Aviation Week and Space Technology

November 28, 1960

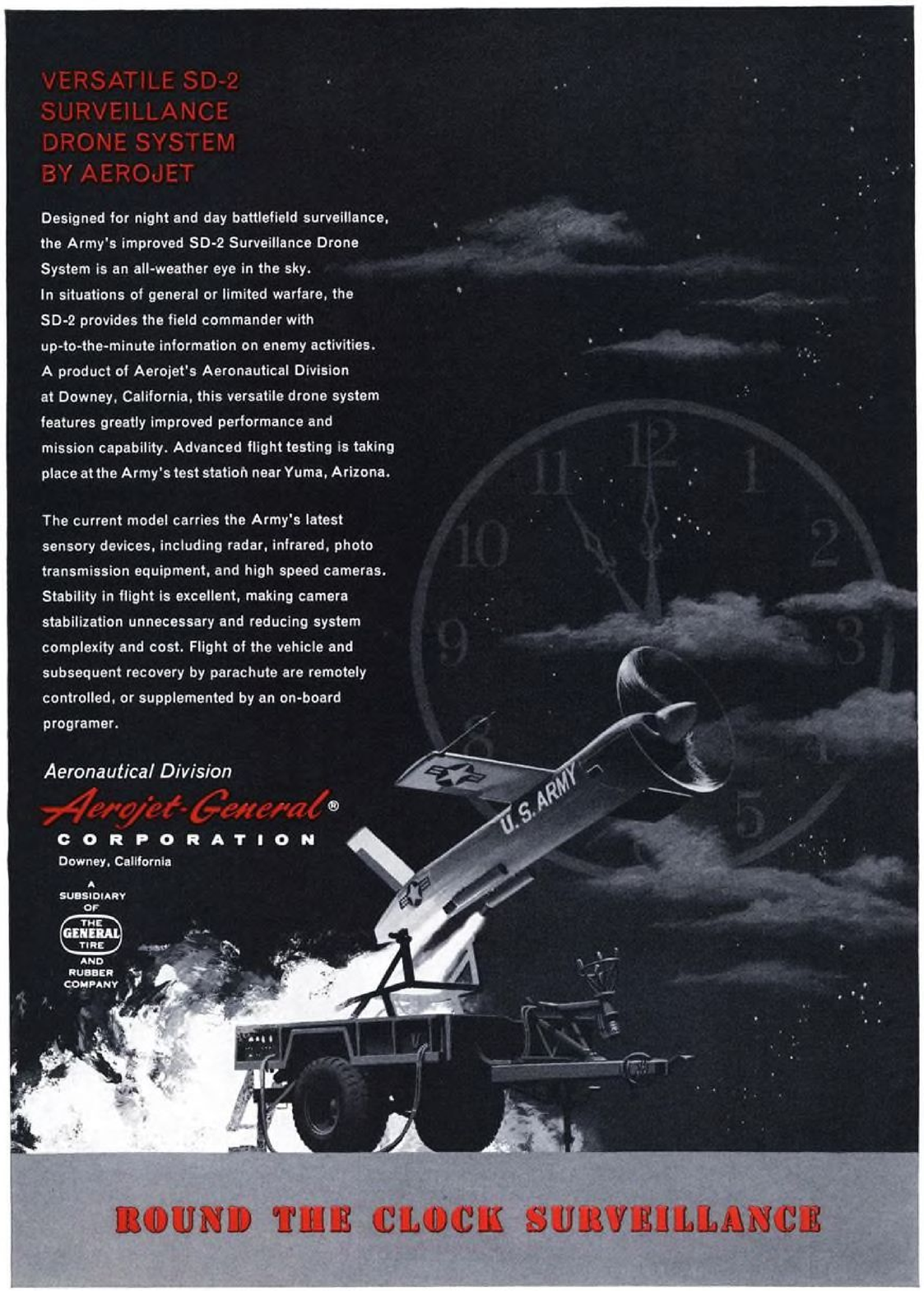
75 Cents

A McGraw-Hill Publication

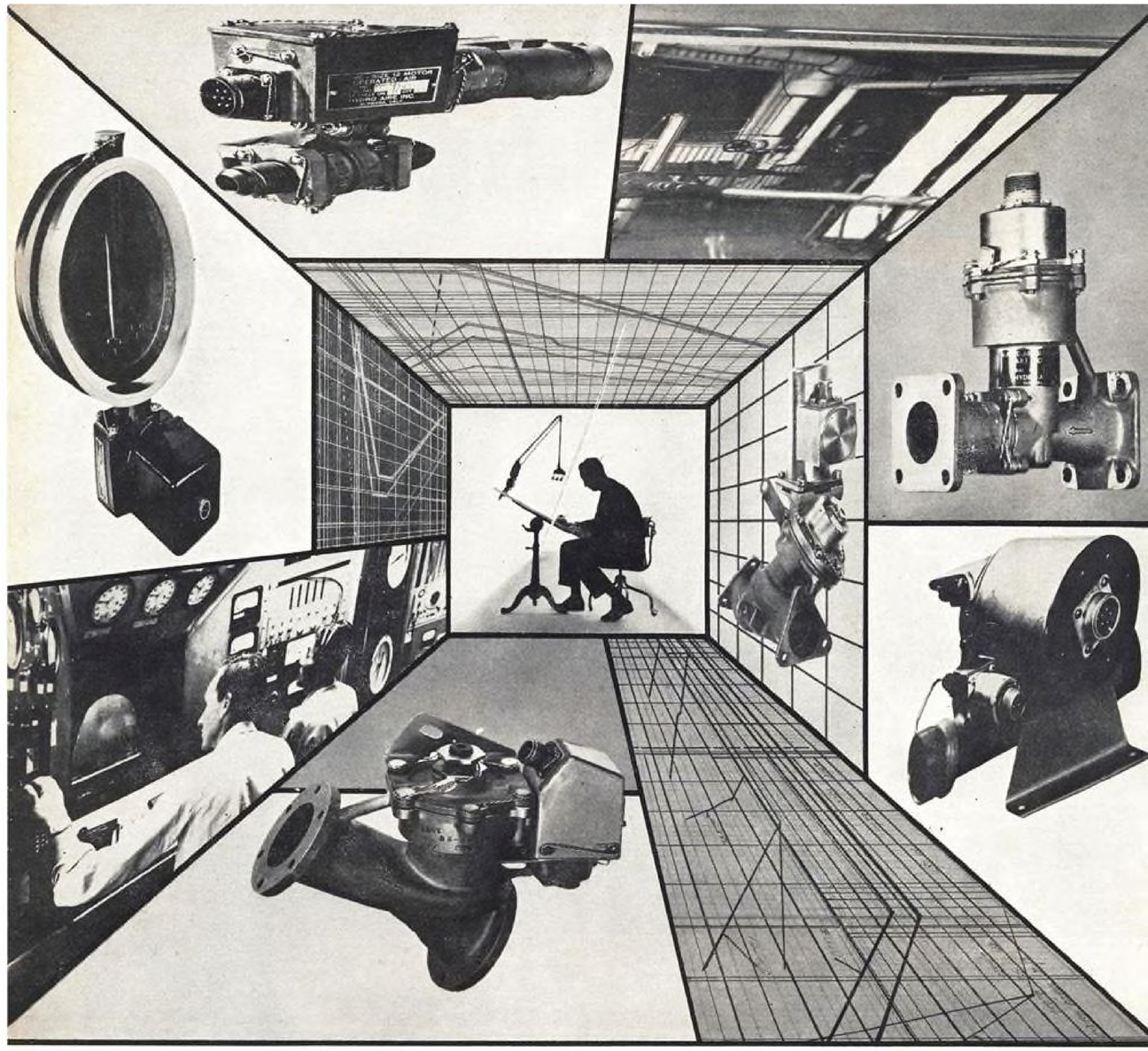
First Details Of QF-104 Drone Program

GE's RVX-2A Re-entry Vehicle
Photographs Earth From 700-mi. Altitude

PERT/PEP Management Technique Use Grows



Engineers, scientists – investigate outstanding opportunities at Aerojet



Why pneumatic control engineers bring their "tough" valve problems to Hydro-Aire

They've been here before. They know Hydro-Aire designs reliable pneumatic valves and delivers on time. So, they come back. It's that simple. How we do it is no secret. We stress design simplicity, apply criteria based on more than 10 years' solid experience. Our Pneumatic Test Lab ranks with industry's best. Our plant is specialist-staffed to get the job done (1) right and (2) on time. Performance is proof. Try us. Our new Pneumatic Equipment Catalog describes current, qualified production designs for operating pressures to 3800 psi; operating temperatures to 1000°F and 500°F ambient. Write on your company letterhead for a copy.

ENGINEERS: write D. B. Nickerson, Chief Engineer, regarding career opportunities at Hydro-Aire.

HYDRO-AIRE
3000 WINONA AVENUE
BURBANK, CALIFORNIA
Developers and producers of reliable control components, sub-systems and systems for the aircraft, missile, electronics and transportation industries.

DIVISION OF CRANE CO.

AVIATION CALENDAR

Dec. 5-8—15th Annual Meeting and Astronautical Exposition, American Rocket Society, Shoreham Hotel, Washington, D. C.

Dec. 6-8—Annual Meetings, National Aviation Trades Assn. and National Air Taxi Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.

Dec. 12-15—Atomic Industry Exhibition, California Masonic Memorial Temple, San Francisco, Calif., concurrent with the Atomic Industrial Forum's Annual Conference (Fairmont Hotel) and the American Nuclear Society's Winter Meeting (Hotel Mark Hopkins).

Dec. 13-15—Tenth Annual Eastern Joint Computer Conference, Hotel New Yorker and Manhattan Center, New York, N. Y.

Dec. 16—Army Aviation Contract Services Symposium, National Aeronautical Services Assn., Mayflower Hotel, Washington, D. C.

Dec. 17—24th Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C.

Dec. 26-31—127th Meeting, American Association for the Advancement of Science, New York, N. Y.

Dec. 28-30—Seventh King Orange International Model Plane Meet, Miami, Fla.

Jan. 9-11—Seventh National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Pa.

Jan. 9-13—International Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

Jan. 16-18—Seventh Annual National Meeting, American Astronautical Society, Dallas, Tex.

Jan. 17-19—Winter Instrument-Automation Conference & Exhibit, Instrument Society of America, Jefferson Hotel and Kiel

(Continued on page 6)

AVIATION WEEK and Space Technology

November 28, 1960

Vol. 73, No. 22

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Sheldon Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited only from persons who have a commercial or professional interest in aviation, including missiles and space technology. Position and company connection must be indicated on subscription order.

Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

Any subscriber who is dissatisfied with this publication for any reason whatever, may cancel his subscription by writing our Fulfillment Manager. Refund for unexpired portion of subscription will be made promptly.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.

Subscribers: Send correspondence and change of address to Fulfillment Manager, Aviation Week, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, including postal zone number. Enclose recent address label if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, Aviation Week and Space Technology, 330 West 42nd Street, New York 36, N Y.

AVIATION CALENDAR

(Continued from page 5)

Auditorium, St. Louis, Mo.

Jan. 23-25—29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 24.

Feb. 1-3—Second Winter Military Electronics Convention, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 1-3—Solid Propellants Conference, American Rocket Society, Salt Lake City.

Feb. 15-17—International Solid-State Circuits Conference, Institute of Radio Engineers, Sheraton Hotel, Philadelphia.

Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.

Mar. 9-10—Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia.

Mar. 9-10—Flight Propulsion Meeting, Institute of the Aeronautical Sciences, Cleveland, Ohio (classified).

Mar. 12-16—Aviation Conference, American Society of Mechanical Engineers, Statler-Hilton, Los Angeles, Calif.

Mar. 13-15—Flight Testing Conference, American Rocket Society, Los Angeles.

Mar. 13-16—Test, Operations and Support Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.

Mar. 16-18—Fifth National Conference on Aviation Education, Mayflower Hotel, Washington, D. C.

Mar. 20-23—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria Hotel, New York, N. Y.

Mar. 20-24—1961 Western Metal Exposition, American Society for Metals, Pan-Pacific Auditorium, Los Angeles, Calif.

Apr. 4-6—International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Apr. 5-7—Lifting Re-entry Vehicles: Structures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 17-28—14th Technical Conference, International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla.

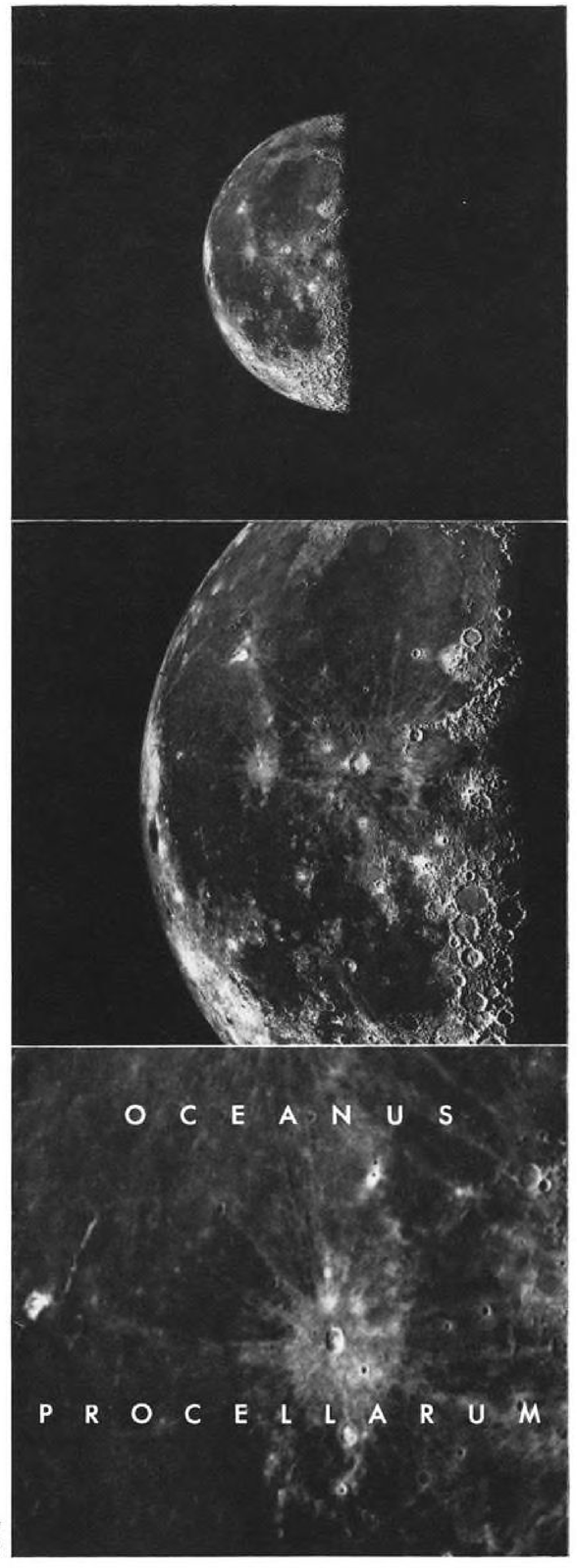
Apr. 30-May 4—Seventh National Aero-Space Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

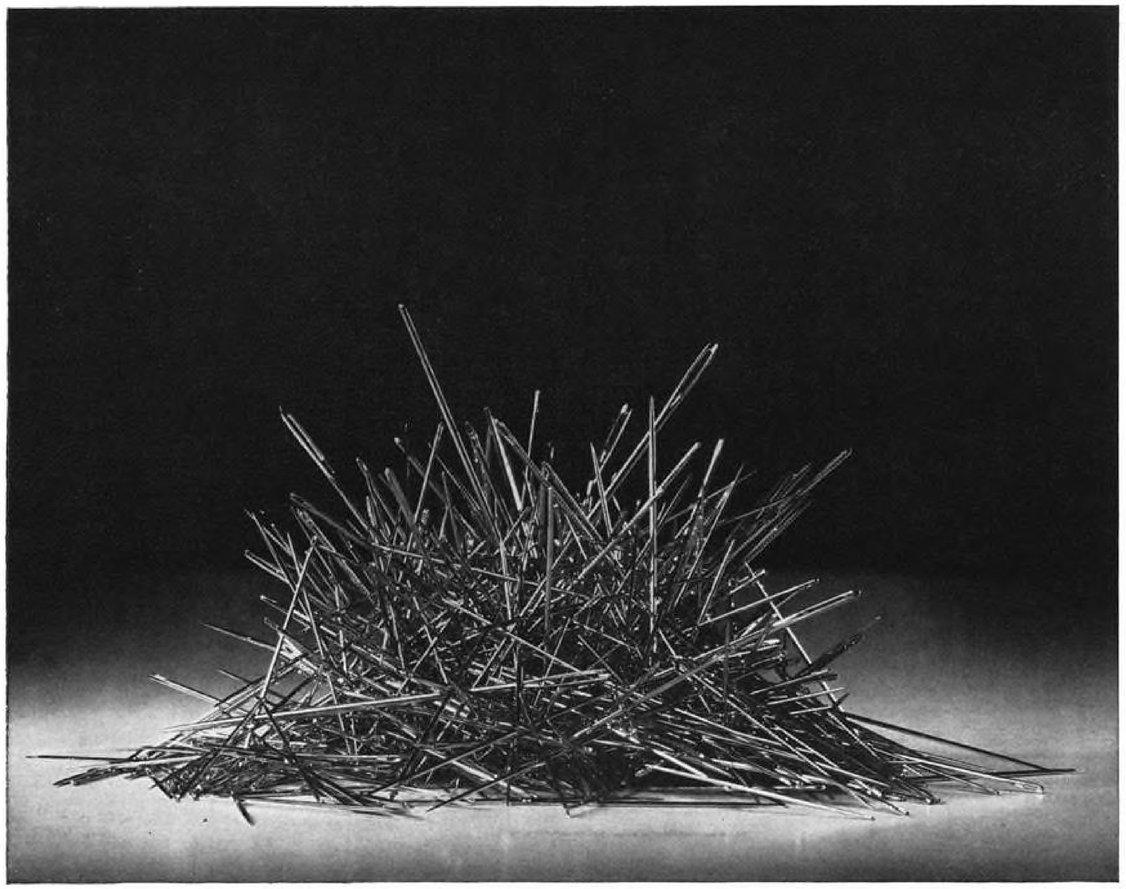
May 8-10—National Aeronautical Electronics Conference, Institute of Radio Engineers, Miami and Biltmore Hotels, Dayton, Ohio.

May 22-24—National Telemetering Conference, Hotel Morrison, Chicago, Ill.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.





NEEDLES . . . *looking for a haystack*

At I-T-E Special Products Division, the finest tools and craftsmanship are ideally suited to solving your most difficult production problem. These machines and men are among the finest in the world, trained to the exacting requirements of the nuclear, missile and electronic industries.

Modern plant facilities and controls provide the proper atmosphere for precision manufacturing. Extensive inert gas welding facilities tame today's exotic and difficult-to-handle metals and alloys. And precise temperature control of heat treating insures proper stress-relief and annealing operation.

In research, development and engineering, specialized staff capabilities have earned I-T-E prime contract awards on critical industrial and defense projects. These experienced facilities are looking for your unique problem to solve. Our engineers will be glad to consult with you on your project. A call might save you weeks of precious time.

Phone GArfield 6-5700.

I-T-E CIRCUIT BREAKER COMPANY
Special Products Division, Dept. AW • 601 E. Erie Ave. • Philadelphia 34, Pa.

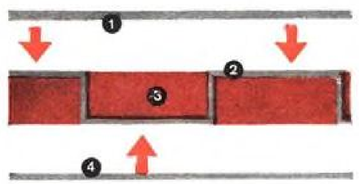
RADAR ANTENNA SYSTEMS | UHF ANTENNA SYSTEMS | PEDESTALS DRIVES • CONTROLS | WAVEGUIDES & COMPONENTS | RESEARCH & DEVELOPMENT | DESIGN & ENGINEERING | PRECISION MANUFACTURING

Johns-Manville Announces... MIN-KLAD INTERLOK

. . . a new structural system interlocking Min-K insulation and high-temperature reinforced plastic

Missile experience shows that in certain heat control situations no one material will perform as well as two (or more)—*an insulation with protective high-temperature facings.*

Problem is how to effectively combine these materials into a structurally strong unit? The answer is Min-Klad Interlok—a new structural system that interlocks Min-K insulation and reinforced plastic, metal or other high-temperature facings.



1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K formulations, and 4) Inner facing.

All the above components combine to provide a custom-made structural strong insulating system.

The result: one product that gives the missile designer every advantage of high-temperature plastic or metal foil—strength, toughness, rigidity! Erosion resistance! High heat capacity!

. . . plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state, and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air.

Wide range of facings

For the hot face, the missile designer can specify Min-Klad Interlok in a wide variety of heat-resistant and/or ablating materials—asbestos-phenolic (ARP-40), and similar reinforced plastics, as well as stainless steel and other heat-resistant metal foils and meshes. For some requirements, the cool face can be made of a different material—for example, one that offers characteristics required for bonding or fastening to other surfaces and parts.

Like all J-M Aviation insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component housings of any shape or size. Write today for technical specifications. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

A NEW ENGINEERING MATERIAL

LORD DYNA-DAMP

Dyna-damp panels and structural sections* can be designed in many configurations for addition to existing structures or fabrication as complete damped assemblies.

Lord announces Dyna-damp—a new engineering material that counteracts broad-band "white" noise and vibration. It offers a new, better way to solve acoustic fatigue and structural response problems.

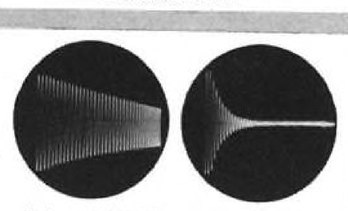
Dyna-damp's laminated design converts vibratory energy into shear strains which are dissipated in a highly damped viscoelastic layer. The damping medium is a special form of BTR® elastomer, bonded between metal elements to give structural integrity and load-carrying strength.

In jets, missiles, ships, vehicles, electronic units—wherever control of resonant response is required—Dyna-damp can introduce dramatically improved performance, higher reliability. It is available to industry in sheet and structural sections or in engineered, finished products for use as primary or secondary structures, electronic chassis, complete mounting systems.

Design engineers can obtain further information and able application assistance on Dyna-damp from the nearest Lord Field Engineering Office or the Home Office, Erie, Pennsylvania.

*patent applied for

Radically improved damping is illustrated by typical decay rate traces.



Undamped: 2024 T-3 aluminum panel

Damped: 3-ply Dyna-damp panel

DYNA-DAMP FEATURES

High strength: bonded construction provides structural integrity across complete part. Ultimate strength: 60% of solid aluminum. Shear strength of BTR layer: over 500 psi. Climbing drum peel strength: over 60 lbs.

Light weight: lighter than aluminum sheet of equal thickness.

Excellent fatigue life: proved greatly superior to aluminum in acoustic tests to 170 db.

Broad temperature operation: −65° to + 250°F.

Ease of fabrication: can be punched, sheared or stretch formed by standard methods . . . fastened by riveting or adhesive bonding . . . sections can also be spot welded.

Environmental resistance: good strength and damping ability maintained after 7-day immersion in aircraft fluids.

LORD®

FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - CEdar 7-9247
BOSTON, MASS. - HAncock 6-9135
CHICAGO, ILL. - MIchigan 2-6010
DALLAS, TEXAS - Riverside 1-3392
DAYTON, OHIO - BAldwin 4-0351
DETROIT, MICH. - Diamond 1-4340
KANSAS CITY, MO. - WEstport 1-0138
LOS ANGELES, CAL. - HOllywood 4-7593
NEW YORK, N. Y. - Circle 7-3326
PHILADELPHIA, PA. - PEnnypacker 5-3559
SAN FRANCISCO, CAL. - EXbrook 7-6280
WINTER PARK, FLA. - MIdway 7-5501

"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

HIGH CLAMP-UP MEETS MACH 2 STRUCTURE NEEDS

hi-Lok®

Faster the speed, more varied the mission . . . the more critical are the structural requirements. Such is the Navy's newest all-weather, nuclear weapons carrying aircraft . . . the carrier-based A3J Vigilante.

Because of their excellent residual preload characteristics, Hi-Loks were selected for use throughout the A3J primary structure. The unique Hi-Lok torque-off feature produces a high, uniform clamp-up of high tensile sheet materials in *all* grip conditions. The installation method is smooth and quiet.

Inexpensive, lightweight, Hi-Lok tooling reduces worker fatigue and avoids the need for heavy squeezers or bulky pull-type equipment and their limitations in close quarters. In open areas, Hi-Loks can be installed at speeds up to 45 per minute.

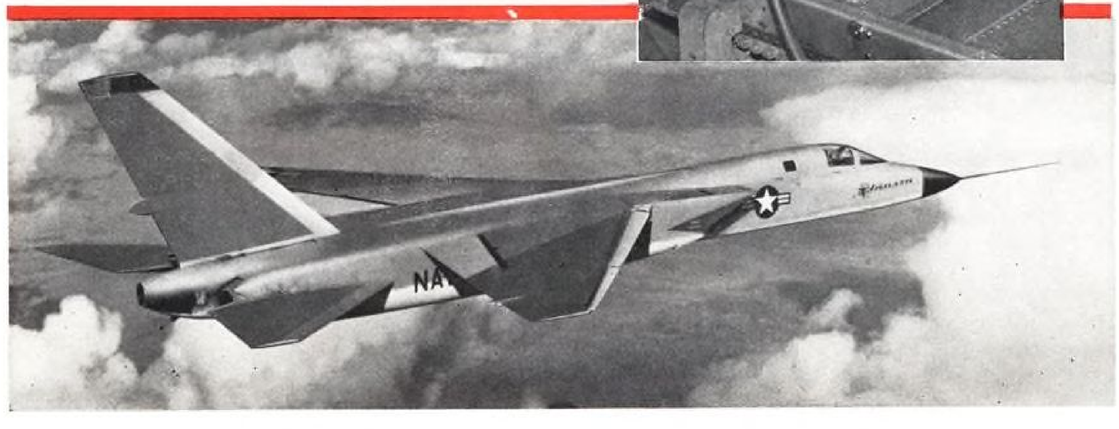
Write or contact us for Hi-Lok technical and specification data.

