreement with Lear, Inc., which was assumed by Lear Siegler, Inc., in the merger, Mr. Handschumacher received during the year ending June 30, 1962, additional deferred compensation of $833.33 semi-monthly. Under his present employment agreement, effective June 1, 1962, Mr. Handschumacher receives additional deferred compensation of $1,458.33 semi-monthly. Salary amount shown above includes compensation received from Lear, Inc., as its president prior to the merger with Lear Siegler, Inc.), 7,147 shares of common stocks; **J. Oostermeyer,** director, 594 shares of common stock; **R. L. Purcell,** executive vice president and director, $60,000 salary, 9,250 shares of common stock, $3,436 amount accrued in company contributions during fiscal year ending June 30, 1962, under the profit sharing and retirement plan; **H. C. Rose,** director, 1,505 shares of common stock; **D. Royce,** director, 8,178 shares of common stock; **A. C. Schwartz,** director, 515 shares of common stock; C. A. Thompson, director, 1,099

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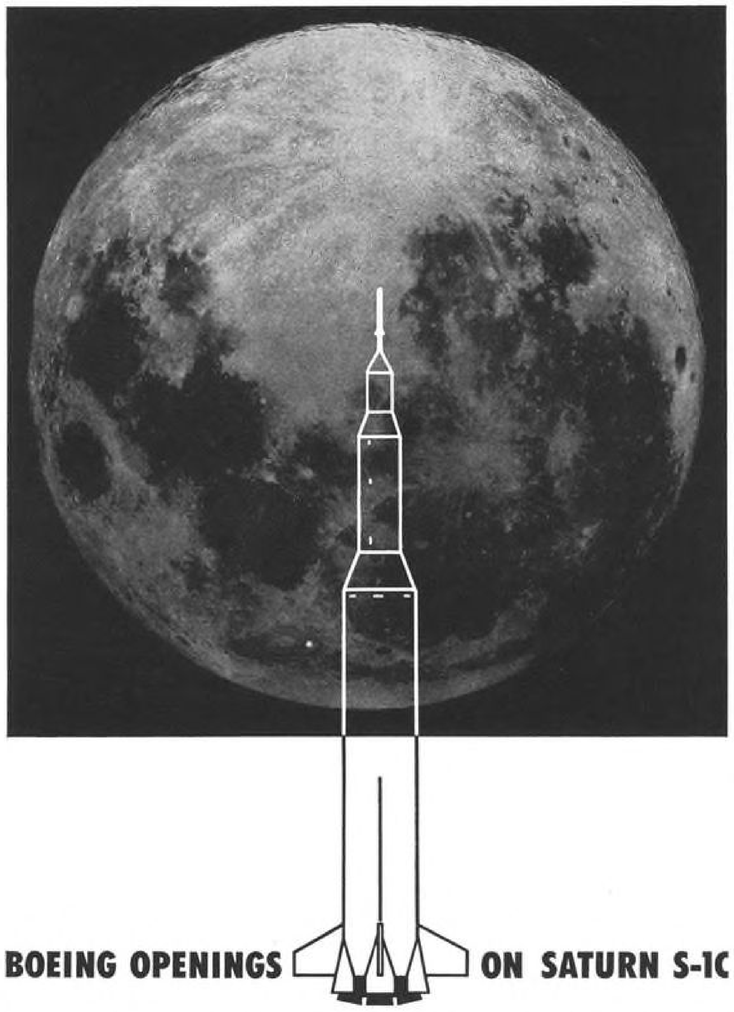

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shares of common stock. All stock owned as of Aug. 10, 1962.