ABOVE In strength and temperature areas, the A3J uses stainless steel Hi-Lok pins (125,000 psi shear or 220,000 psi tensile) with shanks made to .0005 tolerance; with stainless steel collars, these Hi-Loks can be used to 800°F. Other primary structure uses alloy steel Hi-Lok pins (95,000 psi shear or 160,000-180,000 psi tensile) with shanks made to .001 min. as well as head heights to ±.001 tolerance.

RIGHT Here Hi-Loks are being installed in the A3J rear fuselage with Hi-Lok right angle tooling adapted to a Ratchet Wrench Motor. Other Hi-Lok adaptor tooling is available in straight, extended and offset styles to overcome difficult or tight clearance conditions resulting from the unusual structural configurations of high performance airframes such as the Vigilante.

hi-shear CORPORATION

2600 WEST 247TH STREET • TORRANCE • CALIFORNIA

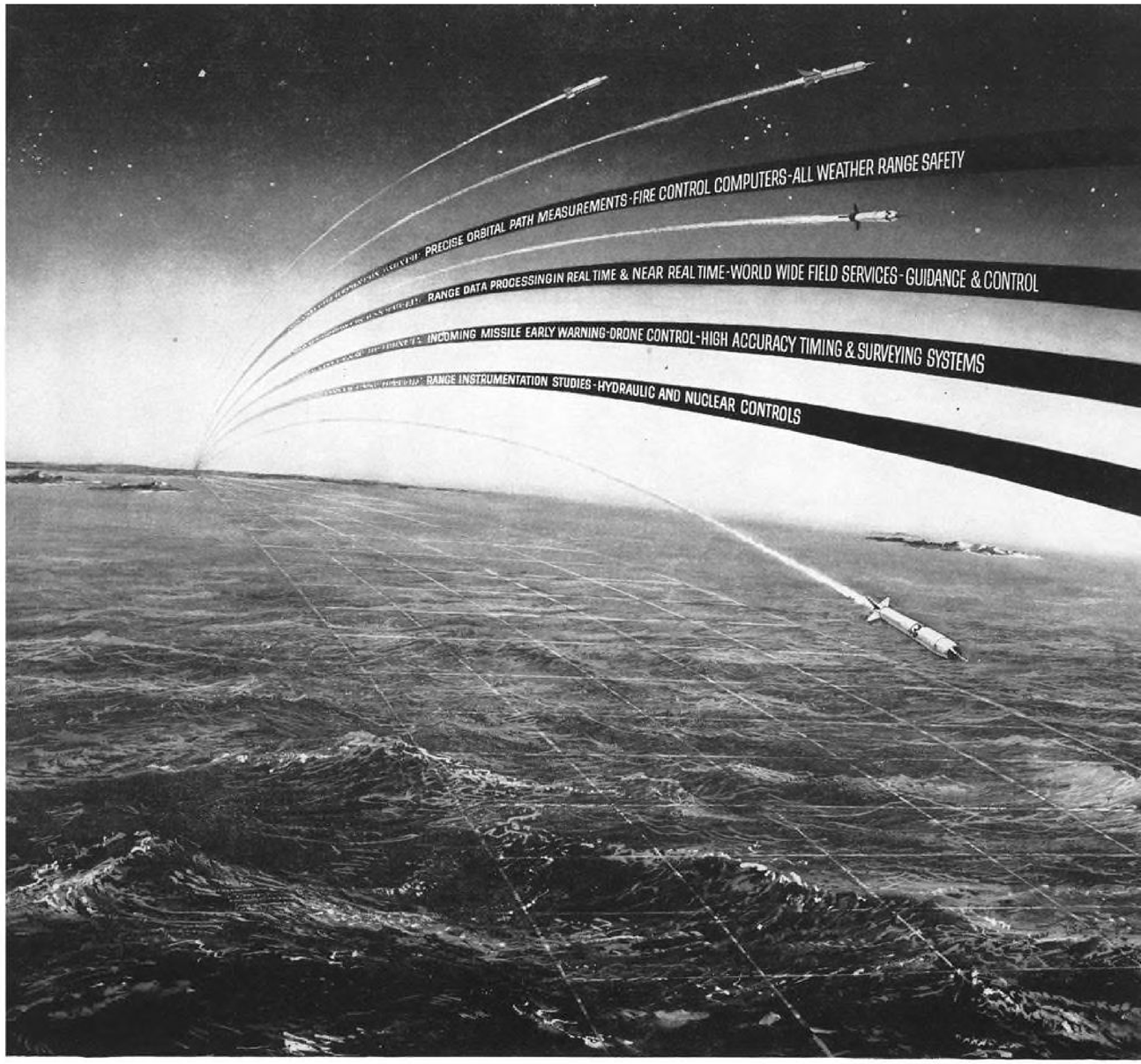


600% more coverage at 2% of cost

Gilfillan has been selected to up-date USAF worldwide GCA network. Now under way, Gilfillan field modifications of 183 USAF GCA systems. Provides, *immediately*, the expanded area of control vital for safer guidance of high performance jets–*at less than 2% of the cost* of replacing these *proven* GCA systems. The low cost *on-site* modifications accomplish the following:

Radar altitude coverage, the most critical factor in jet guidance, is increased more than 400%. Range coverage is extended 50%. Total expansion in radar-controlled airspace, 600%.

Gilfillan
LOS ANGELES



THE MISSILE RANGE: Measure of Capability

The missile range today is a vast proving ground for advanced technologies. It symbolizes the "state of the art" in computation, physics, chemistry, metallurgy, propulsion, hydraulics, electronics, inertial guidance, communications and every other scientific field.

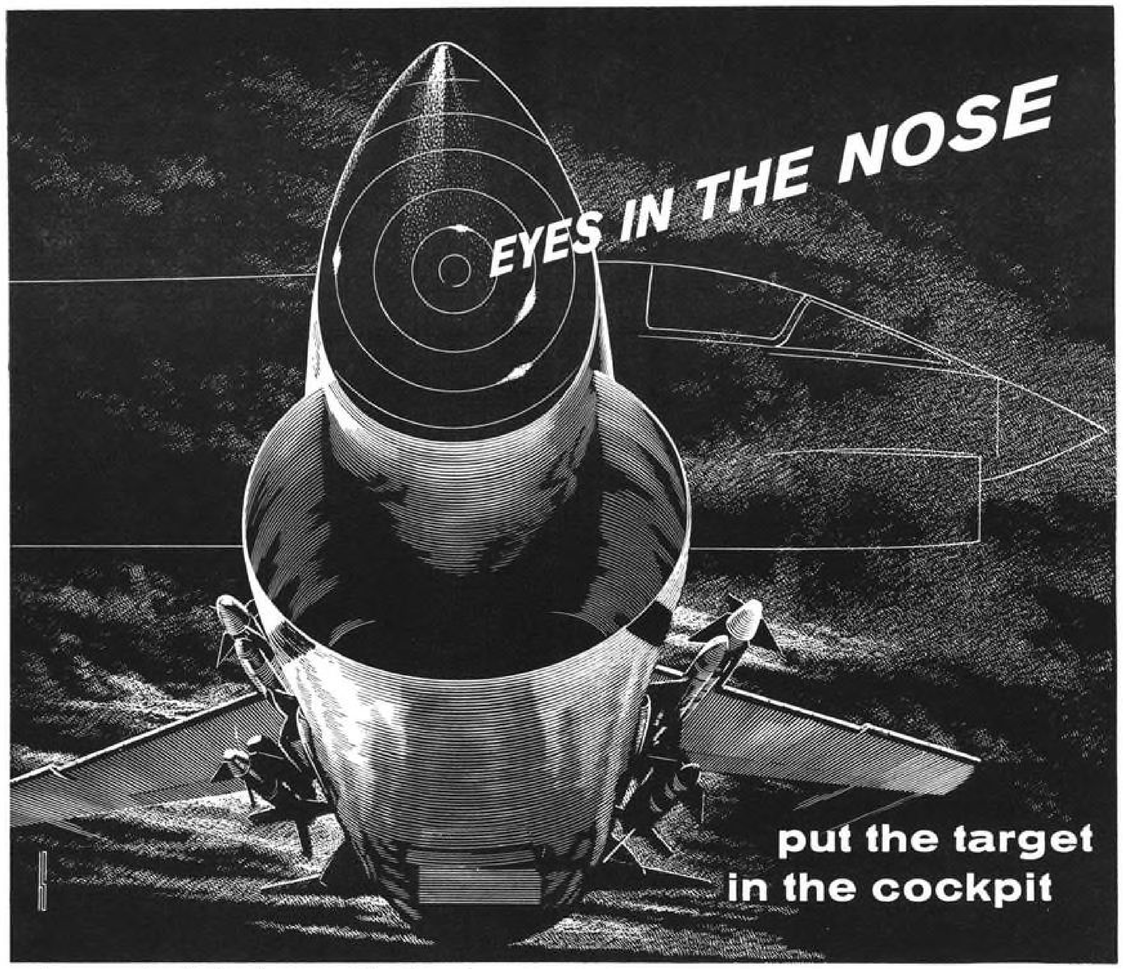
The most critical need of the missile range is to *know system performance exactly*. This calls for integrated standards of measurement and data handling, and therefore for entire systems and entire installations engineered to that objective.

To this problem Sperry Rand has a logical answer: *compatible instrumentation*. The scope of Sperry Rand capability, illustrated above, embraces the whole panorama of the space age. Compatible Instrumentation is the principle of precision in missile range measurement, and a plan of action for applying this principle to projects now developing.

For the necessary team approach to missile range technology Sperry capabilities are joined with those of all other corporate divisions which have contributions to make–among them Ford Instrument Company, Remington Rand Univac, Vickers Incorporated and several component divisions specializing in microwaves, electronic tubes and solid state devices. General Offices: Great Neck, N. Y.

SEA • SURFACE • AIR • SPACE

SPERRY



As a result of development by the Magnavox Company in conjunction with the Navy Department, every Chance Vought F8U-2N Crusader Fighter Pilot sees the target at a glance—day or night, in any kind of weather.

Here are the eyes of a modern weapons system . . . a component that delivers the range, weight and reliability so absolutely necessary to successful tactical operations.

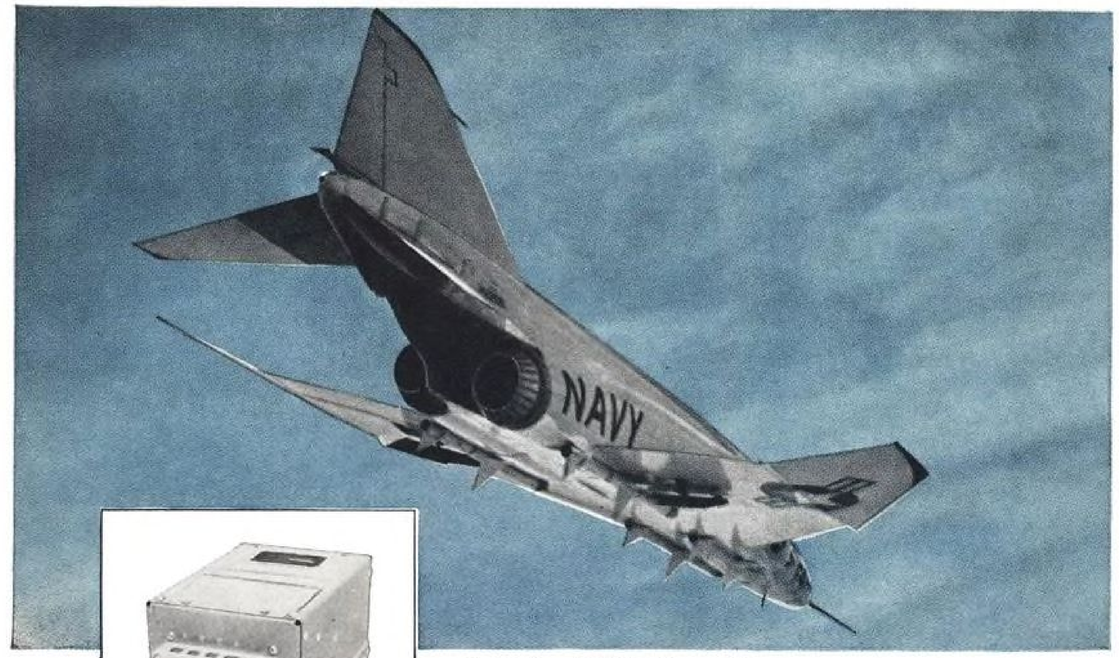
This airborne radar system is just one of many systems which have been and are being designed and produced to satisfy the tactical requirements of the military services in the fields of Communications, Airborne Radar, ASW, Navigation, Fusing and Data Handling.

Magnavox

AIRBORNE FIRE CONTROL RADAR

COMMUNICATIONS	RADAR	DATA HANDLING	ASW	MISSILES

THE MAGNAVOX CO. • DEPT. 304 • *Government and Industrial Division* **• FORT WAYNE, IND.**



The McDonnell F4H-1 Phantom II is the newest fighter to take its well-earned place in the U. S. Navy air task-force. The carrier-based or land-based 1500 mph aircraft relies on Chatham transformer-rectifiers to furnish all the d.c. power required by the aircraft. Two Chatham 28VS60 silicon units are operated in parallel.

MCDONNELL F4H-1 uses Chatham transformer-rectifiers

The McDonnell F4H-1 Phantom II, the newest, highest flying and fastest U.S. Navy fighter, holds both the 100 kilometer and 500 kilometer world's closed course speed records, demonstrating maneuverability and range plus a straight line speed in excess of 1500 miles per hour. Such performance, combined with its ability to carry Sparrow III and Sidewinder air-to-air missiles, makes this twin-jet all-weather fighter an important member of the air defense task force.

To realize such full-scale capability, McDonnell could not afford to compromise when it came to specifying equipment for the F4H-1. Emphasizing reliability and dependability, McDonnell selected Chatham to design and manufacture the power conversion equipment. Two Chatham 60 ampere silicon transformer-rectifiers, built to meet the rigorous electrical and environmental specifications of the F4H-1, furnish all the d. c. power required by more than 60 control and navigational circuits and systems.

McDonnell is yet another of the major manufactures of commercial and military aircraft and missiles who depend upon Chatham to deliver the best in airborne power conversion equipment. To maintain the highest performance standards associated with all Chatham equipment, every phase of design and manufacture is carefully controlled by Chatham engineers . . . even to the manufacture of top-quality solid state components. In this manner, Chatham keeps weight and volume requirements to an absolute minimum while delivering power conversion equipment that is unsurpassed for reliability.

Send for folder T-26A which describes Chatham power supplies. Many are immediately available. Or forward your specifications. We'll gladly recommend the design that will do the best job for you. Chatham Electronics, Division of Tung-Sol Electric Inc., Livingston, N. J. TWX: LVTN NJ-489

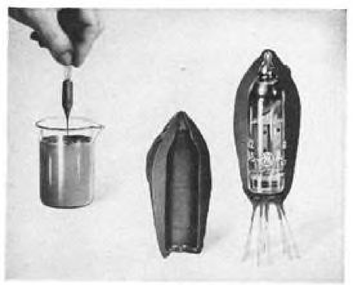
CHATHAM *. . . world's leading supplier of airborne power conversion equipment.*

CHATHAM ELECTRONICS
division of
TUNG-SOL ELECTRIC INC.

General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the "thermal toughness" to stand up under the searing heat of rocket blast-off or possible atomic attack. Add very good electrical properties and excellent resistance to aging, weathering, moisture, flame, ozone and corona and you can easily see why silicone rubber is now being used in virtually every U.S. missile and space vehicle.

Since both space technology and silicone rubber are relatively new, General Electric believes there are many more areas not yet explored where silicone rubbers can help keep a missile functionally reliable and combat-ready. To help designers in their evaluation work, we list here the principal properties and applications of G-E silicone rubber.



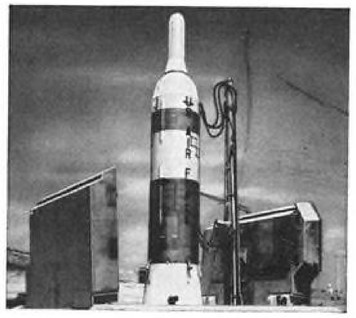
RTV LIQUID SILICONE RUBBER — One of the most versatile materials developed in recent years, RTV is a liquid rubber that cures at room temperatures. Like all silicone rubber, it remains flexible over a wide temperature range and is virtually ageless. Since it comes in a wide range of viscosities, it can be poured, sprayed, dipped, painted or applied with a pressure gun or spatula. It bonds tightly to metal when a primer is used. When not primed, you can readily remove RTV and then reapply more. You can impregnate tightly wound coils with RTV or form sections several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

Viscosity	**from 120 poises (very pourable) to 12,000 poises (paste)**
Specific Gravity	**1.2 to 1.5**
Solids Content	**100%**
Shrinkage	**0.2%**
Heat Resistance	**from —90°F to 600°F, and as thermal insulation, in 5500°F flame for minutes**
Ozone Resistance	**Comparable to Mica**
Electrical Properties	**See last table**

Applications—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

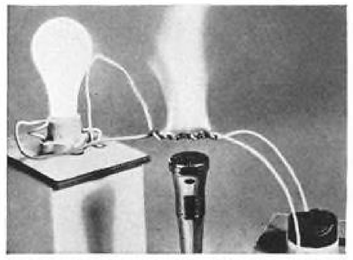
RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.



HEAT CURED SILICONE RUBBER PARTS —Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and non-aging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

Tensile Strength, psi	**800—1500**
Elongation, %	**100—600**
Hardness Durometer (Shore A)	**25—80**
Compression Set, %	**10—80**
Tear Resistance lb/in	**40—200**
Radiation Resistance	**1 x 10^8 roentgens**
Electrical Properties	**See table below**



WIRE AND CABLE INSULATION — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

Volume Resistivity	**10^{15}—10^{16}**
Dielectric Strength, volts/mil	**600—650**
Dielectric Constant, 60 cps	**3.0**
Power Factor	**.0010—.0050**
Radiation Resistance	**1 x 10^8 roentgens**
Physical properties	**Similar to table above.**

Applications—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

●

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section J1133, **Silicone Products Department, General Electric Company, Waterford, New York.**

Progress Is Our Most Important Product

GENERAL ELECTRIC

WHATEVER THE WEATHER

the Ryan AN/APN-97 Doppler Navigator for helicopters continuously and automatically detects and displays drift, vertical and heading speeds. By providing sustained automatic hovering and **all-weather** capabilities, it made possible a vital breakthrough in anti-submarine warfare missions. The first, lightest, self-contained navigator of its kind, the APN-97 is in full production for the Navy, Marines and Coast Guard and is the **only** Doppler helicopter navigator in world-wide operational use. The APN-97 operates on the **approved** frequency of 13,300 megacycles and has demonstrated **very high accuracy.** Applications include: All-Weather ASW, Rescue, Navigation, Blind Landings, Automatic Hovering, Aerial Surveys, Drone Helicopter Control, Traffic Control. World leader in the field of C-W Doppler navigation, Ryan Electronics is also making significant progress in solving problems essential to the success of future missions into Space.

RYAN
ELECTRONICS

A DIVISION OF RYAN AERONAUTICAL COMPANY ▪ SAN DIEGO ▪ CALIFORNIA

Ryan offers challenging opportunities to engineers

November 28, 1960

Aviation Week and Space Technology

Vol. 73, No. 22
Member ABP and ABC

EDITORIAL OFFICES: New York 36—330 W. 42nd St., Phone: LOngacre 4-3000 (Nights LO 4-3035) Washington 4, D. C.—National Press Bldg., Phones: NAtional 8-3414, REpublic 7-6630 Los Angeles 17—1125 West Sixth St., Phone: HUntley 2-5450 Dallas 1—1712 Commerce St., Phone: RIverside 7-9721 European Office—1 rue du Temple, Geneva, Switzerland, Phone: 32-35-63

COVER: One of the first color photographs taken of the earth from outer space was made from the RVX-2A General Electric re-entry vehicle carrying a 70 mm. camera. Picture was made over the South Atlantic just after dawn Oct. 13 from an altitude of 700 mi. Seven separate cloud layers are identifiable over the South Atlantic in sunlight at lower left. Black space outside earth's atmospheric envelope is visible at top of photo, with dividing line between day and night cutting vertically through right center of the photo. Re-entry vehicle recovery pictures appear on p. 63.

PICTURE CREDITS

Cover—General Electric; 28—Wide World (left) United Press International; 29—Wide World (left), NASA; 32—NASA; 33—The Martin Co.; 47—Canadair; 55—Lockheed; 61—Short Brothers & Harland, Ltd.; 63—General Electric; 71, 73, 75—Space Electronics; 95, 96, 97—Aero Commander, Inc.; 125—British European Airways.

84,281 copies of this issue printed

EDITORIAL

More Scrutiny of CAB

Another analytical look at the Civil Aeronautics Board has been taken, this time by McKinsey & Co., management consultants hired by the Bureau of the Budget. For a full report on their recommendations see p. 38. The McKinsey report, along with the survey being made by James M. Landis (AW Nov. 21, p. 37) and some self-analysis by the Board members themselves (AW May 2, p. 38), should provide ample material on which to base a badly needed reorganization and reorientation of the CAB so it can adequately perform its function in the jet age.

We strongly support the McKinsey recommendation that the term of the CAB chairman be increased from a single year to three years. Much of the future success of the Board will depend on the work of an outstanding chairman. It is virtually impossible to do an outstanding job of leading any organization, even a big league baseball team, under an annual contract renewal.

The Renewal Threat

In the case of the CAB, the annual appointment of the chairman has been used sometimes as a political knife to cut the throat of an able chairman who aroused the ire of a politically powerful airline, and there is always an implied threat of this kind of action even if it fails to materialize. A three-year term would give the chairman a much more solid base from which to operate and would permit a more vigorous exercise of leadership.

This premise also supports the increase of the CAB to a seven-man membership. This increase would allow the chairman more time to function in that capacity and tie him down less to ordinary membership duties required under the present system. It would also give the CAB a much broader outlook than it has ever exhibited by providing for more varied opinions on its major issues.

There is also little doubt that some reorientation of CAB activities is required if the Board is to devote its major effort to the major problems of the air transport industry and the public it serves. We see little profit in some of the trivial directions the CAB staff takes, such as its current investigation of Admiral, Ambassador and Clipper club operations. It is obvious that CAB examiners badly need help in the preliminary preparation of route cases. These cases now take as much as two or three years work almost single-handed before they are ready for an examiner to make his recommendations to the Board.

The CAB of the 1960s will be required to cope with some of the most financially acute, technically complex and socially expansive problems that any mode of transport has ever faced, and it must be organized and operated to cope with them properly. Among the major continuing problems it must handle effectively are:

• **Combined impact of creating excessive** route competition during the past five years and the sudden, revolutionary seat expansion created by the capacity and velocity of jet transports. The basic policy of creating competition along many former monopoly routes was sound, but by failing to anticipate and understand the jet impact on this competitive pattern, the CAB went much too far in creating competition beyond what the public requires to provide it with better service and far beyond what the traffic on many of these routes can economically support. A new look at this entire jet age route and traffic pattern is urgently required. The too simple solution of mergers will not solve many of these problems either. Many of the mergers now proposed as solutions to this over-competition, over-capacity problem will simply weaken currently strong trunklines and pave a path toward an eventual return to federal subsidy.

• **Fare regulation will continue** to be a burning issue. The CAB's past policy on fares has been far too narrowly conceived and restrictive to function effectively. It must devote considerable effort to devising a more flexible policy that will adequately protect the public against excessive charges but allow the competing carriers to develop new services and rates that will fill the growing seat capacity available. This is an activity that the Board should be studying continuously, not just waiting until airlines come to its door with specific problems.

• **Foreign competition with both U. S.** international and domestic airlines is growing stronger and more politically potent. The CAB must develop a more powerful voice in the U. S. position on this issue if it is to adequately support the air transport pattern. Currently it is much too subordinate to State Department to do much of a job.

• **Safety is a much disputed function** of the CAB. As the Board is now staffed, it does not have sufficient technically qualified personnel to adequately do the jobs it is supposed to perform. Either the safety function should be completely divorced from the CAB, leaving it free to concentrate entirely on economic matters, or the current safety staff should be enlarged to enable it to discharge its responsibilities properly. The recent performance of the CAB on the Electra safety problem offered strong evidence in favor of getting the technically unqualified Board members out of the safety picture completely.

People Are the Key

But whatever administrative or procedural changes are effected for the CAB, its basic problem will still remain the attraction of high caliber, properly qualified personnel both to the Board itself and to its key staff positions. The recent failures to persuade some top grade people to accept appointments to the CAB were certainly discouraging, and this has been a government-wide problem in recent years by no means confined to the Board. But its solution is the key to the effectiveness of any other reforms that are introduced into the CAB's sphere.

Nobody in the air transport business today will contest the need for a capable, fast-acting Civil Aeronautics Board in the knotty years that lie just ahead in the jet age.

—Robert Hotz

WHO'S WHERE

In the Front Office

The Military Products Group of Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., has announced the following appointments: **Charles L. Davis**, vice president and manager of all Aeronautical Division operations; **M. P. Fedders**, vice president and manager of the company's Boston, Mass., division; **W. T. Noll**, manager of Aeronautical Division operations in Minneapolis; **J. W. Anderson**, manager, Aeronautical Division's St. Petersburg, Fla., facility.

Hans M. Schiff, vice president and general manager, Technical Products Division, Packard Bell Electronics Corp., Los Angeles, Calif.

Lewis Boddington and **Raoul Hafner** have joined the board of Westland Aircraft, Ltd., Yeovil, Somerset, England. Mr. Boddington will be technical director-development, and Mr. Hafner, technical director-research.

Clifford A. Busse, vice president-operations, Siegler Corp.'s Hallamore Electronics Division, Anaheim, Calif.

Robert E. Delany, president, Icelandic Airlines, Inc., succeeding **Nicholas Craig**, retired.

Donald R. Butterfield, vice president-marketing, Idaho Maryland Industries, Inc., Los Angeles, Calif.

Edward G. Schroeder, vice president and director-engineering and sales, Electric Products Co., Cleveland, Ohio.

Charles L. Nelson, assistant to the president of C & H Supply Co., Inglewood.

Charles Liskey, executive assistant to the president, Electro-Tec Corp., South Hackensack, N. J., with headquarters at the Ormond Beach, Fla., facility.

Dr. Clifford Furnas, chancellor of the University of Buffalo, has been elected president and chairman of the board of trustees of the Western New York Nuclear Research Center.

Cmdr. Simon J. Burttschell (USN), head of the National Aeronautics and Space Administration's newly established Test Support Office at the Pacific Missile Range, Point Mugu, Calif.

Honors and Elections

Richard Rhode, assistant director of research of the National Aeronautics and Space Administration, and **Bo Lundberg**, director of the Aeronautical Research Institute of Sweden, have received the Flight Safety Foundation's Award of Merit. Awards of Merit, provided for by AVIATION WEEK magazine, are presented for distinguished service in achieving safer utilization of aircraft.

Lloyd V. Berkner, president of Associated Universities, Inc., has been elected president of the Institute of Radio Engineers for 1961. Also: **Franz Ollendorff**, research professor at the Technion-Israel Institute of Technology, Haifa, Israel, was elected vice president representing overseas countries; **J. F. Byrne**, manager of the Riverside (Calif.) Research Laboratory of Motorola, Inc., was elected vice president representing North America.

(*Continued on page 126*)

INDUSTRY OBSERVER

► Air Force Ballistic Missile Division has been briefing automatic checkout equipment manufacturers individually in an effort to secure off-the-shelf equipment for the Midas and Samos programs. This equipment would not be related to the automatic programing and test system for Lockheed's high vacuum orbital simulator (AW Nov. 14, p. 23).

► **Proposals are due soon for forward area data processing equipment capable of providing fast analysis of data, such as electronic countermeasures information, recorded by Strategic Air Command aircraft. Equipment would be located at forward bases so processing could begin soon after an aircraft landed. The project is being handled jointly by SAC and Rome Air Development Center.**

► Soviets claim to have developed synthetic transistors with parameters similar to germanium transistors. Credited to Nobel Prize chemist N. N. Semenov, the synthetic transistors are made of polyacrylonitrile. The material is given its semiconductor qualities by using electron bombardment or intense heat. Other materials found to acquire semiconductor properties under heat are polyvinylchloride, polyvinylbenzene and polystyrene.

► **Defense Department funding of studies of the transient effects of nuclear explosions on electronic equipment (AW Aug. 8, p. 58) is being controlled by the transient effects panel in the Defense Atomic Support Agency. Serving as nuclear weapons adviser to Defense, the agency has 16 panels whose studies include biological and space effects.**

► Sikorsky is building three twin-engine S-64 flying cranes, powered by Pratt & Whitney JTFD-12 turboshafts. One will be used as a company demonstrator and the other two will be sold to West Germany through United Aircraft's German subsidiary, Weser Flugzeugbau. West German order has not yet been signed.

► **Planned switch to Rolls-Royce RB.163 turbojets for the Blackburn NA.39 Buccaneer should give the naval strike fighter low-level supersonic dash capability. New 10,100 lb. thrust engines are expected to increase the aircraft's speed on the deck from the current Mach 0.9 to Mach 1.2.**

► British TSR.2, tactical strike-reconnaissance fighter design with V/STOL performance, is expected to weigh about 90,000 lb. Technical arguments still continue in U.S. and Britain over the need for this aircraft, which is under development by a joint English Electric-Vickers team. TSR.2 proponents cite its supersonic capabilities coupled with V/STOL performance. Opponents point to high development costs and say the NA.39 with Rolls-Royce RB.163 engines can perform all TSR.2 missions except the short-term Mach 2 dash capability specified by the Royal Air Force.

► **Army pilots are flying the Northrop N-156F fighter and Douglas A4D-2N attack aircraft at Edwards AFB to evaluate the operation of high performance aircraft in a close air support role.**

► Soviet Union has a new all-metal glider, designated A-15, which is equipped with a lightweight "remote pilot" system. Glider carries a two-way radio and transponder beacon. Ground radar operator can determine glider's distance, altitude and speed and is responsible for notifying the glider pilot of deviations from course. Glider also carries a "thermovisor" to help its pilot locate upward air currents.

► **Sweden is considering an order for Bomarc B defense missiles and is discussing performance and price details with Boeing.**

► U.S. aircraft industry will be permitted to bid in future NATO design competitions, but they will face stiff barriers. There is continuing political pressure to keep NATO work in European factories, and high costs are a serious barrier to acceptance of a U.S. design. American companies are increasing cooperation with European firms to reduce costs, and they may submit joint proposals in future competitions.

Washington Roundup

Military Budget Shock

Shocked military budgeteers worked through the pre-Thanksgiving weekend to repair their Fiscal 1962 money requests after Defense Department's review of the original proposals eliminated whole programs and added others that are not wanted.

Revised requests were being presented to Defense last week, but a number of major projects were stalled on the desk of Defense Secretary Thomas S. Gates, Jr. Among them were approval of the government-sponsored supersonic transport program, which Air Force wants to manage, and Tactical Air Command's proposal for an STOL fighter.

Gates does not want to approve any big new projects until he determines their probable impact on the Fiscal 1963 and 1964 budgets. This caution, plus deep cuts in several key development proposals, have convinced some observers that many programs will lose six months because of the change of administration, no matter how rapidly President-elect John Kennedy gets moving in January.

NASA's budget request for Fiscal 1962 will be 25% above the $915 million asked by the Administration for the current fiscal year. NASA also will ask for a supplemental for Fiscal 1961. It will include funds for communications satellites and booster development.

Man-in-Space Fog

Latest example of the kind of confusion resulting from the present official attitude that there is no demonstrable military need for man in space is the Space Plane project. Air Force wants $20 million in Fiscal 1962 to study this manned atmosphere-orbital-space vehicle. But because NASA is the only agency clearly charged with manned space exploration now, it is proposing taking over Space Plane (see p. 26).

Investigation of rocket engine programs by Congress early next year will re-open the old controversy over NASA's award of the 200,000-lb. thrust Saturn hydrogen engine development to Rocketdyne.

Aerojet-General objected strenuously—one official wired the agency that he was "profoundly shocked"—when Rocketdyne's $44 million bid beat out Aerojet's $66 million bid last June. Aerojet President Dan Kimball tried to get NASA Administrator Keith Glennan to hold another competition between these two companies only, since Pratt & Whitney—the third serious contender on a technical basis—had bid almost triple Rocketdyne's price and Glennan had cited cost as a major factor in selecting the winner.

Contract changes made since the award will run development cost above Rocketdyne's original price. This apparently is the biggest lever critics have handed Congress to use in prying the case open.

Watch for a quiet drive by vehicle prime contractors to regain control over initial flight test programs, a function which is being assumed by NASA and Air Force in more and more projects. No contractor demonstrations were allowed on the Mercury capsule, nor are any company flight tests planned for Dyna-Soar.

Industry feels that these demonstrations, long a part of aircraft contracts, are necessary for working out technical bugs before the flight hardware is turned over to the customer.

NASA-AEC Friction

Creation of a joint NASA-Atomic Energy Commission office to handle the Rover nuclear rocket program has not entirely eliminated friction. AEC labs usually are barred from advanced development work, but Los Alamos wants to stay with the Rover reactor through initial flight tests. NASA prefers to bring industry in well ahead of that step.

NASA also wants its Lewis Research Center to act as systems director, but AEC maintains NASA has no charter to direct nuclear reactor work. NASA cites AEC's approval of the Plumbrook test reactor at Sandusky, Ohio, which Lewis operates.

Former AEC Commissioner Thomas E. Murray has cited military support in answering strong criticism of his attempts to end the nuclear test ban. He points to urgent official requests by the three military services for studies of the "revolutionary" new nuclear weapons which Murray says have been kept in the laboratory stage by the ban. He did not quarrel with speculation that these weapons are bombs high in neutron output but low in blast effect and radioactive fallout.

Dr. Herbert York, who had a heart attack last summer, is back at his post as director of defense research and engineering. But there is speculation that he will leave the Pentagon for a less hectic position when the new administration takes over—possibly returning to the University of California Radiation Laboratories at Livermore.

—Washington Staff

Services Challenge NASA's Dominant Role

Pressure increases for bigger military program; major national space policy changes expected.

By Edward H. Kolcum

Washington—Civilian domination of the U. S. space program has entered its most critical period as the military services increase pressure for a bigger role in anticipation of a major shift in national space policy under the Kennedy Administration.

Result could range from a clear delineation of present roles and missions to a general overhaul in which the National Aeronautics and Space Administration would surrender its operational and contracting responsibilities and revert to a research agency. Some top officials of NASA and the Defense Department eagerly anticipate White House action as the only means of clearing the air for a realistic national space effort.

NASA and the services, closely cooperating on a wide spectrum of space and aircraft problems, would prefer that there be no need for a power struggle. However, the military services feel trapped by the lack of a definitive, approved space program. NASA, very much aware of the military chafing, is preparing itself for the expected battle.

All groups have convincing arguments for retaining or expanding their space roles, and behind these arguments are interpretations of the 1958 space act which established NASA.

NASA feels it is following its mandate under a strict interpretation of the space act and is zealously guarding its projects. It has had the potent backing of the White House in this interpretation, but the President has not been as clear in defining the military role. The Air Force, for example, believes it has genuine space missions in warning, communications and surveillance satellites. It insists Soviet Russia will exploit space militarily at every opportunity. Carrying the defense responsibility one step farther, all three services feel they are obligated to study every aspect of space to determine its military potential and to take unlimited and unrestricted advantage of it.

NASA tacitly concurs on the military potential of space and apparently would give strong research support if White House and top Defense policy-makers would agree on specific missions and funding areas. It feels that the Defense Department has yet to obtain clear-cut approval of an over-all space program.

Understandable confusion on the general space program resulted from the frequently-stated position of President Eisenhower (AW Sept. 26, p. 28), virtually excluding military space projects. At the same time, the Air Force was drawing up specifications to back the Samos reconnaissance satellite with the E-6 capsule (AW Sept. 12, p. 31). Similar confusion surrounds Vela, Dyna-Soar and communications satellite projects.

While NASA appears ready to reconsider and perhaps surrender some projects, as it did with the geodetic satellite, the feeling in the agency is strong that it is prepared to wage a strong fight to prevent military domination of the national space effort at the expense of the thorough scientific exploration.

Defense Department is banking heavily on recognition by the Kennedy Administration that there is a military mission in space. Air Force insists it will use space when it is the only way to perform a mission—like global reconnaissance—or when a mission can be performed better there, as in the Midas early warning satellite program.

Defense has been unable to convince President Eisenhower on its space role, which it feels is restricted primarily not by finances, but by a national philosophy which virtually excludes identification of military with space. Legislation clearly spelling out Defense Department's responsibility in space was introduced but failed to pass in the last congressional session.

Both NASA and the Air Force anticipate some changes in the space program, but they differ in predicting the general effect. Air Force says it covets none of the existing NASA programs, but fears the effect of civilian requirements overriding and blocking those necessary for military operations.

NASA anticipates that vast expansion in military programs will bring a corresponding reduction in its own effort. Although hampered by White House restrictions against criticizing military programs, NASA is lining up its spokesmen to meet the expected sales campaign in the White House and in Congress.

The space agency feels the scientific community, foreign reaction and congressional allies will be effective voices in retaining the major role it now has.

NASA may be forced to take its fight to the Kennedy Administration and to Congress with a new staff because at least eight of its top officials hold political appointments and are expected to be replaced. Depending on the extent to which Kennedy wants to change NASA management, officials are expected to be replaced in this order:

- **Administrator Keith Glennan.**
- **Deputy Administrator** Dr. Hugh L. Dryden.
- **Assistant Administrator** for Congressional Relations James P. Gleason.
- **Director of Public Information.** This job is vacant but the duties are being performed by Shelby Thompson.
- **Associate Administrator** Dr. Robert C. Seamans, Jr.
- **Director of International Programs** Arnold W. Frutkin.
- **Director of Business Administration** Albert F. Seipert.

One additional job considered somewhat politically sensitive is that of program planning and evaluation director. Although this is a scientific job, it is held by the NASA administrator's top adviser on the over-all space program. Abraham Hyatt, former deputy director of launch vehicle programs, will take this post Dec. 1, replacing Dr. Homer Joe Stewart.

Exemplifying conflicting areas which now exist in roles and missions is the manned space flight effort, which NASA considers its responsibility. By interpreting this responsibility literally, the civilian agency has bid for direction of the proposed Air Force Space Plane project (AW Oct. 31, p. 26) causing considerable resentment in USAF.

On the other side, NASA says the military often fails to sell its own programs to Pentagon and White House decision-makers, yet blames NASA for holding back progress. This is considered the case in the Dyna-Soar program. NASA feels it is proving its willingness to help the Air Force by identifying Dyna-Soar as an aeronautical program so that it can be funded without violating the national policy prohibiting manned military aerospace vehicles.

Both NASA and Air Force want to see the vehicle develop into an orbital spacecraft, but NASA says it cannot support Dyna-Soar as a true space program until the Air Force gives the vehicle a mission and the mission gets the approval of the Air Force, Defense Department and White House.

Defense itself has approved only a suborbital research aircraft to study temperature and pressure distributions in suborbital flights from Mach 18 to Mach 22, and it has limited Dyna-Soar booster vehicles to those available in 1965. NASA contends that the only booster capable of orbiting a Dyna-Soar weapon system is Saturn.

Air Force plans to request Fiscal 1962 funds to triple its present $50 million support for Dyna-Soar. USAF conceivably could try to skip the suborbital vehicle, over NASA objections, and go directly to an orbital craft.

Samos E-6 Winners

Washington—Martin Co.'s Baltimore Division, General Electric's Missile and Space Vehicle Dept. and Eastman Kodak have been chosen by USAF to develop the Samos E-6 reconnaissance satellite. Martin will do interstage work, GE the recoverable capsule that will return intelligence data to earth and Kodak will do the photo intelligence.

Global Forecasting System Planned With Network of Weather Satellites

Washington—Master plan for continuous operation of seven weather satellites has been prepared by a joint government weather committee to lay the groundwork for a national effort to win the practical and political benefits of a global forecasting system under U. S. leadership.

Master plan calls for the use of Tiros, Nimbus and Aeros meteorological satellites as steps toward the goal of developing an ultimate system of seven satellites and the ground equipment needed to make them practical weather forecasting tools. The program would be run by the Weather Bureau, with the National Aeronautics and Space Administration and other agencies participating.

The plan was developed by a joint weather committee composed of representatives of the Weather Bureau, NASA, Navy and the Air Force Air Weather Service. This group will send a report, along with a request for substantial funding, to the White House shortly after Sen. John Kennedy is inaugurated President Jan. 20.

Committee based its study on the successful results of NASA's Tiros satellite experiment, and it recommended that future Tiros satellites be reoriented as operational systems. Next step would be Nimbus satellite operations, which would begin in mid-1962, and the full real-time global network would be in operation six years later.

Ultimate space meteorological system would consist of four Aeros satellites in stationary equatorial orbits and three Nimbus polar orbiters. Like the Rand Corp. (AW Nov. 21, p. 28), the plan recognizes that use of the full potential of the system depends on better ways to communicate information from the seven-satellite system.

Satellite system would be able to:

- **Determine cloud amounts,** cloud types and vertical structures, and measure ice and snow cover. Observations could be made both day and night.
- **Measure radiation** and temperatures of the earth's surface, clouds, tropopause and atmospheric layers.
- **Measure atmospheric masses.**
- **Detect precipitation areas.**
- **Collect and store data** from remote stations or from free-floating balloons. Balloons could provide wind, temperature and humidity readings.

Permanent meteorological satellite plan now being drafted contains no cost estimates, but it says funding is necessary for development, project direction, facilities and research.

Development effort is required for constant pressure balloons with pressure, temperature and humidity sensors. Also required are development work in satellite-borne radar, radiation sensors, atmosphere mass sensors for surface pressure computations, and high quality, large capacity communications systems, including high resolution television camera systems.

Project direction money is required to carry out international and interagency coordination, to issue development and research contracts, and to device a plan and schedule developments.

Funds will be required to establish readout stations, communications links, balloon launch facilities, satellite launch pads and package instrumentation laboratories.

Research is planned for new instrumentation and on the most efficient methods of distribution and utilization of data.

NASA would retain responsibility for equipment design and development, launching and data acquisition. Weather Bureau would handle data analysis and meteorological research, which would be done at the new National Center for Atmospheric Research at Boulder, Colo.

A new civilian-military liaison committee would be responsible for U. S. coordination, and the World Meteorological Organization (AW Oct. 3, p. 31) and United Nations would be responsible for international cooperation.

Along with the preliminary master plan, the panel compiled a comprehensive definition of satellite potential based on the scientific achievements of Tiros I. The report says the first Tiros was so successful that remaining Tiros and Nimbus satellites should be planned as operational, rather than test vehicles.

Instrumentation already proven provides a capability for daytime cloud observations, ice and snow cover observations, thermal radiation balance, and two-way communications.

Instruments are being developed or tested which improve cloud and snow cover resolutions, as is equipment for night cloud observation and sensors for surface, cloud top and tropopause temperatures.

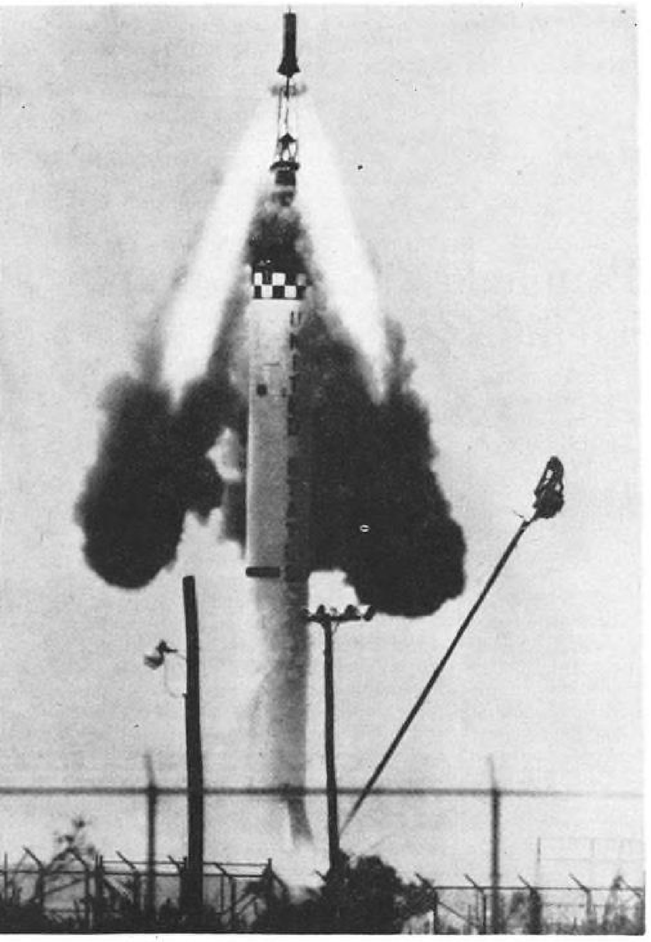
Data potentially available includes complete temperature soundings of the atmosphere; accurate cloud composition and extent, using satellite-borne radar; communications and data processing capacity to collect and transmit information from remote surface and balloon stations; and instruments to measure surface atmospheric pressure, humidity, and variable gases in the atmosphere.

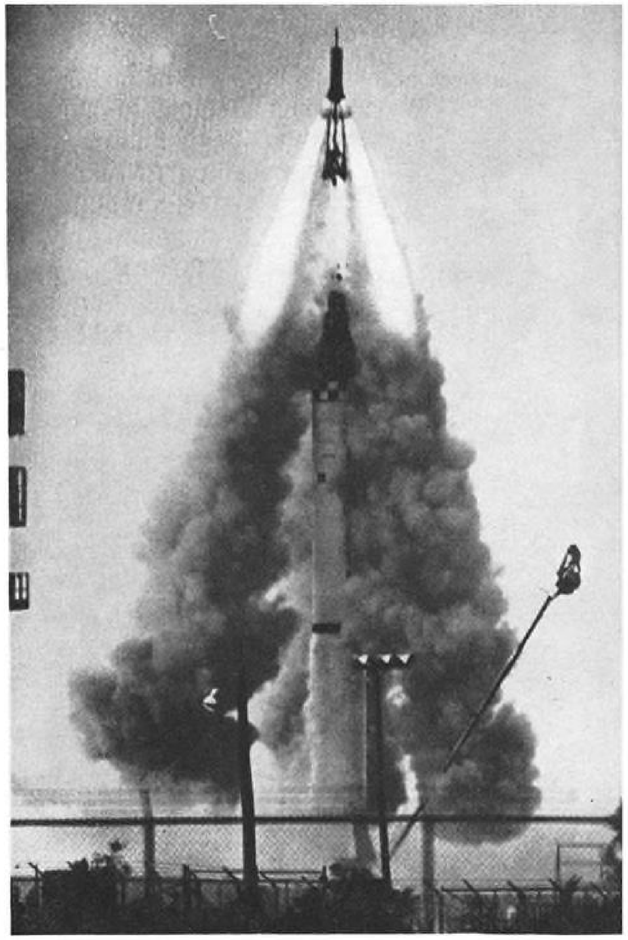
Because clouds are physical indications of atmospheric processes, satellites will principally be used to take and transmit cloud cover photographs. Operationally, weather satellite data will be used for:

- **Hurricane forecasting,** in the U. S. and in Japan, India and Australia. Since tropical storms have clear vortex signatures, satellites will be able to follow storm formation development, and to track the clouds for small-scale (1-12 hr.) forecasting over local areas.
- **Broad-scale forecasting,** from 12-72 hr., which will give meteorologists clear patterns of cloud development and intensity over ocean and land areas where conventional observations are not available, particularly in the Southern Hemisphere. By relating weather systems to cloud structure more directly, existing theories of air masses, fronts and jet streams are expected to become more nearly accurate.
- **Aviation forecasting,** both civil and military, especially for jet operations and air-to-air refueling missions. Particularly significant will be the capability to determine areas of clear air turbulence from high cloud activity.

Small-scale forecasting requires observations within 400 mi. of the forecast area, and broad scale and extended (three to 30 days) forecasts require hemispheric observations.

Present forecasting methods provide 22% of the information required for small-scale problems—flying weather and severe storm forecasts—and 21% of medium and extended range requirements, according to the report. Tiros/Nimbus system would give 43% of small-scale and 30% of the required broad-scale information. The ultimate Nimbus/Aeros seven-satellite network has the potential to give 85% of the data needed for small-scale operations, and 90% for medium and extended forecasts.





MERCURY CAPSULE escape tower has just started separation from the Redstone booster (left) although the booster engine had shut down automatically upon ignition. At right, the tower, is pushed aloft by its two solid propellant rockets which are used for both abort and jettison. National Aeronautics and Space Administration officials said damage to the capsule and booster was slight.

First Mercury-Redstone Flight Test

Cape Canaveral, Fla.—First launch of the Mercury-Redstone (MR-1) vehicle failed here last week after the booster engine shut down almost immediately upon ignition. Preliminary investigation indicated that an electrical connection to the engine apparently was at fault.

Countdown had proceeded to T—zero with one short hold of 2 sec. at T—8 sec. At zero, the Redstone booster engine fired and then automatically shut down after a fraction of an inch liftoff. For reasons yet undetermined, the Mercury escape tower received the signal of "normal engine burnout" which should not have occurred until after 140 sec. Two solid propellant rockets promptly ejected the tower from the capsule.

Launch team said an electronic ground plug had released too soon, sending negative voltage to the tower, which interpreted the voltage as the "normal burnout" signal. Plans last week were to simulate the malfunction in an effort to determine why the tower interpreted the negative voltage as the burnout signal.

The 16-ft. derrick-like unit headed into the clouds, reaching an altitude estimated at 8-12,000 ft. It impacted on the beach some 1,200 ft. northwest of the Redstone launch pad.