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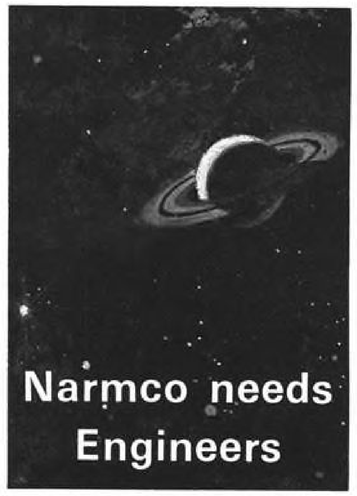
MOTOROLA, INC.—**R. W. Galvin,** president and director, $85,000 salary, 668,556 shares of common stock, 25,230 shares of common stock held by associates, 27,248 shares of common stock held as guardian of the estates of four minor children, sole trustee of Motorola, Inc.'s, employees' savings and profit sharing fund, which owns 84,170 shares of common stock (Mr. Galvin has an insignificant beneficial interest in these shares); **M. J. Hickey, Jr.,** director and consultant, $30,000 salary (in addition, Hickey & Co., during 1962, received commissions of $11,590.33, resulting from purchase or sale of securities for the company, of which Hickey & Co. paid to five other brokers $3,762.15. Also, Hickey & Co. derived a profit of $2,854.59 from transactions with the funds as principal), 11,000 shares of common stock; **D. E. Noble,** executive vice president-communications semiconductor, military electronics, and solid state systems divisions, director, $80,000 salary, 11,732 shares of common stock; **F. J. O'Brien,** vice president-purchasing, director, $65,000 salary, 11,234 shares of common stock, 122 shares of common stock held by the estate of Joan O'Brien, deceased, of which Mr. O'Brien is acting as executor; **A. L. Reese,** vice president and general manager-communications division, director, $60,000 salary, 800 shares of common stock; **W. B. Scott,** vice president-consumer and automotive production, director, $55,000 salary, 4,400 shares of common stock; **E. R. Taylor,** executive vice president-consumer products division, director, $80,000 salary, 7,300 shares of common stock; **E. P. Vanderwicken,** vice president-finance, treasurer, secretary, director, $70,000 salary, 1,200 shares of common stock; **E. H. Wavering,** executive vice president-automotive products division, director, $80,000 salary, 41,400 shares of common stock. Salary figures include accrued company contributions to the employes' savings and profit sharing fund for 1962. All stock beneficially owned as of Feb. 1, 1963.



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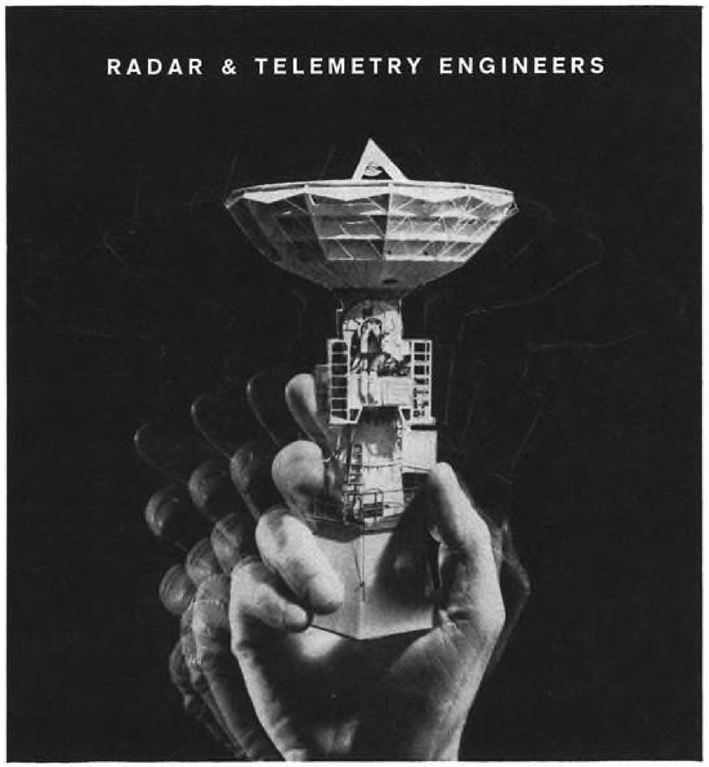

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LETTERS

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.

Drone Reliability

The "Industry Observer" paragraph concerning DASH (AW Nov. 11, p. 23) is your usual timely job of reporting. However, the figures on drone helicopter losses as reported, apparently obtained through reliable sources, include six vehicles being used in research and development.