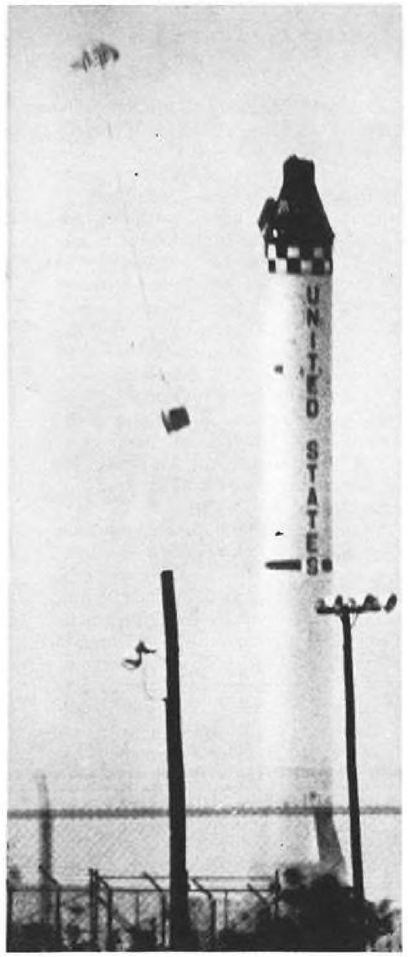
Damage to the Mercury capsule and Redstone booster was slight. Flight previously had been postponed due to a control system gas leak (AW Nov. 14, p. 34).

The larger of the two solid rockets, producing 55,000 lb. thrust, is used for both abort and jettison. The smaller rocket, of 400 lb. thrust capability, is fitted to the base plate between the three nozzles of the larger unit and is used for jettison only. Recovery of the tower showed that both rockets had fired, indicating that a jettison, rather than an abort, signal had been received.

National Aeronautics and Space Administration officials said that until this factor was solved, other Mercury-Redstone shots would be delayed.

Firing of the tower ejected the antenna canister and pulled out the drogue parachute. It also armed three posigrade rockets, located at the base of the capsule, which are used to accelerate the capsule ahead of the booster in the separation phase.

Once armed, the posigrade rockets are fired by sensors at .25g forces. Because of this, and a still-hot command



MERCURY antenna canister was ejected with the tower; drogue chute lowers it to beach area near the launching site.

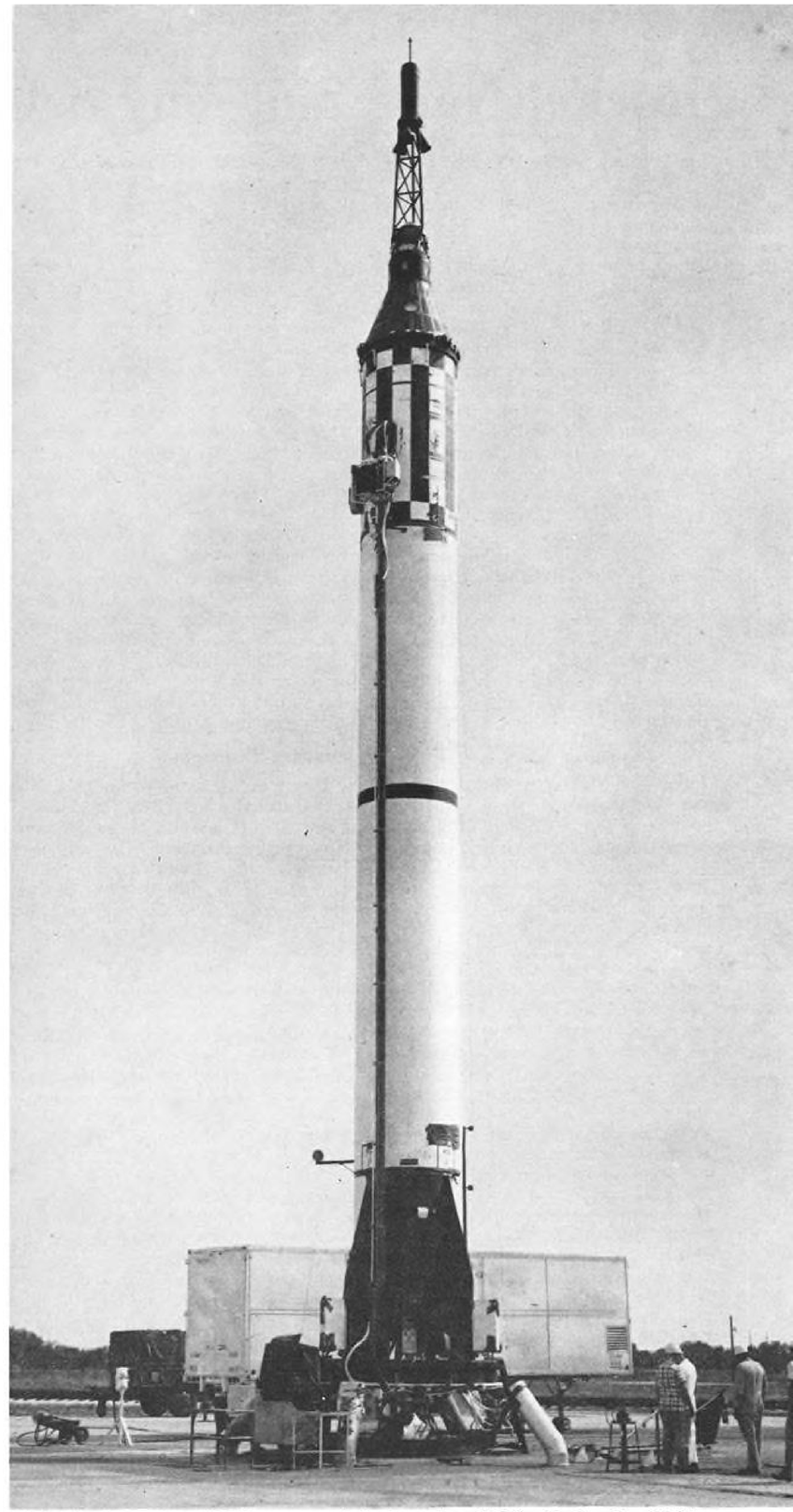
Fails on Pad

destruct system, the area around the MR-1 stand was declared unsafe for 28 hr. after the attempted launch.

Normally, the jettisoning of the tower arms the two parachutes in the top of the capsule to be deployed. The drogue chute opens at 42,000 ft.; the ringsail at 10,000 ft. Barometric sensors immediately detected sea level pressure and both chutes fell out, dangling alongside the Redstone booster.

MR-1 carried an automatic abort sensing system, but as this was operated on open loop and as the escape tower received a normal burnout signal, no significant data was derived.

Purpose of this launch was to have placed a production line Mercury capsule along a ballistic trajectory 220 stat. mi. down the Atlantic Missile Range, reaching a peak altitude of 130 stat. mi.



REDSTONE BOOSTER, with Mercury capsule in place, is readied for the launch. Flight was to test re-entry deceleration of 6g and period of weightlessness of about 5½ min.

Rocket Noise Suit May Set Precedent

By Michael Yaffee

Morristown, N. J.—First round of what may prove to be a precedent-setting legal case involving damages allegedly caused by vibrations from the static testing of rocket engines has gone against industry and, in effect, the U.S. government.

In a case known as Magnus Berg, Halfdon Thoresen, Erling Thoresen et al, vs. Reaction Motors Division, Thiokol Chemical Corp., 25 plaintiffs were awarded a total of $100,000 in compensatory and punitive damages as a result of their suits against RMD for damages said to be caused by ground and air vibrations from the static firing of rocket engines.

The plaintiffs were residents of 15 homes in Lake Telemark, a northern New Jersey community close to Reaction Motors' rocket engine test station at Lake Denmark. Their suits, all of which were tried at the same time in Morris County (N.J.) Superior Court, charged RMD with negligence, trespass and creation of a nuisance and sought compensatory and punitive damages.

On motion of the defense counsel, Judge Elden Mills dismissed the first two counts. After sitting for three weeks, the jury decided in favor of the plaintiffs on the third count and awarded them $5,000 for each of the 15 houses for punitive damages and varying amounts for compensatory damage.

Attorneys for Reaction Motors quickly filed a motion with the trial judge to set aside the verdict on the grounds of illegality. This motion was denied last week and the original verdict upheld. Next step for the defense will be an appeal for a review by the New Jersey Appellate Court.

As far as can be determined, this is the first case in which rocket power (as distinguished from turbojet engine power) has been cited as a damage-causing agent and so the ultimate decision could have important consequences for this country's growing missile and space effort. As a result, although this particular case might be settled out of court, it is believed that the case will be carried shortly to the Appellate Division of the New Jersey Supreme Court.

An appellate court, having been properly briefed, could set standards by which rocket engine contractors might operate without incurring losses, says William F. Campbell, Jr., division counsel of RMD. In this case, the matter of the appeal is particularly pressing because the $100,000 judgment (payment of which is held up pending outcome of the appeal) is garnering interest at 6% annually. Moreover, RMD is continuing its test operations and so is exposed to new suits both by the original 25 plaintiffs and by the rest of the 300 families living in the three northern New Jersey communities (Lake Telemark, Hibernia and Marcella) close by Lake Denmark. Also, it has not yet been determined by the government whether or not such damages will be reimbursible to RMD under terms of the company's contracts or, if they are, to what degree.

At the moment, RMD is awaiting Air Force and Navy concurrence in the decision to file an appeal. As the contracting officers involved in Reaction Motors work, they must be given immediate notice of any legal moves RMD plans to make. Also, under the insurance liability to a third-person clause written into government contracts, the contractor must seek the advice of the contracting officer, and, when a claim is made, the contracting officer has the option of stepping into the case and of either directing or taking over the litigation.

Punitive Damages

Under the terms of its public liability insurance policy, Reaction Motors must retain responsibility for any punitive damages. Moreover, the insurance company's responsibility for compensatory damages in this particular case is limited to only about $600 of the $25,000 awarded by what amounts to a deductible clause in the policy and by the effective date of the policy which covers only the latter part of the period involved in the complaint. (RMD's previous insurer declined to enter the case.) Nevertheless, the insurance company offered to come into the case, and RMD accepted after receiving approval from the Air Force and Navy. As a result, RMD's defense is being handled by Victor Hansen of Mead, Gleeson, Hansen and Pantages, a large law firm retained by the insurance company to handle its defense work. Attorney for the plaintiffs was Irving Ostrow of Goldberger and Ostrow.

Although it is known that the government is extremely interested in the case in light of its potential repercussions for this country's defense and space efforts, so far neither the Air Force nor the Navy has made any move to enter the case. But if the case is appealed, as it is now expected to be, then it is believed that the government will enter the case.

The decision is up to the Department of Justice which would act as the government's legal representative in the matter.

Reactions Motors has already indicated to the Judge Advocate General's office of the Air Force that it would welcome the government's intervention in the event an appeal is filed. The government would probably enter the case as amicus curiae or friend of the court.

In this function, Department of Justice lawyers would file their own brief covering both points of law and the importance of RMD's work to the national defense effort. Besides the prestige factor, RMD feels the Department of Justice could bring to bear its extensive legal knowledge concerning pertinent points of law from all 50 states as well as the wide experience gained by the government in handling suits involving jet power.

At the present time, for example, the government is involved in approximately 100 cases concerning disturbances allegedly created by jets. While most of these cases involve disturbances caused by overflights of jet aircraft rather than static testing of turbojet engines, some points of law appear pertinent to both cases. In the present case for example, the plaintiff's original complaint charged RMD with trespass. This count was thrown out when RMD lawyers, with a reference supplied by an Air Force lawyer, brought to bear a recent decision of the Oregon State Supreme Court. In the case, the plaintiffs claimed that airplanes coming in for landings at low levels emanated vibrations in the air and ground that trespassed their properties. The court decided against the plaintiffs.

Although it presently appears "highly unlikely," an out-of-court settlement is still a possibility in the RMD case. The government has asked RMD to find out what the plaintiffs would want in the way of a settlement and said it would take their reply under advisement. In any settlement, RMD would ask for a covenant in which the plaintiffs would agree not to sue the company in the future. Even if Reaction Motors could get such a covenant—and it appears unlikely that it could, it would not be binding on the rest of the 300 families in the area.

Also, while it is possible for a defendant to "buy his peace" in a case such as this one without prejudicing his position in future suits, that is to say, a settlement is not considered an admission of guilt. But it is generally felt by those involved that this problem of rocket engine testing will have to be resolved eventually and that it will prove less costly to establish legal precedents and definitions now than later.

Another factor arguing against an out-of-court settlement is the difficulty and expense of building a test stand noise suppressor. It is believed that the plaintiffs would demand noise suppression as part of any agreement. As a result of an earlier meeting with residents, RMD agreed to employ a consultant who was to try to build a satisfactory suppressor. A small water deluge suppressor was actually built for a 1,000-lb.-thrust rocket engine which worked for a short while and then was burned out.

Although the outlook for the successful construction and operation of such a unit is not too favorable, says a company official, RMD has submitted a proposal to the Air Force for building a large suppressor for the 57,000-lb.-thrust XLR 99 rocket engine developed for the X-15 aircraft, the largest rocket engine at Reaction Motors and, accordingly, blamed as the major noisemaker.

Reversal Sought

But perhaps the most important reason of all for carrying the case to a higher court is the strong belief that the decision will be reversed. As a Delaware corporation, the company had the choice of going to trial either in a federal court or in the Morris County Superior Court. After the decision had been made for the county court, the Port of New York Authority came out with its proposal to put a $220-million jet airport in Morris County, a proposal that nettled the residents (AW Dec. 21, 1959, p. 30).

As a result, RMD feels that it became impossible to obtain an impartial jury or get a fair trial in Morris County. Any new suits that may arise, says RMD's Campbell, will be defended in a federal court.

In addition, as the basis for their appeal, RMD's attorneys are claiming among other things that prejudicial testimony was permitted, that the judge's rulings were unfair and that his charge to the jury concerning the law of nuisance and punitive damage was in error.

Appellate Decision

Once the case is placed on the calendar of the Appellate Court, it will probably be several months before a decision is reached. The three judges of the Appellate Court will review the case for legality, fairness and so on. There is also a possibility the New Jersey Supreme Court, which occasionally looks around for an interesting case to try, will lift the case off the Appellate Court calendar and try it directly. Should the case be tried in the Appellate Court and the original decision upheld, Reaction Motors' attorneys would then probably seek the necessary permission from one of the three judges in order to carry the case to the New Jersey Supreme Court.

Services Provide Initial Funding For VTOL Transport Program

Washington—Initial funding of the tri-service VTOL transport program is expected to finance the preliminary design competition and a development test program.

Air Force and Army have each transferred $1 million to Navy, whose Bureau of Weapons is the program manager. Navy is expected to put up the third million to get the program under away.

The joint project is aimed at producing about five airplanes for operational research with the type, before committing the services or the manufacturers to a production order.

Outline specification for the design imposes no restriction of type or configuration on the aircraft. But aside from this general approach, the detailed performance requirements are stiff enough to make the most experienced designers look twice at every trick in the bag.

Specifications Outlined

The specifications call for the transport to weigh not more than 35,000 lb. gross, with a four-ton payload capacity. Cruising speed is to be not less than 250 to 300 kt. at sea level with maximum speed between 300 and 400 kt.

Combat radius of the assault transport is to be at least 200 naut. mi., with 300 desirable. Ferry range, in an STOL configuration, is to be greater than 1,600 mi. and up to 2,600 mi.

The transport must be able to hover with full payload at sea level on a Navy-Air Force "hot" day with engines at military power developing at least 5% excess thrust over weight. With the four-ton payload, the hover ceiling must be 6,000 ft.

At mid-point in the mission, the transport must be able to hover out of ground effects for at least 10 min. at sea level.

Operational conditions include carrier capability, prepared and unprepared site takeoffs and landings, and all-weather and night-flying capability.

Requirements were established by a joint service group of three teams from each service, headed by Capt. Robert R. Williams, U. S. Army. Williams was also head of his service's team; USAF team was led by Col. Joseph W. Howell, and the Navy group was headed by Capt. Harold H. Larsen.

These groups were appointed to determine the different service needs and to come up with a single requirement for a logistic VTOL transport that would be equally useful to all three services. They fixed the tentative requirement about one month ago.

From the start one major concern in the program has been the high cost of prototype development. Early recommendation was to wait for another round of development aircraft to prove further capability of the type beyond the first efforts of the flying testbeds now in the air. But time and extra cost ruled that out, and the three services named a single group to try to write a joint operational requirement. This was the task given to the teams under Williams.

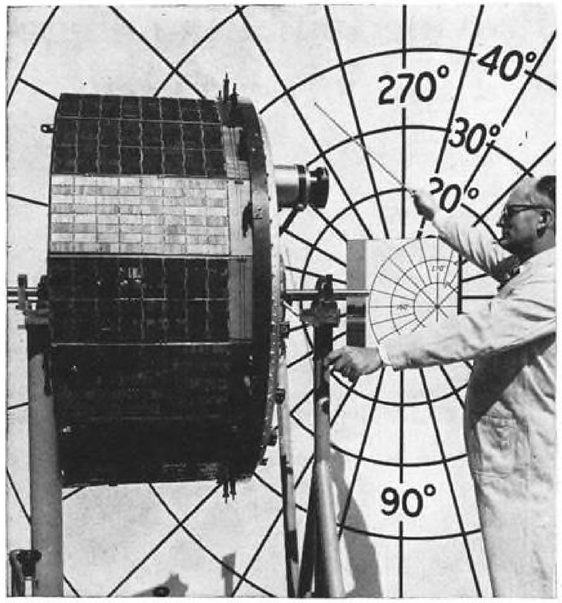
Tri-Service Program

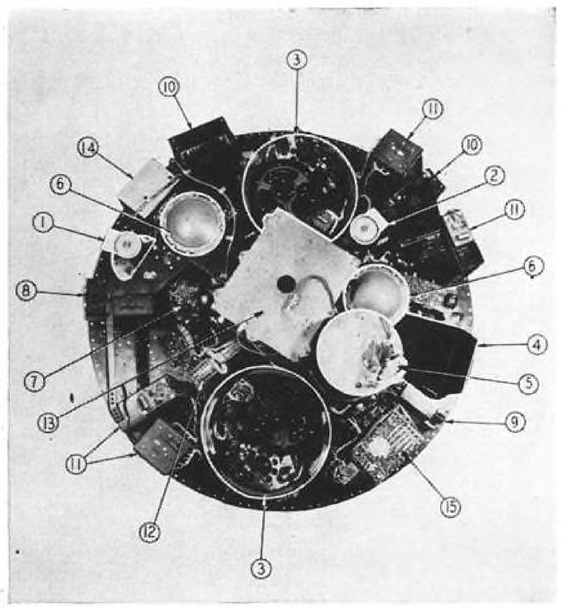
The basic idea was that a tri-service program would save money. Also, by writing a requirement for a usable transport, the services could buy a few airplanes to check operational capabilities through field trials. If the competition winner was a useful vehicle operationally, the services could move into a production order for the type with a minimum of trouble and at minimum cost. If it wasn't, then the program cost would still be less than financing a complete second round of development aircraft.

The teams have also given considerable thought to asking for fixed-price bids as another way to save program costs. Current deadline for entries in the design competition is March, 1961, with the hope that evaluation of the projects would be completed by April or May next year.

VHF Scatter Tests

Washington—Federal Aviation Agency will test tropospheric scatter communications at stations in Greenland and Nova Scotia to evaluate the possibility of using very high frequency (VHF) tropospheric scatter communications over the North Atlantic to ease congestion of the presently used high frequency band and improve communication reliability. The two stations, together with a Pan American World Airways tropo scatter station in Ballybunion, Ireland, should provide VHF coverage over much of the North Atlantic air routes. Use of tropo scatter for ground-air service was pioneered by PAA. Airline experience indicates that use of higher transmitter power and special tropo scatter antennas extends maximum VHF range from 200 to 500-600 mi. (AW Jan. 18, p. 46). FAA hopes to have the two western stations operating early next year.





TIROS II weather observation satellite is positioned for calibration of focus and field of view of its two television cameras (left). Lens of the wide angle camera protrudes from the base plate. Large calibration scale is being used to calibrate the satellite's narrow angle camera at the center of the base plate. Operational devices detailed at right are: (1) wide angle camera (2) narrow angle camera (3) television tape recorders (4) infrared system five-channel radiometer (5) infrared system avionics (6) timing clocks (7) relays for attitude stabilization system (8) avionic control box (9) infrared horizon scanner (10) camera circuits (11) tape recorder circuits (12) telemetry switches (13) antenna diplexer (covering storage batteries) (14) automatic signal generator (15) fuse board, current regulator.

Tiros II Transmits Cloud, Infrared Data

Washington — High quality cloud cover and infrared data were being transmitted by Tiros II during its initial operation last week.

Tiros II, second of three Tiros satellites planned, was launched by a Douglas Thor-Delta from Cape Canaveral, Fla., at 6:13 a.m. on Nov. 23. It differed from Tiros I, launched last sping (AW Apr. 11, p. 28), in that it contains infrared sensors for earth and solar radiation experiments and has a magnetic orientation device.

The 280-lb. package weighs 10 lb. more than Tiros I. It is in a near circular (406-431 mi.) orbit which takes it 48.3 deg. north and south of the equator. Period on the third pass was 98.2 min.

First pass produced three photographs from the narrow-angle camera, which has a resolution of 0.15-0.2 mi. Wide-angle camera, with 1.5-2 mi. resolution, returned eight blank pictures, apparently because the command to transmit was given when the satellite was too low on the horizon and this lens was pointed away from earth.

Tiros experiments are forerunners to Nimbus and Aeros weather satellites which the Weather Bureau foresees as an ultimate system for global and highly accurate forecasting (see story, p. 27).

Infrared experiments are designed to measure:

- **Earth's albedo,** or reflected solar energy, over a spectral range of .2-5 microns.
- **Radiation emitted** by earth and the atmosphere over 7-30 micron range.
- **Radiation emitted** through thin atmosphere in 8-12 micron range, which is expected to provide data on night cloud cover, cloud temperatures and cloud height.
- **Water vapor radiation** at the tropopause, at 6.3 microns.
- **Radiation mapping,** to provide a corollary with television data. Visual range is 0.5-0.7 microns.
- **Thermal balance** between radiation absorbed and that reflected by the earth.

Magnetic orientation device was developed by Radio Corp. of America, whose Astro-Electronics Division designed and built the satellite structure and instruments, except infrared sensors. Desired orientation is obtained by ground command by passing a charge through an aluminum wire around the satellite to develop a precessional torque.

Tiros II is spin-stabilized, and National Aeronautics and Space Administration was planning to fire the first of five pairs of spin rockets last Wednesday to bring spin speed up from 8 rpm. to 12 rpm. NASA conducted the experiment and provided the infrared experiments. Air Force and Douglas launched the satellite.

Like Tiros I, the weather satellite is covered with 9,260 solar cells powering 62 nickel cadmium batteries. Each vidicon system has a 235 mc. transmitter, and a single 237.8 mc. transmitter is used for all infrared experiments. Two tracking beacons operate on 108 and 108.03 mc.

System will be turned off in about three months. Tiros I operated 78 days, returning 22,952 cloud cover pictures.

Discoverer Primate Flights

Washington—Air Force will launch a young Rhesus monkey about Feb. 1 in the first of four primate flights in the Discoverer series.

Brig. Gen. Don Flickinger, head of the Air Force bioastronautics research program, said the Rhesus was chosen over other available primates as test specimen because chimpanzees are too large for the satellite biopack and spider and squirrel monkeys are over-emotional.

Primate will be programed for a flight of 17-18 orbits to determine effects of extended weightlessness and cosmic radiation dosages. Orbits will range from about 100 to 700 mi.

Soviet Radiation Research Praised

Washington—United States leads Russia in significant over-all cosmic ray research, but the Soviets probably have an edge in establishing radiation effects on humans, according to a Commerce Department report.

Soviet lead in the biological-radiation field is attributed to a long lead in rocketry research with animals, the report said, which was started in 1947. Techniques in this field have improved to the extent that Sputnik III discovered a new type of corpuscular radiation, about which the Soviets have released no details.

Assessment was made in a report distributed by Commerce, but reportedly prepared by Central Intelligence Agency. General conclusions are:

- **Soviets have made** advances in cosmic ray research, especially in theoretical work; with their skill in using rockets and satellites to study radiation "they may attain a lead over the West in the study of the effects of cosmic radiation on life in outer space."
- **U. S. has contributed** significantly more in the over-all science of cosmic rays, mainly because USSR uses absolete research techniques and haphazard reporting methods.
- **Notable studies** by the Soviets concerning the origin and variations of cosmic rays have resulted in new theories on air showers and on the relationship of astrophysical and cosmic rays.
- **Increased Soviet emphasis** in this science is apparent in the recent construction of a new research center near Moscow, and expansion of other facilities throughout the country.

Commerce said Soviet research in the origin of primary radiation flux is "top caliber," particularly reflected in the theories developed by V. L. Ginzburg, P. N. Lebedev, I. S. Shklovskiy and P. K. Shternberg. Ginzburg and Shklovskiy predicted polarization of electromagnetic radiation from the Crab nebula, which the Soviets say has been verified, and they developed a theory of non-thermal radio emission.

Commerce observations on other Russian research efforts:

- **Time variations studies:** Ranked "among the best in the world," because all known environmental parameters are considered.
- **Total primary flux research:** The Soviets measure it mainly with outmoded Geiger counters, while the U. S. uses advanced scintillation counters.
- **Composition of primary** cosmic radiation: Soviets have written little on this field. They conduct balloon-borne operations, considered primitive.
- **Cosmic ray interactions:** A study important from a theoretical standpoint but one the Russians conduct with aircraft-borne cloud chambers using a technique five years behind the times.
- **Conventional studies:** Soviets are providing information obtained by the U. S. five years ago. Same commentary is made for Soviet work in elementary particles and cosmic radiation.
- **High altitude air showers:** This work is in a research area tied to The Institute for Atomic Energy. Work is considered competent, but lacking in imagination. Advanced work is probably kept secret by the Institute.

Primary Soviet research facilities for cosmic ray studies are the Physics Institute, Moscow State University and high altitude stations near Murggab in the Pamir Mountains in Tadzhik. New Moscow center includes 10 portable stations and underground laboratories.

Other active facilities are in Armenia at the Aragats High-Mountain Station, Mt. El'brus laboratory in Georgia, and a laboratory in Yakutsk.

Information Disclosure Promised by Johnson

Washington — Government secrecy will not be invoked to cover errors or embarrassment in the new Kennedy Administration but will be confined to security and executive confidence areas, according to Vice President-elect Lyndon B. Johnson.

"In the years ahead, those of us in the executive branch must see that there is no smoke-screen of secrecy. The people of a free country have a right to know about the conduct of their public affairs," Johnson told the annual Associated Press editors' meeting.

"I would not assert that the people's right to know has been throttled in America," he said, "but in recent years it has been considerably muted.

"That will no longer be true when Sen. Kennedy begins his presidency," he said. "He will not of course make any ridiculous promise to conduct all governmental affairs in a goldfish bowl. There are now, there will be, and there always have been matters affecting security and Executive confidence that cannot be publicized in the national interest.

"But I can assure you that the Kennedy Administration believes in the fullest possible freedom of public information; that secrecy will not be invoked to cover up embarrassing human errors and painful facts; and that Sen. Kennedy intends to establish an effective governmental machinery to support the public's right to know," he said.

Two-Stage Pershing Fired

Two-stage version of the Army-Martin Pershing surface-to-surface ballistic missile was fired successfully down the Atlantic Missile Range from Cape Canaveral, Fla. on Nov. 16 (AW Nov. 21, p. 34). Second stage separation and ignition occurred as programed during the flight of the 34-ft. solid-propellant missile. Pershing, fired from its tactical prototype transporter-erector-launcher, is being developed by The Martin Co. under Army supervision.

Jackson Opposes Super Cabinet Officers

By Ford Eastman

Washington—Creation of super Cabinet officers to relieve the President of some of the burdens of running the government was opposed last week by Sen. Henry Jackson's Senate subcommittee on national policy machinery.

Sen. Jackson warned that creation of such top level posts would increase, not ease the burdens the President faces in the fast-changing world situation. He issued the warning in the first of a series of reports entitled Organizing for National Security, which stemmed from the hearings held last spring by the Senate Government Operations Subcommittee on National Policy Machinery, which he heads.

Sen. Jackson also is chairman of the Democratic National Committee and presumably will wield considerable influence as Sen. John Kennedy plans the organization of his administration and chooses the men who will run it.

As the report was released, President-elect Kennedy announced last week that he plans to cut the size of the White House staff and eliminate the position of Assistant to the President, once held by Sherman Adams and now held by Maj. Gen. Wilton B. Persons. Kennedy said the move is intended to promote closer contact between the President and his aides and department heads.

Sen. Jackson said there is no place in the governmental system for a first secretary as suggested by several witnesses before the subcommittee earlier this year, including Gov. Nelson Rockefeller of New York.

"Only the President's responsibility is as wide as the nation's affairs," the Jackson report said. "Only he can balance domestic, economic, and defense needs—and if anyone else were to be given the job, the President would become a kind of constitutional figurehead."

Sen. Jackson said that theoretically, a first secretary would be no mere White House staff assistant, but a super-Cabinet member able to direct fellow Cabinet members in a way that ordinary presidential aides cannot. Also, theoretically, he could relieve a President of many burdens both within the government and in negotiations with other chiefs of government and could act as first adviser to the President on foreign policy in its full modern context.

The report said Cabinet officers would be bound to question the decisions of the first secretary, which would inevitably generate friction and resentment. If the President backed the first secretary in his decisions, it probably would mean downgrading of the Cabinet posts and the filling of these positions with relatively submissive men who "lack strong convictions or much will of their own" at a time when the government needs vigor and drive in high positions.

"It is most unlikely that a President would in fact give a first secretary the consistent backing and support he would require to maintain his primacy over other Cabinet members. To do so would run the risk that the first secretary would become an independent force, politically capable of rivaling the President himself. It would run the further risk of rousing combined opposition from departmental and congressional sources and from affected interested groups," the report said.

The subcommittee also took a dim view of proposals to "upgrade" the Vice President's duties to include coordination and direction of "the secretary of state, secretary of the treasury and all of the other instruments of government in the general area of national security, excluding defense matters."

As for a White House staff for national security planning and coordination to replace the National Security Council and other related boards, the subcommittee expressed similar opposition. Such a staff would find it hard to avoid "ivory tower" thinking and would only create a new layer of planning between the President and the departments and "thus shield him from the full flavor of the planning of responsible operating officials."

"Reforms, to be effective," the report said, "must be made in terms of the real requirements and possibilities of the American governmental system. That system provides no alternative to relying upon the President as judge and arbiter of the forward course of policy for his administration. It provides no good alternative to reliance upon the great departments for the conduct of executive operations and for the initiation of most policy proposals relating to these operations."

However, the report said forthcoming subcommittee staff reports will make wide-ranging recommendations for changes in the policy process, which will be aimed at finding "better ways" for:

• **"The President to delegate** more authority for decision-making to individual heads of departments and agencies. There has been too much emphasis on coordination and too little on delegation. Policy-making has tended to be reduced to a group effort where no single person has real authority to act and where no individual can be rewarded for success or penalized for failure."

• **Making the National Security** Council "a forum for more meaningful debate on issues which the President alone can decide." The report suggested the council have fewer participants in its meetings and concern itself only with issues of central importance for presidential decision.

• **Enabling the secretary of state** "to serve the President as first adviser in national security problems. . . . He should be able to advise the President on the full range of national security matters, from the point of view of their relation to foreign problems and policies."

• **Relating military power** "more closely to foreign policy requirements. The Secretary of Defense shares with the secretary of state the main burden of advising the President on national security problems. A full and welcome partnership of the Departments of State and Defense is the prerequisite of coherent political-strategic counsel for the President."

• **Making the budgetary process** "a more effective instrument for reviewing and integrating programs and performance in the area of national security. There is need to return to the earlier tradition which regarded the budgetary process as a key program management tool of the President."

• **Organizing the presidency** to "intervene flexibly, imaginatively, and fast where gaps in policy development or execution threaten to upset the President's cardinal objectives. . . . It calls for more discriminating use of able staff assistants right in the immediate office of the President himself who are alert to trouble spots and sensitive to the President's own information needs."

• **Attracting and retaining** "outstanding officials for both appointive and career posts in the national security departments and agencies. Poor decisions often result less from poor organization than from poor policy-makers. The one thing which could do the most to improve national security policy would be to raise the standards of excellence among career and appointive officials."

At Kennedy's Palm Beach, Fla. vacation headquarters, Clark Clifford, liaison representative with the Eisenhower Administration on transferring control to the new administration, said top priority is being given to the filling of about 80 positions, such as Cabinet and sub-Cabinet posts and agency heads. The next list will contain about 400 to 500 lower level jobs, while a third list will contain about 1,200 additional positions.

Cuba Has Eight MiGs, State Department Says

Washington—Cuba has eight Soviet bloc MiG fighters and 10 Soviet helicopters, and the Cuban arms stockpile is growing as weapon deliveries continue from Communist nations, according to a U.S. State Department report.

State Department said that Cuban arms, which were supplied in the past by nations from both the Soviet bloc and Western Europe, now are supplied exclusively by Communist countries. Inventory includes a Soviet mobile radar system along with the fighters, helicopters and other operational equipment.

Cuba's regular armed forces now total 40,000 men, and they are supported by an armed militia of 200,000. State Department said the arms stockpile is growing as Soviet ships continue to deliver weapons. The report observed that Maj. Ernesto Guevera, president of the Cuban National Bank, spent a considerable amount of time in Moscow and was in Communist China last week, indicating continued negotiations for arms.

Cuban arms buildup increased tensions in the Caribbean, and they were further heightened by attempted revolts in Guatemala and Nicaragua. President Eisenhower sent a Navy carrier task force to the area after the Guatemalan and Nicaraguan governments said they plan to invoke the Rio mutual defense treaty against Cuba for complicity in the revolts.

The Navy attack carrier Shangri-La and four destroyers patrolled the Caribbean Sea between Cuba and Central America to discourage any attacks across the area. Shangri-La had been at sea conducting carrier pilot landing qualifications with a mixed load of single and multi-engine attack aircraft and fighters. Later, the Shangri-La was relieved by the USS Wasp, an anti-submarine warfare carrier with part of its ASW aircraft complement replaced by Douglas AD-6s. The piston-engine AD-6s would be especially effective in close support missions, including attacks on shipping.

Second X-15 Flight

Edwards AFB, Calif.—Second flight of the X-15 rocket research aircraft with Reaction Motors' 57,000-lb. thrust XLR-99 engine was made by North American test pilot Scott Crossfield last Tuesday, Nov. 22.

Main purpose of the flight was to test the shutdown and restart capability of the engine.

Following launch at 45,000 ft., the engine burned at idle power for 51 sec. after which it was shut down for 15 sec. The engine then was restarted and burned for an additional 74 sec. during which time Crossfield briefly advanced the throttle to full power. Functioning of the engine during restart was reportedly "very satisfactory."

Maximum altitude of 62,000 ft. and a speed of Mach 2.5 was reached. Total flight time was 7 min.

Norad Control Site Work to Be Resumed

Colorado Springs, Colo.—Construction of a hardened site for the Combat Operations Center of the North American Air Defense Command will soon be resumed here after having been delayed for a year and half while provisions were made for control equipment to meet requirements for anti-ICBM satellites.

Air Force plans for defending against ICBM's envisage the use of anti-missile satellites, those being developed under project Spad by Convair and Random Barrage by Thompson Ramo Wooldridge (AW Oct. 31, p. 33).

These systems are based on an operational concept of intercepting ballistic missiles during their powered phase after they rise above a cloud layer. Control of such a system would require a much larger installation at Norad than originally planned for control of anti-aircraft defense systems and Nike Zeus anti-ICBM systems.

Of an original $10 million voted by Congress in 1959 for access roads and excavation, $1.5 million has already been spent for the roads. Air Force has received authorization from the Senate and House Appropriations Committees to resume the excavation portion of the project.

Members of the Senate and House Appropriations and Armed Services Committees were highly critical when the project was halted for "restudy."

At present there is no money available for construction within the excavation, but Air Force has included this item in its budget request for Fiscal 1962.

Regional headquarters of the General Services Administration in Denver prepared specifications for bids on excavation, which were due Nov. 1. General Services was expected to announce successful bidders in Washington in 30-40 days.

Site of the Center is Cheyenne Mountain, west of Colorado Springs. Current operations of Norad are directed from an above-ground blockhouse which could be immobilized relatively easily in an attack.

News Digest

Adm. Arleigh A. Burke, chief of naval operations, will retire when his current term expires next August. He is serving his third two-year term as chief of naval operations and a member of the Joint Chiefs of Staff.

Ballute drag balloon was tested last week on a re-entry vehicle launched to an altitude of 170,000 ft. by a three-stage Cook Research Cree rocket. Goodyear Aircraft Corp.'s 9 ft. diameter coated fabric balloon was released at 75,000 ft. and Mach 1.5 to stabilize and slow the re-entry vehicle, and a parachute was deployed when it slowed below Mach 1.

Shareholders of Hiller Aircraft Corp. approved a plan to make the company a subsidiary of Electric Autolite Co. of Toledo, Ohio. Under terms of the plan, 4¼ shares of Hiller stock will be exchanged for each share of Electric Autolite. Stanley Hiller, Jr., will remain as president of the aircraft company and also will become a director of Electric Autolite.

Terminal guidance and data facility for the X-15, which combines and displays data from several radars along the aircraft's 400 mi. flight test path to keep aircraft under continuous surveillance and assist pilot in making final approach, will be constructed at NASA's Flight Research Center.

Hughes Aircraft Co. is studying methods of stiffening the Echo inflatable communications satellite under a $65,103 National Aeronautics and Space Administration contract.

Ranger-Agena Sterilizer

Los Angeles—Lockheed's Missiles and Space Division will design and build a prototype sterilizing unit for the Ranger-Agena program to ensure a germ-free condition for the lunar landing vehicle. The mobile sterilization gas transfer system will be built under contract from NASA's Jet Propulsion Laboratory.

A gas mixture dispensed by the mobile ground unit will sterilize the vehicle just before launch. The unit is expected to use a mixture of ethylene oxide and Freon-12 gases, which will be pumped into the Agena-B nose cone chamber to cleanse the vehicle for several hours. The gas would then be flushed out of the chamber into disposal tanks by means of nitrogen or helium and neutralized. Prototype unit is to be completed for testing during January.

Study Urges Sweeping Changes in CAB

Extra members, longer term for chairman proposed in survey aimed at cutting case backlog, red tape.

By Robert H. Cook

Washington—Sweeping changes in the Civil Aeronautics Board were recommended last week in a management study ordered by the Budget Bureau to find ways of reducing the Board's case backlog and cutting its red tape.

McKinsey & Co., management consultants, recommended expansion of the CAB from the present five to seven members and called for a three-year term for the chairman in place of the current one year term. Extensive procedural and administrative changes also were recommended as a means of eliminating the Board's "large and increasing backlog."

The McKinsey study was ordered by the Eisenhower Administration, but it has been completed so close to the end of the President's second term that any action on its recommendations will have to await the inauguration of President-elect John F. Kennedy on Jan. 20. Kennedy has asked former CAB Chairman James M. Landis to recommend changes in regulatory agencies, including CAB, aimed at streamlining procedures and insulating them against political pressure from the White House. The Landis report is due Dec. 15, and Kennedy will have both sets of recommendations available as he decides how to change the present organization of CAB.

Several of the McKinsey survey's most significant recommendations, including the possibility of expanding CAB membership, were suggested last April by individual Board members in AVIATION WEEK interviews (AW May 2, p. 38).

Most Critical Problem

Pinpointing the Board's most critical problem as "how to get the most out of 750 individuals," the Bureau of the Budget survey criticized CAB's concentration on purely adjudicatory matters so that insufficient time and attention is given to planning the most efficient use of its staff or the elimination of procedural bottlenecks.

More than 65% of the Board's time is spent on adjudication and 20% on international affairs, the survey estimated. The balance of CAB members' time is calculated at 10% for general office work, 3% for speeches and public relations and 2% devoted to accident hearings.

While the Board has made some progress in accelerating its formal handling of cases—these procedures average 32 months to completion this year, compared with 47 months in 1959—its workload continues to increase, the McKinsey report said. As of June 30, the Board had a backlog of 1,527 cases, reflecting an increase of more than 30% over the previous year.

In particular, the safety workload is up 25% this year over last and can be expected to increase 5% in 1961. Complexity of the turbojet transports also has required more manpower per accident investigation, which last year totaled 379 man days compared with 213 required in the previous year, the survey said. Increased demands in this area have distracted the CAB from its responsibility to conduct research and analysis designed to prevent future air tragedies, the report added.

Blueprint for Reform

Blueprint outlined by McKinsey to clear away CAB's backlog of work and streamline its current operating procedures concentrated on these areas:

- **Simplify and expedite** CAB procedures.
- **Increase the effectiveness** of the Board itself.
- **Provide increased staff** support for CAB.
- **Improve the Board's** administrative support.

Urging a greater use of informal procedures to process docketed cases, the survey pointed out that 80% of the Board's cases are settled in less than six months by this method, while the balance handled under full formal proceedings required an average of 32 months or longer. Most of the formal cases were required to comply with provisions of the Federal Aviation Act and could not be avoided, the study pointed out.

CAB efforts to reduce the volume of formal proceedings by permitting an exemption from a complete hearing under Section 408b of the act were praised by the consultants, who urged that similar action be considered for other types of cases.

Recognizing that formal hearings can not be avoided with some issues, the survey suggested that action to reduce the procedural steps be taken in such important areas as the setting of air fares and route awards. Greater use of analytical data prepared by the CAB's staff could reduce many procedural steps, and a change in hearing procedures to limit, or eliminate, cross examinations and lengthy briefs to the Board would shorten the required hearing time, the McKinsey report said.

Informal proceedings could likewise be shortened by reducing the volume of routine requests, petitions and applications now requiring processing, the report said. Blanket exemptions, such as granted by the Board for transportation of special technical representatives, could be substituted.

Limited Chairman Term

Less than 1% of the CAB's time is devoted to directing its staff—a factor which McKinsey indicated might be a result of the limited terms allowed Board chairmen.

An estimated 75% of the past chairmen have had less than two years of experience in that office, the survey said, indicating that such short terms were too brief to acquaint the chairmen with complex CAB operations or to give them a chance to provide effective leadership in developing long-range plans for the Board. This has been particularly true where chairmen had no prior Board experience, as most have not, the report said.

The annual appointment of a Board chairman also has had an "unsettling effect" on the Board members, of whom 12 out of 21 failed in the past to complete their terms and served less than 3 years, the McKinsey survey said, recommending that Board chairmen be appointed for three-year terms and that a study be initiated to find the reasons for the CAB's high membership turnover.

Makeup of the Board also should be expanded to include 7 members, compared with the present membership of five, which would then permit adjudicatory matters to be handled by two panels of three Board members each, the survey suggested. Decisions of these panels would be final and not subject to appeal by the full Board unless considered necessary by the full Board or one of the panels. Such an arrangement would not only split the Board's total workload but would also allow the chairman more time to handle internal administrative and policy matters, the survey pointed out.

Improvement also is needed in the Board's operation of the executive director and general counsel offices, McKinsey said.

Executive Director

Responsibilities of the executive director should be fully recognized to include authority to aid the Board in policy-making and planning, oversee the flow of cases received by the CAB and generally review procedures and eliminate workload bottlenecks, the report said. It approved the operation of the general counsel's office, but recommended that staff attorneys handle accident investigation hearings rather than assistant general counsels.

Because of the wide variety of tasks handled by the Bureau of Air Operations, the survey found, this division of CAB should be replaced by four separate units under the headings of Office of Internal Affairs, Bureau of Rates, Bureau of Routes and Bureau of Special Authorities, all of which would report directly to the executive director.

Carrier Accounts and Statistics Office appears to be organized and staffed sufficiently and does not require any changes, the report said, but it should institute a study to determine the need for many of its presently required statistical reports.

Twin problems exist within the Bureau of Safety, the report said, in that the director of this bureau has full responsibility for the over-all handling of accident investigations and the Bureau has not concentrated enough on training and research needed to keep abreast of technological developments.

Project Manager Staff

The consulting firm recommended the establishment of a project manager staff section of three or four managers who would be individually responsible to the director for complete accident investigations. Any of these managers' spare time could then be spent on training and research.

In addition, the survey called for disbanding of the hearing and reports section of the bureau. Staffing for the project manager group could be obtained in this manner, the consultants added.

Enforcement duties of the CAB should be periodically reviewed to spot any backlog, and cases should be handled on a priority basis, the survey said.

Bureau of Hearing Examiners, which the consulting firm noted "exerts an influence" over proceedings, should be strengthened by providing each examiner with a staff of 2-4 technical assistants, while the chief examiner should concentrate on developing guides to aid the examiners and the public in conducting proceedings.

To properly plan its future course, CAB should have an independent staff to work on organizational and operational improvements, the report said, since neither the Board nor its staff presently has the manpower data needed to judge the effectiveness of the staff or to direct it. Present personnel methods, the survey noted, fail to project the Board's long-range manpower needs.

Hughes Releases Six 880s to Northeast

Northeast Airlines' competitive potential in the New York-Florida winter market was a major factor last week in gaining release from Howard Hughes for six of Hughes Tool Co.'s Convair 880s for direct lease by Northeast.

Though not officially confirmed, AVIATION WEEK learned that Hughes will order six Convair 600s to replace the Northeast airplanes. This also was a significant condition in release of the airplanes (AW Aug. 22, p. 50).

Northeast will lease the aircraft and spares from Convair Division of General Dynamics and the General Electric CJ805-3 engines and spares from GE for seven years with options for renewal and purchase.

Whether Hughes' personal feelings were a factor was not clear. Presumably he would have preferred that Trans World Airlines, which he owns, put the airplane into service ahead of Northeast since TWA was first to order it. But Delta Airlines, the second buyer, got its 880s into scheduled operation while TWA's 880s sat on the ramp awaiting Hughes financing for TWA's jet fleet (AW Oct. 31, p. 35).

As a practical consideration, Hughes had committed himself to provide Northeast with $9.5 million for working capital as part of the 880 lease, and this loan would have given Northeast sufficient credit standing so that the lease could have carried through bank financing. Hughes had turned over $5½ million to Northeast by mid-summer, but had paid nothing since. On that barrier, the Northeast lease was stalled while Hughes battled on in the TWA financing negotiations.

Pressure and persuasion of Hughes continued and finally swayed him, based on these factors:

- **Northeast needed the airplanes** this winter if they were to be of any real value. Next winter might be too late. Northeast's temporary certificate into Miami expires next spring and its equipment picture might be a factor in its continuation.
- **Competitive opportunity** Northeast would gain might not be gained again.
- **TWA-Northeast** merger plans made a strengthened Northeast fit Hughes interests.

Northeast pressed the Florida competitive aspect strongly. National no longer is leasing jets from Pan American and relies on its own DC-8s. Eastern is primarily committed to turboprops with the Electra and must divide its DC-8s with other routes such as New York-Mexico City. Thus Northeast feels it can match the combined daily jet trips of both with its six 880s, plus 707s leased from TWA.

Based on last year's traffic, Northeast estimates National and Eastern's combined jet round trips can accommodate less than one-fourth of the Florida market, and that Northeast will be able to pit jets against turboprops and piston equipment for the rest.

Twelve TWA 880s still are on the ramp at Convair's San Diego plant. Northeast crews have been in training with TWA and Convair (AW Nov. 7, p. 47) and the first airplane modified from the TWA group was due for delivery to Northeast before the end of last week.

Northeast's 880 configuration calls for 13 rows of five-abreast coach seats and five rows of four-abreast first class seats and a lounge in the forward cabin seating 12 for a total of 97 passengers.

The 880s are scheduled to go into service Dec. 15 and with them Northeast will offer its first direct jet service between Boston, Philadelphia and Miami.

TWA Financing

Trans World Airlines interim financing continued under active discussion last week. Although there were reports it might be completed before the weekend, the previous history of delay did not produce any aura of optimism.

Bank of America now is regarded as the prime candidate to become lead bank, replacing Irving Trust Co.

Hughes is known to have brought a Merrill Lynch, Pierce, Fenner & Smith group to the West Coast to discuss again the possibility of raising funds by putting Hughes Aircraft Corp. stock on the open market. Since the aircraft company is now held in trust, this might pose formidable tax problems.

Landis Fails in ALPA Presidential Bid

By David H. Hoffman

Miami Beach, Fla.—James M. Landis' campaign for the presidency of the Air Line Pilots Assn. ended in failure here last week when the union's board of directors denied him the two-thirds vote required to place the name of a non-pilot in nomination.

Responding to a roll call ballot, directors representing 6,804 pilots joined in opposing Landis' request to run against incumbent President Clarence N. Sayen. Of the 7,692 votes needed to waive ALPA's bylaws, only 4,694 were cast for the newly appointed adviser to President-elect John F. Kennedy.

Somewhat despondent after listening to nine days of debate in which he could not take part, then watching his opponent win another four-year term without opposition, Landis told AVIATION WEEK that had the election been by popular ballot, he and not Sayen would have won.

To substantiate his claim, the former Civil Aeronautics Board chairman cited returns from councils in which the membership had been polled prior to the convention. Generally, these split votes favored at least the nomination of Landis.

Among the major airlines, Landis drew solid support from the ranks of Eastern and American pilots. United Councils, by contrast, seemed to split down the middle, while Pan American members opposed Landis' candidacy by proportions of three to one.

Exercising the association's unit rule, Capital, Braniff, Flying Tiger, Mohawk, Trans Caribbean, Lake Central, Ozark, Pacific, Riddle, Overseas National, Capitol and Piedmont cast their members' votes against Landis.

Once the issue had been decided, ALPA's nominating committee delivered its report recommending that Sayen be returned to the association's top office—a post he has held for the past nine years. After a two-minute, standing ovation, Sayen lauded the controversy and debate that had marked the nine-day convention. From such as this, he said, great decisions emerge.

Questioned immediately after the election, Landis said that its outcome would not affect his attitude—generally a negative one—on accepting a post in the Kennedy Administration. Asked specifically if he was willing to return to CAB at Kennedy's request, Landis told AVIATION WEEK, "I wouldn't want to."

He maintained that the election would not change his conviction that the over-all goals of ALPA were in the best interest of the industry. However, some bitterness was apparent in the formal statement issued by Landis just after the vote was tallied here. In it he said:

"The refusal of a substantial portion of the board to regard me as eligible and thus permit me even to seek the nomination is difficult for me to understand. My qualifications in the fields of aviation, of law, of administration, of government are written of record. My inability to fly a plane is the apparent barrier. I say 'apparent' for it is difficult to conceive of men who would lay claim to being members of a profession seriously entertaining the belief that the art of flying a plane is an indispensable qualification for administering the complicated affairs of this association.

"Nor can there be any real ground for believing, inasmuch as the policy of the association is made by the directors and not the president, that implementation of that policy is so complex as not to be capable of being understood by a person not a pilot. The reasons must be other than these. As to what they may be, [it] is a matter of conjecture upon which I choose not to comment."

To round out its slate of elected officers, the board voted Don J. Smith of TWA another term as treasurer; John Carroll, also a TWA captain and former chairman of the airline's Master Executive Council, as first vice president, and Paul D. Atkins of American as secretary.