If only drones actually delivered to the Navy for operational use are considered and the losses reviewed with respect to the operational time accumulated (1,490.2 hr.) and number of flights flown (2,293) by these vehicles, then the proper perspective is obtained; e.g., utilizing a one-sided 95% confidence level which is far more stringent than the normally used 90% factor, the computations based on the preceding operational data as of Oct. 30, 1963, indicate the following:

(a.) Considering losses from all causes, the reliability of the weapon system is 99.04%.

(b.) Eliminating losses resulting from human factor, the system reliability then becomes 99.19%.

This data indicates that, based on experience to date, we theoretically expect to lose only 9.6 drones per 1,000 flights due to all causes. This is considered an outstanding achievement for a complex electronic system controlling an unmanned helicopter in flight. Actually, the reliability of the Drone Anti-Submarine Helicopter Weapon System exceeds that expected by the Navy when the DASH concept was first envisioned.

Even this excellent reliability will be further improved as component data is accumulated and those components exhibiting minimal reliability are redesigned as a function of normal product improvement.

JOHN G. HOLLWEDEL
Director, Quality & Reliability Control
Gyrodyne Co. of America, Inc.
St. James, Long Island, N. Y.

Pilot Seniority

A number of years ago the pilots of Resort Airlines had an Airline Pilots Association local council meeting for the purpose of joining ALPA.

A few years before this, Resort had an expansion and needed captains. Their present co-pilots were unable to check out so captains were hired from other airlines so that the company could expand. These captains were told that they would be placed at the bottom of the captain's seniority list and not on the bottom of a date of hire list. This seniority list was voted on and accepted by a majority of Resort pilots at that time. Years later, a date of hire seniority list was drawn up by the inexperienced co-pilots after they had obtained enough experience to check out.

At the local council meeting the pilots were told that ALPA wants a single seniority list and to vote for one or the other. This vote was taken with the date of hire list winning the vote. A large number of captains immediately became co-pilots and an equal number of co-pilots became captains. Unorganized confusion, fights and lack of cooperation occured daily in the cockpits for years afterwards.

When recourse was taken by the losing pilots the president of the union denied that ALPA wanted the vote taken of the two seniority lists in the first place and said that the pilots did it. Attorneys will not handle this case. Recourse through the government has been futile.

In view of the union demands the company went out of business. The pilots are having trouble obtaining employment with the other airlines as they are required to start at the bottom of the date of hire seniority lists of each company and cannot check out as captain until all pilots hired before them are checked out. Airlines also use the excuse that these experienced pilots are too old for these long seniority lists.

What does a pilot do with several ATR type ratings and about 20,000 hr. flying time? Other fields of employment cannot hire pilots due to their union requirements.

CAPT. G. A. WOODWARD, JR.
Eau Gallie, Fla.

Comanche Merits

In reference to Arthur Stasney's letter (AW Nov. 18, p. 134), I would like to say that, technically, he is correct and we hope the public has as great a chuckle out of the comparison as I had upon reading his letter. Certainly there is no real comparison, point-by-point or performance-wise, any more than there is a comparison between the cost of manufacturing one over the other in today's market or in the cost of trying to maintain one airplane as compared to the other. The Comanche carries 400 hp.—the Mustang carries 1,200 hp. (or more). The Comanche was built for public use while the Mustang was built for use as a military fighter plane.

The principle that might prompt a man to desire an airplane of the P-51's performance, as compared to other single engine airplanes, is the point the writer of this letter was trying to imply. In so doing, he used "poetic license" in expressing himself.

I would like to say that the Comanche 400 is quite an airplane and will be enjoyed by many single engine owners through the coming years. The performance is far above any other single engine, commercially produced airplane today and I am sure that Mr. Stasney will enjoy a flight in the airplane when the opportunity presents itself.

J. W. MILLER
Director of Marketing
Piper Aircraft Corp.
Lock Haven, Pa.

SST Problems

With reference to your editorial "New Light on SST Problems" (AW Nov. 11, p. 21), the final paragraph is indeed the crux of the whole matter.