From the outset of the convention here, it was apparent that Landis' campaign had failed to make a significant dent in the ranks of pilots placed high in the ALPA organization. A huge majority of the committee chairmen, regional vice presidents and chairmen of the airline master executive councils (MEC) actively backed Sayen throughout the two-week meeting. In countless informal conversations, these senior officers—most of them highly respected by the association's membership—persuaded undecided directors to line up behind the incumbent president. To outside observers here, the move to cultivate Sayen support largely went unnoticed amid the positive statements and more positive literature distributed by the Landis-for-president campaign headquarters.

In explaining why Landis could not win favor with ALPA's organization despite his impressive background, most directors queried by AVIATION WEEK said first, "He's not a pilot." Presumably, because of this, the 61-year-old attorney could not appreciate operational problems that cropped up daily in airline cockpits. Nor could Landis lay claim to the background of experience common to the men he would work with and lead as ALPA president.

However, some other well informed captains traced another theory to square Sayen's organizational popularity with the groundswell of anti-Sayen sentiment that swept through ALPA domiciles prior to the convention. Since Sayen took office in 1952, this argument ran, association membership has almost doubled; new pilots coming into ALPA during the 1956-58 period of peak airline hiring were unfamiliar with the strides taken by the association under Sayen in the early 1950s. They were, however, familiar with the setbacks suffered by ALPA since promulgation of the Federal Aviation Act in 1958, including compulsory retirement for airline pilots at age 60, more stringent physical examination requirements, right of FAA inspectors to displace "second officers" from the third seat in jet cockpits.

Bitterness stemming from these and other reversals was translated to Sayen opposition by the new generation of ALPA members. But not all junior pilots who were anti-Sayen also were pro-Landis, it was felt. This observation was offered to explain the Landis bloc's diverse character and lack of unity at the board of directors meeting.

Angry Young Pilots

Not only were there angry young pilots in the anti-Sayen camp, there were also those who consistently have opposed the incumbent president since his first election. A third group that generally sided with Landis was composed of pilots from particular airlines where recent labor-management disputes have been won by management. Eastern Air Lines, in this area, was a prime example.

On the other hand, ALPA officers who have worked closely with Sayen over the years concede his ability as a tough negotiator, respect his education, sympathize with his anti-press conduct. But because Sayen generally has refused to meet with rank and file pilots of ALPA's widely dispersed domiciles, this image has not projected to the association, which increasingly regards Sayen as somewhat of a myth, more often read about than seen.

As the convention slowly progressed here, supporters of Landis realized that their candidate's chance of election was growing slimmer. Exposed to the persuasive influence of ALPA officers and Sayen-appointed committee heads, the directors tended to forget whatever unrest existed back at their domiciles. Although the Landis group never moved to make the election an early agenda item, resolutions aimed at waiving the bylaws to enable popular election of ALPA's president twice were defeated by the 295-man board of directors. This, the majority felt, would necessitate expensive "campaigns" that might enable "outsiders" to win election because of their access to unlimited funds.

No Comment

Throughout the meeting, Sayen refused to state whether he would accept a nomination if one were tendered. Even though the directors entertained few doubts as to his availability, Sayen maintained that he wanted to study the policies adopted at the meeting before agreeing to stand for re-election. Strategically, this decision ensured that regardless of Sayen's intent, the election would be one of the last items on the long agenda.

On one major issue—whether airline pilot salaries were climbing fast enough—the candidates took sharp issue. According to Landis, some pilots' "real monthly income increase" has been less than 7% in the last nine years.

To back up his contention, Landis cited this example: "In 1951, the monthly income of an Eastern Air Lines 8-yr. captain for 80 hr. flying DC-3 equipment half day and half night was $974. Today, he receives $1,158 per month or an increase of 19%. Meanwhile, the consumer price index has risen 12.5%, so that his real monthly income increase is less than 7% over these nine years. This is hardly a matter about which one can boast," he said.

Pilot Income

Sayen, in his "state of the association" report to the board, said that in 1952 the average salary of all pilots was about $9,743 per year. By 1955, this average had become $12,309; by 1956, $12,529; by 1957, $12,823 and by 1958, $13,753. For Calendar 1959, Sayen said, average ALPA salary exclusive of pensions was $15,495, with captains earning $19,041 and first officers, $11,385.

Based on present pay scales and current equipment, the average pilot who begins flying now and continues for 35 years will earn about $1,174,000 during his lifetime, including retirement benefits. His average salary, Sayen said, will be over $22,000 per year.

ALPA-ALSSA Issue Unresolved

Miami Beach, Florida—Air Line Pilots Assn., after 30 hr. of heated debate, most of which took place behind closed doors, did not resolve its union relationship with the stewards and stewardesses of U. S. carriers.

Paralyzing the pilots' board of directors meeting here was this issue: Should cabin attendants be absorbed by ALPA or allowed to form their own organization, an organization that could become a raiding target for hostile unions.

After a series of votes stretched across three days, majority of the directors favored forming a separate stewards and stewardesses division within the framework of ALPA. This, therefore, became association policy.

But when it came to enacting the bylaw changes necessary to translate this new policy into action, more than one third of the directors balked, thus stalemating the convention. Those who hesitated feared that merger with the Airline Stewards and Stewardesses Assn.—a chartered affiliate of ALPA whose president, Rowland Quinn, recently moved out of the pilots' Chicago headquarters—would give the cabin attendants too loud a voice in shaping association policy.

Snarled by parliamentary maneuvers for most of three days, the central issue also became enmeshed in the politics of ALPA's election, with incumbent President Clarence N. Sayen generally favoring ALSSA integration with pilots. James M. Landis, Sayen's opponent, was thought to lean in the opposite direction on the ground that a hostess-pilot union might become unwieldly. Since Quinn's abrupt departure, Sayen has been ALSSA's titular president.

American Loses Round

Washington—Bureau of Enforcement advised the Civil Aeronautics Board last week to withdraw American Airlines' recently-granted New York-San Francisco nonstop authority because the carrier violated Board rules.

CAB bureau contends the Board received illegally direct communications supporting a third nonstop airline between the two cities and urging expedited hearings from the City of San Francisco, county supervisors in California, chambers of commerce, travel agents and congressmen.

The CAB granted the nonstop authority to American last year, but TWA and United asked the U. S. Court of Appeals to review the CAB decision, arguing that improprieties in the nature of ex parte communications required the CAB to set aside the nonstop authority award. The court remanded the case to the CAB to determine if rules had been violated.

ALPA Moves Against Local Safety Hazards

Miami Beach, Fla.—Air Line Pilots Assn. will accelerate its effort to make city officials and airline users aware of potential safety hazards at their local airports, Clarence N. Sayen, president of the pilots' union, told AVIATION WEEK. Interviewed here during the association's Biennial Board of Directors Meeting, Sayen said that without fanfare, increasing numbers of ALPA pilots would be sent to confer with political and civic leaders in an attempt to point out deficiencies existing at their local airport.

Short runways and the absence of adequate navigation aids and instrument letdown systems, according to Sayen, form ALPA's number one flying safety problem today, a problem that should be shared by the public. In 1959, he said, these accounted for one out of three airline accidents and one out of three fatalities.

Despite this record, not one dollar has been appropriated for federal aid to airports next year, Sayen said, adding that Elwood Quesada, Federal Aviation Agency administrator, must "bear full responsibility" for the government's failure to furnish money to make the nation's airports safer.

As airways adviser to the President, Quesada was behind the veto that killed a bill providing for $100 million of federal airport aid annually for the next five years, Sayen said. Over the last 10 years, Sayen said, federal airport aid annually has averaged $28.5 million, or less than 10% of Dulles International Airport's total projected cost. By contrast, $3.22 billion was spent last year on highways by the federal government.

As a result of past neglect, airports now are so obsolete that a sustained federal and local level effort must be undertaken to catch up, Sayen said.

All Bonanza Flights Now Turbine Powered

Las Vegas, Nev.—Transition to turbine-powered equipment has been completed by Bonanza Air Lines with the inauguration of Fairchild F-27A schedules on the last route segments formerly served by Douglas DC-3s.

F-27 first was introduced into the airline's route structure in March 1959, and resulted in an increase of 33% in available seat miles. Bonanza now operates a fleet of eight F-27s and holds an option on two more for delivery in 1961. The airline, however, found it necessary to furlough five co-pilots who were no longer needed as the faster, 40-passenger F-27 was phased into operation.

CAB Expected to Rule by Feb. 1 On United's Merger With Capital

By L. L. Doty

Washington—Chances now appear strong that a Civil Aeronautics Board decision on United Air Lines' proposed acquisition of Capital Airlines will be issued before Feb. 1.

Both United and Vickers-Armstrongs, British manufacturer of Capital's Viscount transports and the carrier's principal creditor, originally set Feb. 1 as the absolute deadline for the effective date of the merger. Vickers-Armstrongs has made it clear to the Board that if the merger is not approved by that time, Vickers would be forced to proceed with its foreclosure action against Capital's fleet under the terms of defaulted notes secured by chattle mortgages on the aircraft.

Cancellation Threat

United has told the CAB it would drop the entire plan to acquire Capital if the merger agreement was not approved by the Board before Feb. 1. Here is a timetable which, if followed as expected, could bring a final decision several days in advance of the deadline:

- **Briefs were filed** last week under a Nov. 25 deadline, leaving the way open for the examiner's initial decision.
- **Examiner's decision** can be expected as early as Dec. 9, probably no later than Dec. 17. Examiner Thomas L. Wrenn accelerated the pace of the hearings by quickly cutting off discussions he considered irrelevant and gave every indication during the hearings that he wanted the case expedited rapidly.
- **Assuming Wrenn's initial** decision is issued on Dec. 9, exceptions will be due on Dec. 19 and briefs on Jan. 7.
- **Oral arguments** will begin promptly. Allowing several days for the arguments and about one to two weeks for the Board to write its decision, final action could come sometime between Jan. 19 and 26. Chances are good that the Board will allow the normal 30-day period for the filing of petitions for reconsideration by intervening parties, which would place the effective date sometime late in February. However, this formality would not deter United from taking its first major steps toward consummating the consolidation of the two carriers.

The need for urgency in approving the merger as early as possible is strongly stressed in separate briefs filed by United and Capital last week. To hedge against any unanticipated delays in bringing the two companies together, a special merger team comprised of representatives of both carriers already is working out basic details of the overall plan.

In its brief, Capital emphasized that it "stands on the brink of bankruptcy" and said:

"In fact, were the Board not now considering the merger agreement which has been submitted, it is extremely doubtful that Capital would today be a going concern." The airline said the merger is the only available method of resolving the critical financial situation in which the airline finds itself, pointing out that it is now completing its sixth consecutive year of net losses—excluding gains from the sale of aircraft.

The airline said that the result of these sustained and heavy losses has been a steady deterioration in Capital's net worth and in the book value of the company's common stock. Net worth of the airline was $17.1 million as of Dec. 31, 1955, compared with $3.6 million as of June 30, and book value per share of common stock plummeted from $18.83 to $4.06 in the same period of time.

The airline pointed to its cash position as "critical" and noted that, as of Sept. 30, it had a cash balance of only $4.1 million, approximately $1 million of which is unavailable for immediate use. Daily cash depletion, the carrier said, sometimes amounts to more than $2 million.

Capital said it has been forced to reduce its service in major markets as "newer and faster aircraft" have been placed into competition. As a result, Capital's participation in traffic has dropped substantially during the past two years. For example, the carrier's percentage participation in industry passenger revenue miles fell from 6.3% in January, 1958 to 4.9% in 1960.

On the threat of foreclosure by Vickers-Armstrongs, the airline said it "has no real defense" against the suit. It added:

"If the merger is not approved by Feb. 1, it is . . . quite obvious that no effective action could be taken to prevent Capital's loss of its entire fleet of aircraft and the termination of its operation as a certificated air carrier."

The airline termed "illusory" any hope of retaining the aircraft and operating pursuant to Chapter X of the Bankruptcy Act. It claimed that heavy losses would undoubtedly be aggravated by the reluctance of the public to fly with an airline in reorganization and that it would be questionable, therefore, whether the airline could continue operations for a period of time necessary to work out a plan of reorganization.

In its brief, United outlined these principal phases of its plan of action once the merger is approved:

- **Retirement of DC-3s** and DC-4s. Capital operated 15.5% of its plane miles in 1959 with unpressurized aircraft.
- **Immediate introduction** of turbojet service in certain of Capital's major markets. Turbojet service will be gradually extended to replace all piston-engine aircraft where airport conditions permit.
- **Introduction** of, or increase in, service in a number of markets where Capital is either not providing service or is offering minimum schedule frequencies because of lack of competitive equipment.
- **Substantial expansion** of day coach services through use of dual configuration of turbojet aircraft.
- **Expansion of cargo** service in Capital markets through the use of larger combination aircraft, and the operation of all cargo flights on segments capable of supporting such service.

Common Points Served

United said integration of operations will result in increased efficiency and economy. The carrier said that United and Capital serve 12 points in common from which more than 67% of Capital's total traffic is enplaned. It added that approximately 50% of Capital's aircraft departures are from these points, and 64% of the airline's expenses are incurred at the 12 cities.

On the basis of 1959 cost levels, United claimed the combined companies will save $1.9 million annually through the consolidation of activities, facilities and personnel at the 12 common points.

On employment, United stated in its brief that it "proposes to offer a job to each and every employe, reserving only the limited right to exercise its discretion with respect to officers of the company."

United noted that the size of the surviving carrier resulting from the merger will "not alter competitive relationships" and "will not be unique." United estimated that the merged company will fly 23.9% of domestic trunkline traffic passenger miles and added:

"By comparison, American, during the past 10 years, has never carried less than 20% and in 1950 and 1951 carried 25.4% and 24% respectively," the carrier said.

United argued that diversionary effects on competitive routes will not be significant if the two airlines are merged on grounds that the combination of the two carriers will not give the surviving company any more authorizations or greater access to traffic than United and Capital now have independently.

Aeronaves Backs U.S. Jets in Consortium

By Glenn Garrison

Mexico City—Proposed jet equipment pool among Mexico's three international carriers faces a roadblock from Aeronaves de Mexico, recently equipped with a Douglas DC-8 and scheduled to open jet service to New York next week.

CMA Mexicana de Aviacion has proposed the "equipment consortium" as a sort of holding company which would buy jet transports and lease them back to the three participants—Aeronaves, CMA, and Guest Aerovias Mexico. This is advanced by CMA as the most flexible and economically advantageous means of providing all three carriers with needed jet equipment. CMA now operates de Havilland Comet 4s over some routes; Guest has no jets.

The Comets presently appear to be the stumbling block. CMA told Aviation Week that Comets are important to the airline and definitely would go into the pool. But Aeronaves' position is that jets in such a pool should be of U. S. manufacture.

Guest is favorable to the consortium idea and reportedly would go along with the inclusion of Comets.

DC-8 Delivery

Aeronaves' equipment outlook was greatly improved by its agreement with Eastern Air Lines, providing Aeronaves with a DC-8 off Eastern's position in the delivery line (AW Sept. 12, p. 52). The Mexican carrier has ordered two additional DC-8s with delivery scheduled next year. The agreement with Eastern put Aeronaves into the jet field at least a year ahead of time.

In return, Eastern was enabled to put its own jets on the New York-Mexico route, and to offer coach service. Eastern previously had been restricted to first class piston flights on the route.

Aeronaves derives one third to 40% of its revenues from the New York route, according to E. G. Busch, director of traffic and sales. It has been operating Bristol Britannia turboprop aircraft to New York in 92-passenger mixed configuration. The Britannia has not proved too dependable, Busch said, with electrical systems offering a number of problems. Nevertheless Aeronaves traffic on the route this year is up by more than 10% and loads averaged 66 passengers on the daily service during the first six months of 1960. During the third quarter of this year, the average was 72 passengers.

Aeronaves became wholly nationally owned just over a year ago. All its stock now is held by the Nationales Financiera, (national banking institution). It had been losing considerable money under previous ownership and was heavily in debt to Financiera.

According to Busch, the net loss as of a year ago was about $600,000 a month. Aeronaves now is breaking even on operating expenses, Busch said, but is still losing about $160,000 net a month because of financing losses resulting from the "unbusinesslike" former operation.

Reduced Costs

The improvement has resulted from "cutting out all the fat" and careful control of expenditures, Busch said. For example, there were 58 employes at Idlewild at the start of 1960, and the total now is 36. The arrangement with Eastern will, among other things, bring down the cost of operating at Idlewild. Aeronaves' DC-8s will be serviced in the U. S. and, for a while, maintained by Eastern.

The agreement has been described by Eastern as "a significant departure" from the pattern of earlier arrangements between U. S. and foreign-flag airlines, inasmuch as no financial investment by Eastern is included.

Neither is there management or policy control through stock ownership, according to Eastern.

Busch said "we're paying our own right down the line." Aeronaves signed the purchase contract directly with Douglas, he said, and Eastern's deposit was transferred to another Eastern airplane. Financiera is providing the money for the Aeronaves equipment.

Aeronaves will operate with 28 first class and 90 tourist seats in its DC-8s. When the first airplane, which will handle the run singlehandedly for some months, has to go into maintenance, Britannias will take over the schedules. The turboprops will carry 92 tourist seats and first class passengers will be turned over to Eastern.

Under the recently renegotiated bilateral between the U. S. and Mexico, Aeronaves gained several new routes. Service to San Antonio, Tex., and Tucson, Ariz., will be activated in a few months with DC-6 equipment, Busch said.

There are no plans as yet to operate a route to Europe via New York, another of the recent awards.

The Britannias now will go on Aeronaves' route to Tijuana in economy-tourist configuration. They are not expected to prove too economical in this service.

Aeronaves ran a pre-inaugural, courtesy flight to New York last week with its DC-8, leaving Mexico City almost simultaneously with an Eastern pre-inaugural which had come down from New York. Eastern's off-on time for the run to New York was 3 hr. 56 min. Aeronaves' time was slightly higher. Advertised scheduled time for Eastern is 4 hr. 40 min. southbound and 4 hr. 10 min. northbound. Aeronaves had run some ads with shorter published times, but Busch said they would be corrected to the same totals as Eastern's.

There is something of a runway problem at Mexico City, where the elevation is 7,347 ft. and the runway presently is 11,000 ft. long. Runway strength limitations have been at question. According to Busch, the New York nonstop can probably be made with almost a full load. Eastern's northbound pre-inaugural, with 108 passengers and extra crew, took off at 241,500 lb. gross weight for the trip. Maximum gross restriction of 235,000 lb. was waived for the occasion. The allowable maximum was expected to go up to 245,000 within a few days for a maximum of 12 DC-8 operations daily by Eastern. Maximum gross of the airplane is 265,000 lb. Eastern expects to operate the nonstop without payload restrictions most of the time, with perhaps six fuel stops necessary over the winter period.

The DC-8s are equipped with Pratt & Whitney J75 turbojets.

CMA, which has been plagued with strike troubles, now has two Comets in operation and was scheduled to receive another last week. The two airplanes operate 10 weekly Los Angeles flights, five Chicago flights, and three San Antonio flights. According to H. Max Healey, general manager, the Comets have been virtually trouble-free from an operational standpoint. Average over-all load factor has been 82%, with a 60% load factor being a little better than break-even.

CMA Requirements

Nevertheless, Healey told Aviation Week, CMA has never contended that the Comet 4 was the ultimate answer to the jet requirements of Mexico as a whole, to all requirements of the other operators, or even to CMA's requirements for all time. CMA's requirements at the time it ordered Comets were what dictated the choice, Healey said, with delivery time a factor and financing terms "a lesser aspect."

With CMA as the motivator, a study group to investigate the consortium proposal was set up about six weeks ago, Healey said. The two other carriers are represented, along with an observer from the Ministry of Communications. Healey said progress is "very satisfactory."

By the consortium arrangement,

he said, six aircraft could do the work of eight.

If such an arrangement is worked out, Healey said, he can foresee CMA absorbing on some of its own routes advanced types of jet equipment which definitely will be turbofan-powered. Comets would go into the pool, and would serve, for example, the Guest route from Mexico City to Miami.

The airline is partly owned by Pan American, which recently reduced the extent of its holdings to a reported 32%. Its fleet includes DC-6s, DC-4s, DC-3s, C-47s, and four C-82s, recently grounded as uneconomical. In addition, three DC-7s are now on lease to Northwest and CMA is taking back and paying for a DC-7 which PanAm now operates.

According to Healey, the airline plans to "evolutionize" in the next six months to a fleet of DC-7s, Comets, and DC-6s. Where the fleet comprised 39 aircraft in June, 1959, the number will be reduced to 17 by June, 1961. Despite the reduction, available passenger miles will rise about 47%.

Under the new bilateral, CMA picked up a route to Dallas, but otherwise was not much affected, Healey said.

The third international Mexican carrier, Guest, which serves Miami and operates routes to Europe, is wholly Mexican-owned and recently was bought by a financial syndicate. Guest has a close working relationship with Scandinavian Airlines System, involving management and equipment.

There has been some speculation in Mexican circles that a merger between CMA and Aeronaves might come about, but there is little indication that this has substance at least at this point. Another rumor predicts the consolidation of the three carriers into one national airline in the next few years.

Generally, the new bilateral agreement does not appear to have caused any strong reaction in aviation circles.

The recent bilateral is a conditional agreement and depends upon American carriers' cooperation in maintaining equity of services, according to Mexican Ambassador Antonio Carrillo-Flores. This cooperation sometimes can best be served by arrangements made by parties in the field, such as Eastern and Aeronaves, rather than at the official level, the ambassador told AVIATION WEEK.

Difficulties in the negotiations have stemmed in part from the Mexicans' fears of American resources which might be thrown into the competition, and from U.S. resistance, on principle, to restrictions. But the ambassador believes U.S. carriers understand the problems and will cooperate to maintain equity.

United Seeks $145 Million Loan To Finance Boeing 727 Order

Miami Beach—United Air Lines and Wall Street banking houses are discussing a $145 million loan to finance 40 727 transports, a triple-turbofan design Boeing is trying to sell the airlines for medium-range routes.

United President W. A. Patterson told the Air Line Pilots Assn. board of directors meeting here: "We'll order the 727s within the next few months, if I can get this money" (AW Nov. 14, p. 52). Patterson had flown here immediately after conferring with lenders in New York City.

The long-expected order would be a first step toward production of 727s. It would also boost United's turbojet fleet to 129 jet aircraft, largest number ordered by a carrier to date. In all, 40 Douglas DC-8s, 29 Boeing 720s, 20 Sud Caravelles and the 40 727s will be or have been delivered to United. Eastern Air Lines is also interested in a fleet of 40 727s (AW Oct. 31, p. 52).

Explaining how his airline arrived at the number of jets it should buy, Patterson said United studied the gross national product (GNP) in an effort to correlate the value of all goods and services sold in the U.S. with the volume of air transportation in a given year. Analysis showed that every $100 increment in the GNP represented 15 passenger miles of inter-city travel, exclusive of automobile traffic.

Using this relationship, United applied its historic 20% share of the domestic market to GNP forecasts for the next five years. The result—essentially conservative in not considering that a greater share of U.S. airline business might shift to United—indicates how many jets should be bought. Established lead times indicate when they should be ordered.

Carriers that fail to survey future markets in figuring their fleet needs are flirting with financial disaster, Patterson said, adding, "Whoever signed that order for 65 Viscounts also signed the death certificate of Capital Airlines."

Patterson criticized "outside analysts" for being "appalled" when United announced it would spend $11 million this year for safety research and operational training. These same analysts, Patterson said, assume that airlines will lose two aircraft annually in accidents, yet they cannot understand why a sizable sum should be spent to prevent this loss, despite the $5 to $6 million cost of some new jets.

Turning to the Civil Aeronautics Board in his discussion of industry problems, Patterson remarked, "There is something I don't ever think will be corrected." For example, when asked to suggest qualified people for CAB appointment, Patterson said that he hesitated because of the salary earned by those that he should recommend.

To an able and qualified executive, CAB service means sacrificing up to 60% of present income, Patterson said. "Should I suggest such a salary cut, they'd ask, 'if this is so good, why don't you take it?'"

Really capable men use CAB as a stepping stone and should not be blamed for it, Patterson said. Realizing this, government often asks appointees to take the job for "two or three years," knowing that they will refuse it on a long-term basis. Such people become captives of the CAB staff, its only permanent employes.

As a result of this situation, Patterson said, big lenders worry more about the impact of new CAB policies than about the industry's ability to stay financially healthy.

United has already taken steps to lay the foundation for such a financing program by registering a $25 million issue of convertible debentures with the Securities and Exchange Commission. This program, aimed at meeting United's general financing needs for the Capital Airlines merger and its Boeing 720 purchases as well, would help keep United's debt-equity ratio in balance.

Communist Party Joins Criticism of Aeroflot

Moscow—Growing barrage of Soviet criticism against the government's airline Aeroflot has been joined by Ekonomicheskaya Gazeta, official publication of the Russian Communist Party's Central Committee.

According to Ekonomicheskaya Gazeta, "the exceedingly great capabilities of our [commercial] aircraft are still being used unsatisfactorily. Because of the prolonged periods required for maintenance and general overhaul, the planes stand idle at the airports a considerable part of the time, and large capital investments are immobilized."

At one time, the paper recalled, Aeroflot's State Scientific-Research Institute proposed merging the carrier's maintenance and major overhaul services. "This would have permitted a sharp reduction in the time and cost of repair work and increased its quality as well. But Aeroflot's directors adopted an exceedingly wary, or, more precisely, an overly-cautious attitude toward this suggestion."

Canadair CL-44D4 turboprop transport made its first flight recently at Montreal (AW Nov. 21, p. 36). U. S. cargo carriers have ordered 17.

Canadair CL-44 Makes First Engineering Test Flight

Swing-tail CL-44 is powered by four Rolls-Royce Tyne two-spool turboprops rated at 5,730 eshp. each at 15,250 rpm. at sea level.

Airline Income & Expenses—3rd Quarter, 1960

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Property	Charter	Federal Subsidy	Total Operating Revenues	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	102,706,223	1,772,602	8,387,198	650,373	.....	114,235,546	104,344,675	8,981,527
Braniff	18,087,484	491,859	935,875	375,793	.....	19,967,179	18,320,860	1,282,369
Capital	24,942,085	578,897	1,007,609	163,048	.....	26,991,199	27,415,160	−1,030,127
Continental	15,836,232	256,151	611,718	124,307	.....	17,008,573	14,649,340	1,852,849
Delta	28,035,052	534,146	1,678,753	279,211	.....	30,751,384	29,804,920	763,310
Eastern	60,607,560	1,242,908	2,905,225	11,665	.....	65,273,715	67,059,188	−2,291,180
National	12,793,498	274,883	844,909	397,560	.....	14,457,568	17,181,657	−2,627,194
Northeast	9,150,340	137,005	390,945	12,268	.....	9,780,048	10,732,224	−1,453,012
Northwest	20,739,211	606,583	1,754,388	33,406	.....	23,261,964	20,809,218	2,038,181
Trans World	72,151,036	1,449,877	4,016,483	385,977	.....	78,378,084	73,277,607	4,018,399
United	91,846,076	2,953,824	6,614,422	954,582	.....	102,601,597	89,176,562	13,312,121
Western	16,613,575	305,595	560,465	188,653	.....	17,751,825	15,613,532	1,949,583
INTERNATIONAL								
American	1,505,449	9,412	181,653	9,412	.....	1,784,704	1,823,618	−38,848
Braniff	2,731,918	71,453	299,072	.....	.....	3,158,969	3,022,109	80,424
Caribbean Atlantic	852,110	7,151	44,316	6,530	.....	926,264	813,348	115,052
Delta	774,898	7,099	59,601	.....	.....	843,890	1,026,284	−202,999
Eastern	8,438,919	120,169	365,546	11,665	.....	8,928,464	8,147,383	649,798
Mackey	339,008	.....	11,014	181,528	.....	538,001	509,595	28,889
National	440,739	3,836	39,558	7,517	.....	493,693	440,242	53,451
Northwest	7,592,017	1,698,385	1,229,054	100,940	.....	10,866,856	9,697,686	943,315
Pan American Combined	96,314,575	5,587,648	12,226,035	3,144,049	.....	119,308,574	106,881,123	9,858,864
Alaska	1,507,731	48,613	148,106	.....	.....	1,696,597	1,806,600	−109,393
Atlantic	50,437,981	2,711,842	4,561,322	1,222,682	.....	59,687,808	49,815,862	9,863,347
Latin America	20,942,915	606,125	4,037,477	604,331	.....	27,122,070	28,718,275	−1,493,612
Pacific	23,425,948	2,221,068	3,389,130	1,317,036	.....	30,802,099	26,532,737	4,315,501
Panagra	3,843,344	161,079	796,582	15,259	.....	5,163,074	5,330,264	128,233
Resort[5]	.....	.....	.....	.....	.....	24,916	85,321	−35,330
Trans Caribbean	1,915,475	.....	172,475	53,641	.....	2,218,615	1,925,544	339,110
Trans World	28,435,428	1,865,188	1,963,596	1,379,503	.....	34,647,789	25,368,283	8,896,950
United	8,471,138	245,097	166,472	20,721	.....	8,945,897	6,089,657	2,690,459
Western	990,820	8,715	33,669	.....	.....	1,004,306	1,143,470	−115,534
LOCAL SERVICE								
Allegheny	2,957,740	46,822	161,741	1,909	836,874	4,017,009	4,290,082	−170,398
Bonanza[1]	.....	.....	.....	.....	.....	.....	.....	.....
Central	664,330	20,740	43,466	9,698	1,118,948	1,867,254	1,414,470	448,498
Frontier	1,841,404	42,595	128,408	43,623	1,569,475	3,654,606	3,289,562	327,076
Lake Central	796,660	18,589	38,677	1,023	426,042	1,283,098	1,205,746	64,913
Mohawk	2,681,509	36,261	94,493	69,616	673,834	3,599,856	3,562,102	−96,644
North Central	3,652,676	90,550	201,976	18,173	1,562,699	5,540,552	5,458,944	28,501
Ozark	2,112,418	43,828	123,794	27,723	942,619	3,267,824	3,110,627	134,397
Pacific	1,787,910	42,671	39,472	149,350	1,327,650	3,352,053	2,654,130	541,576
Piedmont[4]	1,994,430	30,308	83,542	69,016	1,507,706	3,710,961	2,831,119	790,521
Southern	635,091	24,299	35,711	.....	947,685	1,649,790	1,604,694	33,712
Trans-Texas[3]	.....	.....	.....	.....	.....	.....	.....	.....
West Coast	1,759,971	27,925	57,953	6,744	2,216,062	4,088,972	2,905,261	1,114,347
HAWAIIAN LINES								
Aloha	1,454,995	6,035	29,320	5,116	.....	1,542,534	1,457,397	20,799
Hawaiian	1,978,095	8,465	248,338	444,223	.....	2,728,767	2,681,767	−21,628
CARGO LINES								
AAXICO[1]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana[1]	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	.....	31,206	3,335,053	2,649,136	.....	6,104,279	6,695,361	−755,460
Riddle	.....	22,548	925,459	937,494	.....	1,896,224	2,410,506	−530,052
Seaboard & Western[1]	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	2,402,992	.....	2,402,292	2,119,291	567,080
HELICOPTER LINES								
Chicago Helicopter	488,673	10,440	3,011	700	392,870	896,173	908,279	−2,696
Los Angeles Airways	72,386	39,004	39,718	575	392,897	545,794	384,667	174,512
New York Airways	279,439	15,317	17,760	14,775	578,358	912,048	874,318	21,893
ALASKA LINES								
Alaska Airlines	837,781	171,827	184,677	744,948	743,787	2,711,990	2,139,384	581,189
Alaska Coastal	387,152	26,530	38,870	21,368	210,936	694,487	582,377	104,563
Cordova	67,377	25,838	42,631	116,144	85,402	340,796	327,273	8,003
Ellis	247,758	14,678	24,450	6,658	82,256	387,937	379,824	6,948
Northern Consolidated	371,841	137,263	132,119	62,811	154,315	867,105	828,664	3,608
Pacific Northern	2,576,010	215,173	380,038	4,749	362,737	3,582,936	3,009,402	523,360
Reeve Aleutian	587,153	124,346	141,029	31,055	.....	895,626	633,491	257,628
Western Alaska	35,156	5,363	2,765	20,096	13,836	77,708	63,525	12,460
Wien Alaska	525,531	189,789	141,009	221,745	260,850	1,379,712	1,346,978	1,872
Avalon Air Transport[2]	236,277	3,891	6,333	40,553	.....	287,283	302,712	−15,942

[1] Not available. [2] Since June 24, 1960. [3] Extension granted due to destruction of records by fire. [4] Airline division figures.
[5] Non transport figures—no operations during period.
Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.

THE *VARIABLE CAMBER* PROPELLER

New Hamilton Standard propeller will provide the equivalent of camber adjustment for every flight condition . . . offers major performance improvements for future aircraft

A new Hamilton Standard propeller, now under development for the Navy, will eliminate the historic compromise in blade design between the need for a high-lift airfoil for take-off and a low-lift airfoil for cruise. The propeller achieves this advance without a radical departure from established, fixed geometry blade design. By changing the relative angle of paired blades, the propeller produces an effect similar to the flap action of a wing. Result: the new Hamilton Standard propeller will automatically simulate the most efficient camber for *every* flight condition . . . take-off, climb, cruise and landing.

POTENTIAL: the new propeller will make possible a variety of important performance options for many types of future aircraft. Present studies, for example, show the propeller could provide the following performance increases:

	VTOL AIRCRAFT	HIGH-SPEED TRANSPORT	AEW/ASW AIRCRAFT
Payload	40-50%	30-40%	—
Range	30-40%	20-30%	—
Endurance	—	—	15-20%

UTILIZING SIX OR EIGHT LOW-CAMBER BLADES, mounted in pairs on a common hub, the propeller would achieve the effect of a camber change by altering differentially the relative angle of each blade set. Such adjustments are controlled by constant-speed governing.

FOR TAKE-OFF, blade angles are adjusted differentially so that each pair of blades simulates a high-camber surface for maximum thrust.

FOR CRUISE, the paired blades automatically move apart and act as individual, low-camber surfaces for maximum efficiency.

FOR LANDING, the blades would assume a reverse thrust position, as shown. On VTOL aircraft, they would revert to the high-thrust configuration used in take-off.

THE "VARIABLE CAMBER" PROPELLER is one of several advanced propeller designs under development at Hamilton Standard today. Complete information on these programs is available. We welcome your inquiry.

HAMILTON STANDARD

DIVISION OF UNITED AIRCRAFT CORPORATION

WINDSOR LOCKS, CONNECTICUT

AIRLINE OBSERVER

► Trans-Canada Air Lines decision to slash its long-haul passenger rates (AW Nov. 14, p. 40) will put two opposing philosophies on fare structure to a final test. Theory behind the TCA move—that fares attract and open new traffic markets, thus bolstering gross revenues—is in sharp contrast to the drive by U.S. carriers for higher fares as the only means of combating rising expense levels in order to maintain profit margins (AW Nov. 21, p. 35). While the TCA fare plan, which calls for cuts up to 25% on routes over 600 mi., will not have a direct competitive effect on U.S. carriers over major long-haul routes, the example set by the government-owned Canadian airline will not help the position of U.S. carriers on the rate issue. In addition, if TCA is successful in draining new traffic from the railroads and highways in substantial volume without incurring deficits, U.S. carriers may be forced to seek a revised fare structure along similar patterns, particularly if traffic increases hold to the presently slow rate of growth.

► Meanwhile, U.S. carriers continue to seek increases on jet air coach passenger rates. During the summer months, coach traffic handled by the 12 domestic trunklines represented more than half of all traffic carried (AW Nov. 21, p. 35) and the airlines now want to reduce the margin between coach and first-class rates to an average 25%. Jet coach rates have already been increased on transcontinental routes, and Eastern, National and Northeast were slated to boost their rates on the East Coast routes to Florida late last week to bring the jet coach fare up to 75% of the first-class fares now in effect.

► Watch for Air Line Pilots Assn. and Air Line Dispatchers Assn. to join forces in opposing Federal Aviation Agency's proposal to give tower operators final control over takeoffs in marginal weather. Pilots and dispatchers feel the FAA proposal, brought about by the recent crash of an Arctic-Pacific Airlines Curtiss C-46 transport (AW Nov. 21, p. 45), represents an attempt to transfer responsibility for a flight from the pilot in command to ground authorities.

► Assn. of Local Transport Airlines has several plans under study designed to promote heavier use of local service airlines by military services. Sales vice-presidents of ALTA members will meet in Washington shortly to discuss the plans and develop a recommendation for consideration by the association. One plan calls for the sale of five to 10 seats at reduced rates on certain flights serving military bases. Reduced rate will be justified by carriers on grounds that seats will be automatically paid for whether they are used or not. Local service carriers serve 327 areas in which military bases are located. Total of 59 of the bases are entirely dependent on local service carriers for commercial air transportation.

► Aeroflot is testing a new autotrain for transporting passengers to aircraft parked long distances from Moscow's Vnukovo terminal. Similar to but larger than baggage trains, the Soviet autotrain includes a tractor and several roofed, open-sided cars capable of carrying a total of 104 passengers. The autotrain will also be used to transport maintenance personnel and equipment to planes parked in distant parts of the service area.

► Thai Airways is considering the Avro 748, Handley Page Herald and the Fokker Friendship—all twin turboprop transports—to replace its fleet of seven Douglas DC-3s. The Friendship is the leading contender for an initial order of three airplanes because it has been in airline service for two years.

► Douglas DC-4 transport registered in the name of International Material Supply Corp. of Palm Beach, Fla. has been seized at the request of the Federal Aviation Agency for alleged violations of Civil Air Regulations. FAA investigation revealed the plane was used to transport passengers between Buffalo and London without a commercial operator certificate. The Florida corporation is alleged to have carried 288 passengers on four charter flights during July and August without a license—constituting 288 separate violations, each of them subject to a fine not to exceed $1,000.

SHORTLINES

► **Alitalia,** the Italian airline, is now offering twice weekly Douglas DC-8 turbojet flights from Rome to Johannesburg, with stops at Athens, Nairobi, Kenya, and Salisbury, Federation of Rhodesia and Nyasaland.

► **British Overseas Airways Corp.** plans to begin Bristol Britannia turboprop service from London to Bengasi and Tripoli, Libya, Dec. 1 on a twice weekly basis. BOAC points out the warm climate of Libya around Tripoli is becoming a new winter tourist attraction, and the Libyian area also is being fast developed as a major oil center in North Africa.

► **Civil Aeronautics Board** has set Dec. 5 for a hearing on the joint application of Resort Airlines and Trans Caribbean Airways for transfer of Resort's New York-Caribbean Route 135 to Trans Caribbean. Resort also is asking for a temporary suspension of its services.

► **International Air Transport Assn.** Director General Sir William Hildred told the Passenger Traffic Assn. of New York recently that reductions in international fares agreed upon by the scheduled airlines during 1960 should result in $100 million savings to international travelers over the next two-year period. Sir William said: "For an industry which is currently able to congratulate itself on having made an over-all operating profit of 3% before taxes, this is a $100 million act of faith."

► **KLM Royal Dutch Airlines** has begun Douglas DC-8 turbojet service on its Amsterdam-Sydney route, cutting flying time approximately 22 hr. KLM plans to replace Lockheed Electra turboprop airliners with the DC-8 on Amsterdam-Singapore routes this week. Amsterdam-Sydney flights will stop at Frankfurt, Rome, Cairo, Beirut, Karachi, Bangkok, Manila and Biak, N. E. I. Amsterdam-Singapore service is via Geneva, Rome, Cairo, Dhahran, Karachi and Bangkok.

► **Piedmont Airlines** is scheduling new service to Frankfort, Ky., for Dec. 1 as a result of the Civil Aeronautics Board decision in the Great Lakes Area Local Service Case. Frankfort will be served with two daily round trip DC-3 flights.

► **United Air Lines** was scheduled to begin daily Douglas DC-8 turbojet service from Washington to Los Angeles Nov. 27 on a nonstop basis to supplement five daily jet flights which make stops en route.

First Unmanned QF-104 Flight Delayed

By William S. Reed

Los Angeles—First unmanned flight of a Lockheed QF-104 drone now is scheduled for next April when Air Force Category II tests are completed.

Meanwhile Category I testing at Palmdale, Calif., during which safety pilots have ridden through "hands-off" flights, has been completed. Category II tests will commence at Eglin AFB, Fla., next month and Lockheed test engineers will demonstrate the system to the Air Force. Testing of the range facilities at Eglin will be conducted concurrently with director-pilot training and drone checkout.

Although all flights to date have been conducted with a safety pilot aboard, complete "hands-off" flights have been made. Flights also have been made with the safety pilot controlling the aircraft through the drone autopilot by what is called the "metal stick."

Air Force pilots qualified in the F-104 will be the director pilots. Participation by Lockheed flight crews will end when the drone system is demonstrated with a safety pilot aboard late this month.

One troublesome aspect of the program has been developing a landing technique; response time of the drone pilot to visual changes in the aircraft's attitude or position on the landing approach was too slow. Method now used is to set up an airspeed on approach and vary the rate of sink by controlling the power setting. A straight-in, ILS-type approach with a 2½ deg. glide slope is used. The aircraft can contact the ground without a change in attitude but flareouts are being made as the technique develops. Result is somewhat similar to the landing approach used to bring Navy jet fighters aboard carriers. Many of the landings have been described as "rough," especially since Air Force specifications on landing gear strength are not as high as for shipboard fighters.

External appearance of the QF-104 will not be appreciably changed since the cockpit will be retained for piloted operation. Approximately 90% of all flying will be piloted. Mission profiles will be rehearsed to check out range safety and provide training for landing pilots, director pilots and radar control crews.

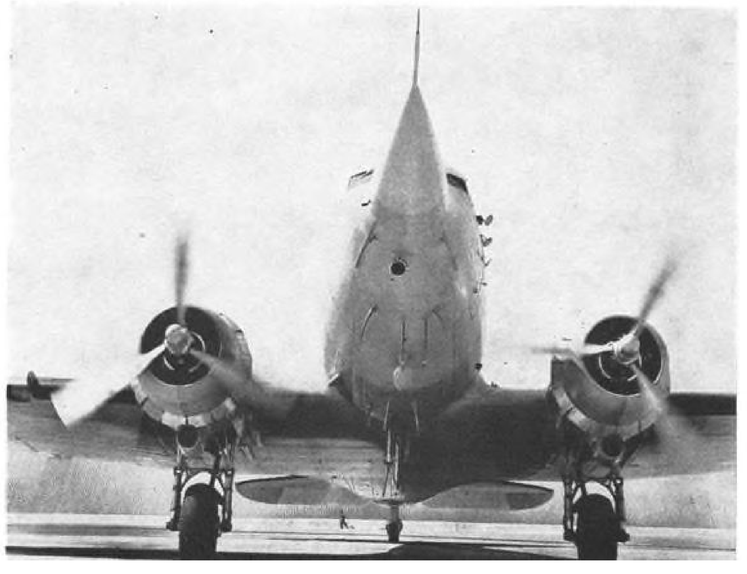
Once the drone is lined up with the runway for takeoff, the throttle is "beeped" to increase power and as soon as the afterburner cuts in, the brakes are released. Sequencing from brake release is automatic with heading-hold used to keep the flight path centered on the runway. Liftoff is accomplished at a prescribed airspeed, landing gear and flaps retracted and a normal climb angle established.

Selected altitudes and airspeeds can be commanded of the drone anywhere within the flight envelope of the aircraft. Altitude- and airspeed-hold features in the automatic pilot system are commanded for a particular airspeed-altitude combination and held by the drone automatically until a change in command is directed.

If at any time during flight the drone loses contact with a radio carrier signal, it will direct itself to an altitude of 20,000 ft. and set up a shallow left hand pattern, remaining approximately on station until command is re-established or until it can be destroyed or runs out of fuel. The Federal Aviation

F-104G Avionics Tested on DC-3

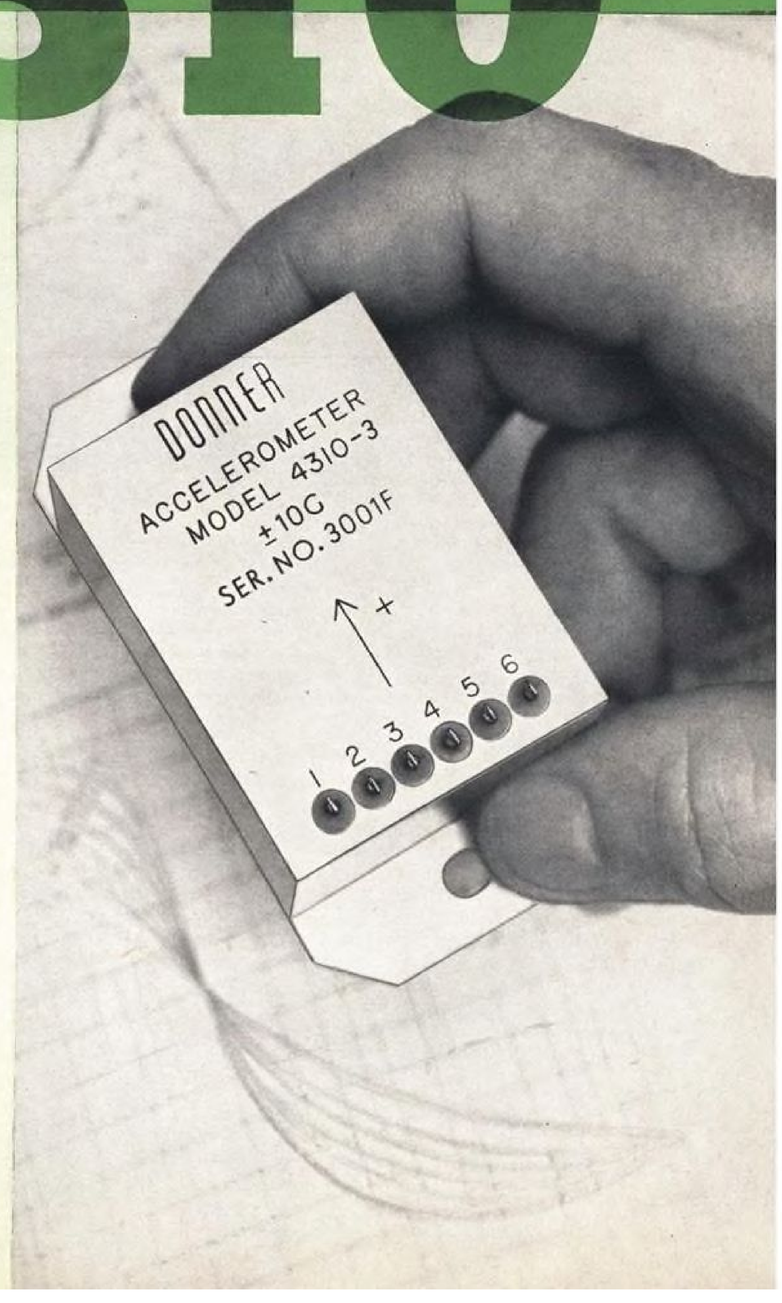
Douglas DC-3 transport owned by Lockheed Aircraft's California Division has completed more than 40 test flights fitted with a Lockheed F-104G Super Starfighter radome to evaluate the jet's radar and fire control equipment (bulge over cockpit houses infrared optical gunsight). Fuselage contains complete F-104G cockpit plus banks of test and measuring equipment; auxiliary power is provided by a sports car engine. Tests cover the gunsight, in-range computer, bombing computer, Tacan receiver, inertial navigator, air data computer and position homing indicator. Radome is 8 ft. long and is filament-wound for better "see-through" qualities.



ACCELEROMETER RELIABILITY IS

4310

Three years and 3000 accelerometers later, the solid state Donner Model 4310 0.1% force balance servo accelerometer is still "state of the art." And it is the only precision instrumentation accelerometer with proven reliability—reliability defined by experience.



A TRANSISTORIZED SERVO TRANSDUCER WITH A RECORD 4310

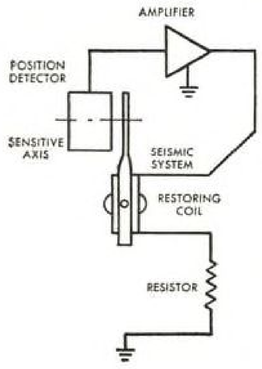
First introduced in the fall of 1957, Donner Scientific Company's Model 4310 linear accelerometer has been successfully applied to the problems of missile and aircraft dynamics. Applications include telemetering, servo stabilization, gyro erection, acceleration switching, and short range inertial guidance. Polaris, Mercury, Atlas, Minuteman and Pershing are typical missile projects where the 4310 has played an important role. Engineering programs for both the Boeing 707 and DC-8 jet transports used the Donner 4310 as part of their test instrumentation.

9 REASONS WHY THE DONNER 4310 IS A STANDARD OF EXCELLENCE

1. High output, ±7½v dc standard, up to ±60v dc special. High output virtually eliminates signal to noise ratio problems, the need for an additional amplifier to drive voltage controlled oscillators in telemetry applications, and provides sufficient power to drive a recorder directly.
2. Use of the oil filled Model 4310 eliminates the need of filter networks for dc or low frequency applications.
3. No regulated power supply required. Standard Donner 4310's operate from a ±15 or +28v dc power source ±15%. Power drain is so low that they can be operated from miniature battery packs.
4. Overall weight can be reduced. The air filled unit weighs but 3.2 ounces; the oil filled, 7.5 ounces.
5. Available in split case to meet limited space requirements. Sensing element is in one case, electronics in the other.
6. For the measurement of broadband accelerations, the high natural frequency of the electronically damped unit provides flat response from dc to over 100 cps in most ranges.
7. "Infinite" resolution.*
8. Performance. Linearity, 0.05% f.s. Hysteresis, 0.02% f.s. Repeatability, 0.01% f.s. Null indeterminacy, 0.02% f.s.* Statistical summation of probable errors from these factors, $3\sigma < 0.06\%$.
9. Price $450 for an 0.1% instrument. Almost five times better accuracy than any proven accelerometer available at a comparable price.

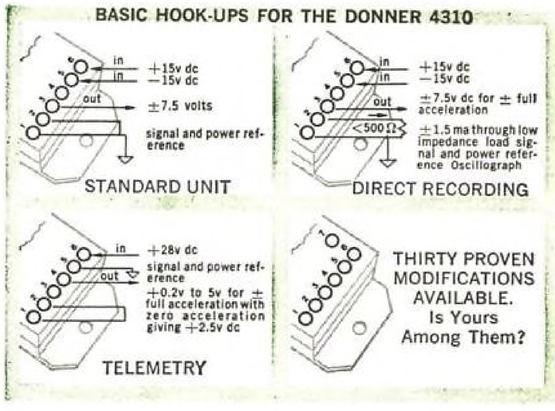
*Next time your Donner sales engineer calls, ask him to explain.