What if, in 1910, the federal government had reached the quite reasonable decision that a mass producible, gasoline powered, four to six passenger public road vehicle was a major national goal. An open road speed of 100 mph., with an endurance of 2 hr. at that speed would have been a reasonable requirement, and in the research and development required for that time period, quite comparable to an SST effort today. One can picture the Department of Commerce attempting to conduct a Phase 1 design competition with industry—largely buggy manufacturers—wondering what the department intended to use for roads. There was no military experience to fall back on, and in fact no military requirement, for if I read my history correctly, the Army was quite satisfied with mules, and the troops resigned to walking.

Of course, none of this happened: It was understood in those days that the only purpose of government was to insure the right of each individual equally to provide for himself as only he, the individual, knew best, and to protect the individual from the few who in any society are improvident or thieves. In this free atmosphere, private enterprise, unhampered by federal aid and its concomitant-control, conceived and developed the motor car which years ago surpassed in performance, quality, and low cost the grandest dreams our fathers could ever have had in 1900. Had government embarked on the "Super Highway Performance Conveyance" program in 1910 I dare say we would today be driving a slightly improved version of the Model "T" (after all it did have an automatic transmission).

Oh yes, the government did decide to go into the road building business. Of course, we still don't have roads suitable for the vehicles long since developed by unfettered private enterprise, but that has no connection with an SST does it?

G. E. O'NEIL
Seattle, Wash.

More on TFX

While not wishing to renew a discussion of the TFX controversy, I would like to make the following comments in reply to Mr. Pripps' letter (AW Oct. 28, p. 110).

First of all, the Martin XB-51, a three-engined light bomber, was never in competition against the six-engined B-47 which was a strategic medium bomber. (The Martin entry ~~was~~ the medium bomber competition was the XB-48, a six-engined aircraft with unswept wings.)

Second, the "very fine" YB-60 was derived from the old B-36 and, therefore, did not have the development potential of which the B-52 has proven itself. Also, the B-52 had a substantially higher top speed.

MICHAEL E. TAUBER
Los Altos, Calif.

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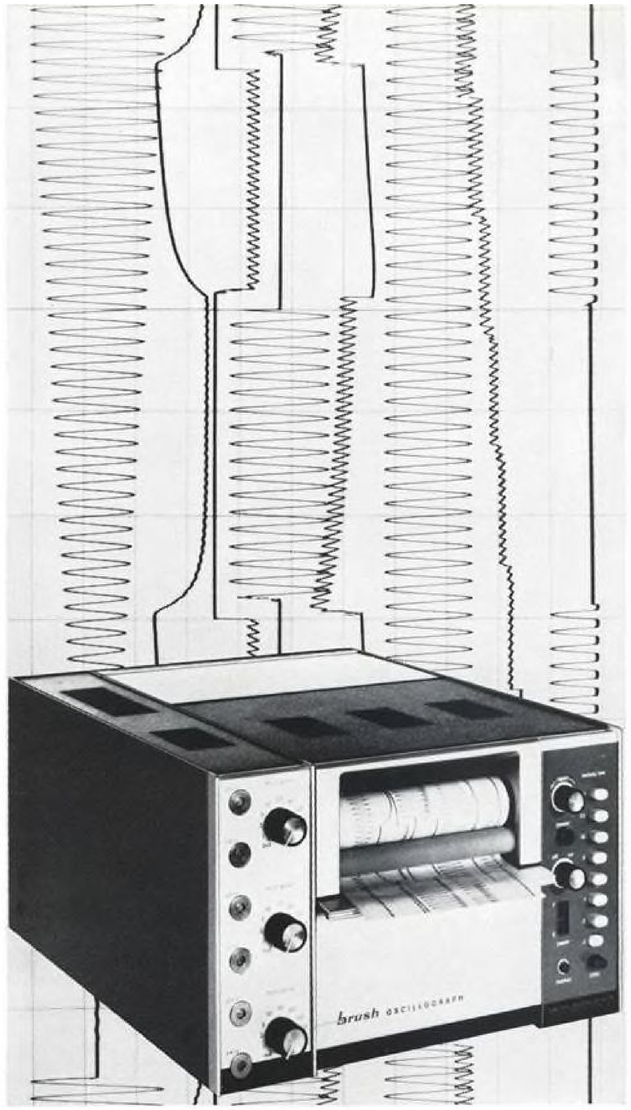

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