HOW IT WORKS



The Donner accelerometer operates as a subminiature servo system, responsive to input linear acceleration along its sensitive axis. Under an acceleration, the acceleration sensitive mass tends to move. As movement occurs, the position-error detector and servo amplifier generates a feedback signal which is returned as current through the restoring mechanism. The electromechanical servo action results in a balance between the input force created by the acceleration and the feedback force proportional to the current in the restoring coil. The restoring current, or the voltage it develops across a series resistor, is the output of the accelerometer and a precise measure of input acceleration.

BASIC HOOK-UPS FOR THE DONNER 4310



NEW 6 PAGE TECHNICAL BROCHURE READY NOW. For complete information, write for our bulletin, "The Donner 4310 Linear Accelerometer, A Standard of Excellence." Please address Dept. 09.

DONNER
SCIENTIFIC COMPANY
A Subsidiary of Systron-Donner Corp.
CONCORD, CALIFORNIA
MUlberry 2-6161

Challenging career opportunities available for engineers and scientists. Please contact us.

Agency, however, reportedly is unhappy with the Air Force's selection of 20,000 ft. as the lost-command altitude. The FAA has indicated a preference for a lower altitude of around 4,000 ft. Difficulty is that fuel aboard the drone would be expended much more rapidly at a lower level, minimizing the time available for determining the trouble and re-establishing control. Also, aerial gunnery would be much more hazardous at the lower altitude should it become necessary to destroy the aircraft.

The drones will carry photographic and television cameras to register near misses by ground-to-air and air-to-air missiles.

Once the mission has been computed, the drones will be returned to a prescribed rendezvous area where they will be picked up by a director aircraft designated DT-33A. Back-seat pilot will control the drone and prepare it for entry into the landing approach. As in the ground control phase, airspeed and altitude will be selected by the director pilot and automatically maintained by the drone.

After the director has the drone in landing configuration, he will enter it into the landing approach near the ILS outer marker. DT-33 will fly formation with the QF-104 down the landing approach, with the director "flying" the drone, or, if desired, with the drone accomplishing the approach automatically through an ILS approach coupler.

Directors stationed on the ground near the landing runway will take over visually as the aircraft comes down the glide path. Control will be taken over by the ground director when visual contact definitely is established. DT-33 will make a go-around.

Since most of the flights will be with a pilot aboard the QF-104 no effort will be made to strip the airframe or engine of those safety items necessary for flight safety.

Approximately 25 F-104A aircraft are being modified into drones. The aircraft are expected to retain the Mach 2.5 speed capability and to operate at better than 70,000 ft.

NASA Awards Contract For Nuclear Safety

Washington—Lewis Research Center has awarded at $270,850 contract to Controls for Radiation, Inc., to perform monitoring and safety services at the National Aeronautics and Space Administration Plum Brook nuclear reactor facility.

Firm will monitor the area for radiation, store and issue protective clothing and devices, monitor incoming and outgoing radioactive materials, dispose of radioactive waste and collect weather data. Plum Brook facility is scheduled to go into operation early next year.

SHORT SB.5 recently made flight with adjustable wings swept back at 69-deg. angle.

British Flight-Test Short SB.5

Short SB.5 low-speed research aircraft now is flying with wings swept at 69 deg. as part of a program aimed at adding to background data for supersonic transport design in England.

Tests of the extreme-sweep configuration should complement those done on the SC.1 VTOL testbed, another research aircraft designed and developed by the Aircraft Division of Short Bros. & Harland, Ltd., Belfast (AW Oct. 17, p. 78).

British views on supersonic transports generally tend to favor a VTOL layout, with multiple jets and extreme sweepback.

The SB.5 was originally designed and flown to test a series of wing sweepbacks and tail positions for the English Electric P.1 fighter, specifically in the low-speed flight regime. The latest configuration features not only the high degree of sweep, but also a drooped-nose leading edge, one characteristic of a new supersonic wing geometry developed by engineers at the Royal Aircraft Establishment, Farnborough.

Changed airplane performance due to the high sweep meant that more power was needed to fly. The Rolls-Royce Derwent turbojet originally installed has been replaced by a Bristol Orpheus BOr.3 rated at 4,850 lb. thrust, an increase of about 35% over the 3,600-lb. rating of the Derwent.

In addition, the nose wheel and landing gear have been moved to match the new center of gravity position, the cockpit layout and instrumentation have been changed somewhat and a zero-level Martin Baker ejection seat has been fitted.

Although the SB.5 was developed as a project to precede the P.1 fighter, actual flight tests of the research airplane ran in parallel with those of the P.1, so that the value of the low-speed research program has been assessed as doubtful by some British observers. Four different configurations were designed into the SB.5 project: 50 deg. sweep on the wings, with a tailplane set high on the vertical fin; 60 deg. sweep, with the high tail or with tailplane set low on the fuselage, and 69 deg. sweep, with a high tail. The current geometry shows a low-set tail again, indicating that the P.1 flight experience has fed back into the research aircraft program, rather than vice versa.

First flight of the SB.5 with 69-deg. sweep was made Oct. 18 by RAE Farnborough test pilot Denis Tayler, who lifted the plane off the runway at RAE Bedford for a 20-min. routine flight after only a single taxi run.

Span of the plane in its latest configuration is 25 ft. 11¾ in., and length is 47 ft. 4 in. Height over-all is 15 ft.

Manual to Illustrate Steel Casting Defects

Manual of radiographic acceptance standards for lightweight airframe steel castings is being developed by Naval Ordnance Laboratory, using specimens and test results provided by American Brake Shoe Co., Mahwah, N. J.

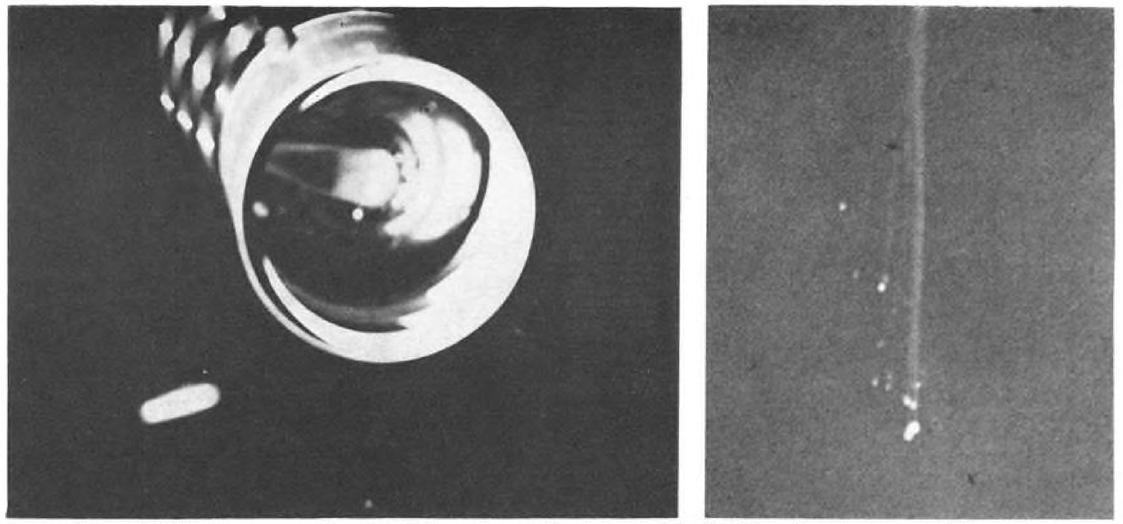
American Brake will produce castings 8 in. long, 6 in. wide and with wall thicknesses of 0.13 to 0.75 in. Each casting will have a single defect such as shrinkage, inclusion, cold shut, crack, gas hole, hot tear or misrun, which must be clearly identifiable on an X-ray. Six alloy compositions will be used in the castings and, in most tests, radiographs will be made to display defects in several degrees of progressively increasing severity.

PRODUCTION BRIEFING

Chance Vought's Aeronautics Division will produce infrared sighting scope housings for Army M-14 rifles under a $144,037 contract from Varo Manufacturing Co., Garland, Tex.

Air Force and Thiokol Chemical Corp. broke ground in Utah with a blast of solid propellant as construction was begun on a new $30-million plant for production of first-run stage Minuteman engines. Plant site is 12 mi. west of Tremonton, in the northeast part of Great Salt Lake region.

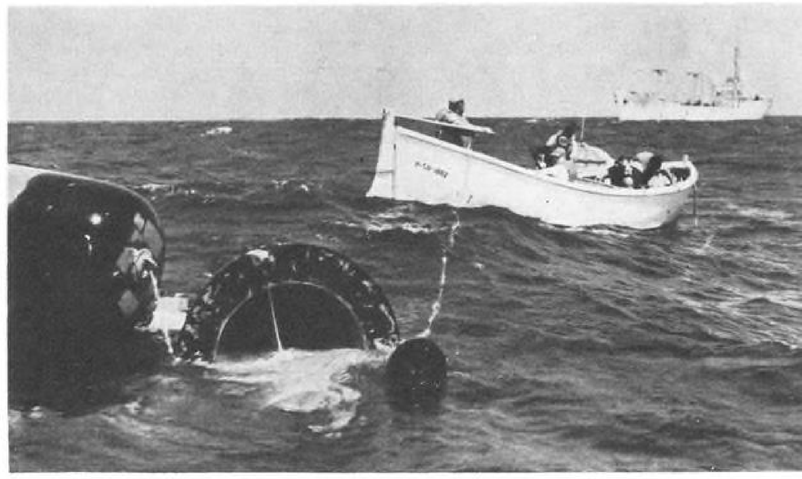
Westinghouse Electric Corp. has received a $2.3-million contract from Wright Air Development Division for continuing development of molecular electronic systems.

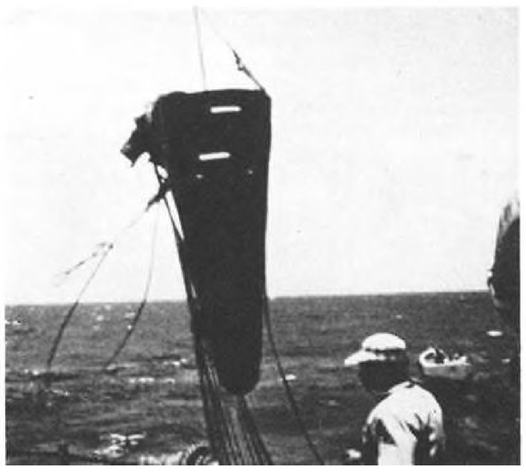


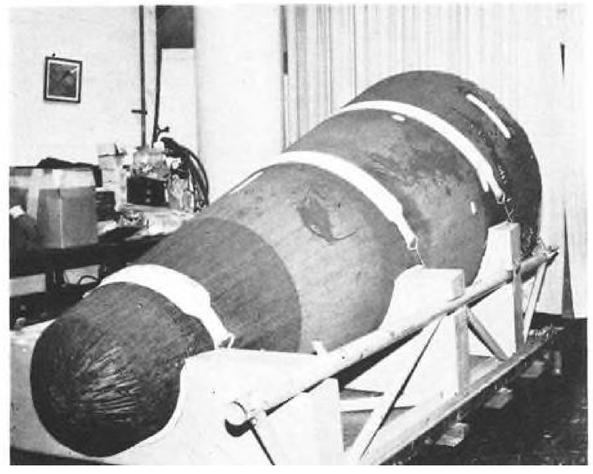
Convair Atlas ICBM booster separates from RVX-2A re-entry vehicle at about 250-mi. altitude, then breaks up (right) upon re-entry.

GE RVX-2A Re-entry Vehicle Recovered From Atlantic

General Electric RVX-2A re-entry vehicle, boosted by a Convair Atlas intercontinental ballistic missile, attained a maximum altitude of about 700 mi. and was recovered in the South Atlantic 5,000 mi. downrange from Cape Canaveral, Fla. (AW Nov. 14, p. 19). At right a small boat launched from the recovery vessel Whiskey (in background) engages the nose cone, which is hauled aboard the vessel (below, left). Photo below, right shows the 2,700 lb., 12-ft. long, 5-ft. diameter re-entry vehicle mounted on a platform on board Whiskey. Primary objective for the RVX-2A re-entry vehicle, launched from Cape Canaveral Oct. 13, was to test a new type of ablation material. Vehicle also contained 18 scientific experiments and took the colored photograph of cloud coverage of the earth on the cover of this issue.







Negative Ion Neutralization Investigated

By Russell Hawkes

Monterey, Calif.—Injection of negative ions is being investigated by Aerojet-General Corp. as a means of neutralizing the positive electrostatic charge of ion exhaust from an ion rocket.

Unneutralized exhaust is apt to cause uncontrolled variations in the thrust vector of any ion rocket large enough to be of practical use and may even stall the motor completely by creating such a large positive space charge outside the motor exit as to eliminate the axial difference in electrical potential which accelerates the propellant.

The most common approach to the problem of neutralization is the injection of electrons into the beam. If the number of electrons emitted equals the number of ions, the vehicle itself will remain neutral. However, the mixing of electrons with the positively charged exhaust is difficult because part of the electrons will have such high velocities that they will be unable to mix with the slower, more massive ions.

Space Demonstration

Experimenters believe they have solved this problem in the laboratory but most of them concede that only actual demonstration in free space will prove their solutions.

The Aerojet-General study of negative ion neutralization was described at the American Rocket Society Electrostatic Propulsion Conference here by R. J. Sunderland, J. R. Radbill and R. D. Gilpin of Aerojet's Astronautics Laboratory. They report that the materials having the best electron affinity are the halogens and the alkali halides, but halogens are difficult to handle and alkali halides require high temperatures to produce vapor pressures large enough to feed an ion generator. The Aerojet scientists used sulfur hexafluoride which is relatively inert, available and has a molecular mass compatible with that of a beam of positive cesium ions. Its boiling point of −63.8C suggests that it may be trapped easily at liquid nitrogen temperatures.

The extra electron of a negative ion enables it to counter the effect of a positive ion with its electron shortage so that equal numbers of oppositely charged ions form a plasma that is neutral in its over-all effect. Since negative ion mass can be approximately the same as that of positive ions, it is easier to achieve similar velocities and the mass flow of negative ions adds thrust. Nuclear physicists already have made use of high current negative ion sources to double the effective energy of electrostatic accelerators. Ten of the 18 sources credited by the Aerojet team in their bibliography were Russian.

A number of experimenters have neutralized ion beams by injecting electrons. The main obstacle to neutralization by electrons is the velocity variations of electrons leaving a cathode. Both ordered and disordered electron injection patterns have been tried.

The American Rocket Society Electrostatic Propulsion Conference heard Park French of Thompson Ramo Wooldridge report on his study of circular beam neutralization by orderly injection. French said a method producing disordered or random electron motion and a large amount of electron scattering near the motor exit may lead to the simplest neutralization device but is not as susceptible to theoretical analysis as ordered electron flow. French's analytical study indicates that it should be possible to use ordered electron flow and obtain neutralization in the critical area near the exit electrodes of ion motors. The method should allow full-scale operation of high-thrust ion motors in test chambers.

It consists of injecting the electrons from a hot cathode to travel in spiral paths with the rate of advance of the spiral about equal to ion velocities. Neutralization is purposely left incomplete to provide the field necessary to drive the spiral motion. French said that this causes a slight continuous expansion of the beam but does not reduce propulsion efficiency. Since the injection requirements are not very complicated, he said, the development of a cathode to supply neutralizing electrons does not seem difficult.

Measurement and Instrumentation

Measurement and instrumentation of laboratory ion motor installations are considered critical problems because of the lack of plans for an early test in space. Important properties to be measured include ion beam current, beam power, thrust, ion trajectories, potential distribution and charge distribution. A report on techniques of beam diagnosis was delivered at the Monterey conference by the staff of Electro-Optical Systems, Inc., of Pasadena, Calif., holder of USAF ion motor development contracts.

The Electro-Optical team listed instruments they are now using, including:

• **Flat plate ion collector** with a layer of thin metal honeycomb on its face to measure beam current. This design overcomes objections to simple flat-plate collectors and conventional Faraday cup collectors. Because a flat plate bombarded by ions emits secondary electrons which are difficult to suppress, the current reading it produces may be four times as high as the actual beam current. The Faraday cup is too narrow to measure a beam which may be as wide as the test chamber in which the ion motor operates. A honeycomb collector obtains the same effect as a Faraday cup without this disadvantage. The frontal area presented to the ion beam by the honeycomb walls is only about 1.5% of the total collector area and the honeycomb cell depth is from 4 to 10 times the cell width. With a correctly biased grid, current can be read to 1% accuracy with high reliability. Variation of collector current with a small bias voltage is only about 1% for 7 kv. ions.

• **Calorimeters which measure** beam power in the form of heat generated by the impact of ions on the collector used for current measurements. The honeycomb face must be made of very thin high-conductivity metal to minimize time constants and radiative power losses. The EOS calorimeters use platinum resistance thermometers to sense the rise in coolant water temperatures as the measure of delivered power. Thermistors have been used and found to be more sensitive, but the platinum resistance thermometers offer better stability and linearity. At a cooling water flow rate of 23.6 gph. the calorimeter is sensitive to power changes as small as 0.5 watt and has a response time of eight seconds. Cooling water is circulated by an independent system of pumps and accumulators because of erratic pressure on the city water mains. City water is used on the cold side of a heat exchanger that removes heat from the collector cooling circuit.

• **Light, pendulous collector** with a honeycomb face to measure ion motor thrust. The collector, suspended by four tungsten ribbons, is displaced by the pressure of the ion beam and the displacement is measured by viewing a scribed glass reticle attached to the collector through a microscope. An attached copper cylinder in the field of a permanent magnet damps the motion of the collector. Electro-Optical scientists say it is an extraordinarily useful instrument. It is simpler in operation than a calorimeter, has a response constant under one second, and is an absolute instrument with which a force constant can be calculated directly from the mass and support length or from the mass and period of oscillation. The optical readout now limits sensitivity to about seven micropounds but the noise level is much less. The Electro-Optical staff believes a good electrical readout will yield a sensitivity of less than one micropound.

MSVD POSITION INDEX

POSITION CATEGORY	MISSILE RE-ENTRY VEHICLES Thor Atlas Titan Skybolt	CURRENT SATELLITES & PROBES (FLIGHT TEST STAGE) NERV (Nuclear Emulsion Recovery Vehicle) Discoverer (Orbiting Satellite Recovery Capsule)	ADVANCED SATELLITES (EARLY DEVELOPMENT STAGE) Advent Satellite (Communication Satellite) plus other programs still classified	ADVANCED SYSTEMS & RESEARCH STUDY APOLLO Manned Space Vehicle Study Aerophysics—Aerodynamics Studies
Projects Engineering	40 41 50	40 41 50	40 41 50	50
Reliability Engineering	10 11 48 49 53	10 11 48 49 53	10 11 48 49 53	
Systems Design	42 58 59	42 58 59	42 58 59	42 58
Advanced Systems	2 8 16 22 47	8 16 24 28 47	2 16 22 35 60	2 8 16 22 24 28 35 47 60
Thermodynamics — Aerophysics	4 25	4 25	4 25	2 19 38
Aerodynamics — Flight Mechanics	1 18	1 18 37	1 26 37	1 26 37
Instrumentation & Communication	3 6 7 8 12 15 29 36	3 6 7 8 15	3 6 7 8 12 15 29 36	8
Navigation, Control & Power	6 12 14 15 27 29 34 35 36 47 51	6 14 15 34 47 51	6 12 14 15 29 34 35 36 51	35 47 51
Ground & Space Support	6 12 13 14 20 21 28 33	6 13 14 20 21 33	6 12 13 14 20 21 29 33 36 52	
Life Support Systems	23	23 28		23 28
Missile Arming & Fuzing	6 14 15 27 58 59			
Structures Engineering	55 56 57	54 55 57	54 55 57	54 56
Applied Mathematics	5 9	5 9	5 9	5 9
Quality Systems Engineering	13 29 33 46	13 33 46	13 29 33 46	
Quality Control Engineering	6 17 43 44 45	6 17 43 44 45	6 43 44 45	
Manufacturing Engineering	30 39	30 39	30 39	
Materials Studies	31 32	31 32	31 32	31

Check the next four pages for detailed job specifications

1 AERODYNAMICIST

Selection of configurations providing required aerodynamic characteristics and determination of aerodynamic coefficients and pressure distributions at subsonic through hypersonic speeds. Other assignments in aerodynamic techniques, wind tunnel experimentation and free flight experimentation. AE or ME with 2-10 years experience.

2 AEROPHYSICS SYSTEMS ENGINEER

Will conduct aerophysics studies and provide technical leadership on studies carried out in the engineering and laboratory operation to produce aerophysics preliminary designs and analyses for proposed systems. Requires advanced degree, 6 or more years experience and broad aerophysics background.

3 ADVANCED ANTENNA AND PROPAGATION ENGINEER

Provide high level theoretical and experimental studies of antennas, propagation and target reflectors for all radio frequency bands leading to new and improved concepts. EE (advanced degree desired) with 6 or more years experience.

4 THERMODYNAMICS ENGINEER

Responsibilities include work in boundary layer skin friction and heat transfer, wake and separated flows, transition, real gas, aerodynamic noise, materials heat transfer and thermal configurational analysis. Engineering or Physics degree with 3 or more years of experience.

5 APPLIED MATHEMATICIAN

Perform mathematical investigations of such advanced programs as trajectory studies and related navigation problems, space communication and the interpretation and analysis of flight telemetry data. MS or PhD in Mathematics or Theoretical Physics.

6 CIRCUIT DESIGN ENGINEER

Responsible for transistor circuits on a broad variety of equipment such as amplifiers, sensing devices, timers, computers and test equipment including work on circuit philosophy and information theory. EE with 3 or more years experience.

7 COMMUNICATION EQUIPMENT ENGINEER

Will design and evaluate airborne and ground telemetry, voice and video circuits and components. Requires thorough knowledge of both transmitter and receiver design, 5 years experience and EE.

8 COMMUNICATION SYSTEMS ANALYSIS ENGINEER

Analysis and synthesis of new instrumentation and communication systems to meet future requirements. Requires analytical knowledge in the fields of communication, instrumentation and data processing. EE with 4 or more years of experience.

9 COMPUTER PROGRAMMERS

Analysis and programming for technical data systems, flight test data systems and advanced engineering investigations on new IBM 7090. Requires math degree, minimum of 2 years experience on a large scale, binary computer and ability to direct the work on a complete program.

10 COMPONENTS / STANDARDS ENGINEER

Responsible for the application, selection, evaluation and standardization of component parts such as transistors, diodes, capacitors, resistors, relays, mechanical hardware, etc. Requires engineering degree with five or more years of experience.

11 DESIGN REVIEW ENGINEER

Establish high level design reviews of various MSVD products with the objective of improving upon the technical adequacy of the design. This includes consultation and procurement of outside consulting services. Strong technical ability in electronic, structural or mechanical engineering required.

12 DIGITAL COMPONENT AND CIRCUIT DESIGN ENGINEER

Will design and evaluate A/D and D/A converters, multiplexers, parity check generators, digital storage devices, binary counters, etc. for both airborne and ground digital equipment. EE with 2-5 years experience.

13 ELECTRICAL TEST EQUIPMENT ENGINEER

Design of test equipment for missile and space vehicle systems and components including electro-mechanical, communication, and navigation and control types of equipment. EE with 3-5 years of product design experience in related field required.

14 ELECTRO-MECHANICAL ENGINEER

Design of medium sized precision equipment involving the application of structures, open and closed loop drive and control systems, and precision measurement and alignment devices. ME or EE with 3-8 years of design experience related to mechanical ground support equipment.

15 ELECTRONIC PACKAGING ENGINEER

Application of heat transfer, vibration and stress analysis to packaging of conventional and miniaturized airborne components and systems. ME with 4 or more years experience.

16 ELECTRONICS SYSTEMS ENGINEER

Advanced conceptual work on complete airborne electronic systems design work with emphasis on communications, telemetry and radar systems. Requires broad electronics background, EE and 8 or more years in airborne electronics systems.

17 FIELD REQUIREMENTS ENGINEER

Determines operational plans for the execution of field performance and evaluation test programs. Engineering liaison between customer, associate contractors and MSVD to schedule joint test plans and provide the necessary equipment. ME or EE with 5 years in field test.

18 FLIGHT TEST ANALYSIS ENGINEER

Studies leading toward the demonstration of vehicle flying characteristics as determined from flight test data. Familiarity with vehicle dynamics necessary to specify parameters to be measured. Requires engineering or physics degree plus 2-5 years of applicable experience.

19 GAS DYNAMICIST

Will perform investigations of such areas of gas dynamics as magneto-gas dynamics; non-equilibrium effects in gas dynamics at high altitudes, mass transfer and heat transfer, boundary layer theory and flow field analysis. Requires PhD or the equivalent in experience.

20 GROUND SUPPORT ELECTRONICS SYSTEMS ENGINEER

Design and development of ground electronic systems, through the RF spectrum, for application in the support systems of the re-entry or space vehicle. Requires BSEE, 6 years experience with background in such fields as communciations, telemetry or radar.

21 GROUND AND SPACE SUPPORT APPLICATION ENGINEER

To provide technical direction in the preliminary design involved in the development of ground and space support systems. BS plus 8 years experience with knowledge in electronics/electro-mechanical fields including monitor control and instrumentation system development.

22 GUIDANCE AND CONTROL ADVANCED SYSTEMS ENGINEER

Will be responsible for broad systems analysis, synthesis and mechanization of advanced concepts in guidance and control for application to future systems. Requires an established background of at least 5 years in guidance and control with emphasis on creative analysis and design.

23 HUMAN FACTORS PSYCHOLOGIST/SCIENTIST

Work in the area of man-in-space; displays and controls for space vehicles and work-space layouts. Other psychological studies involved in training proficiency measurement instruments, technical manuals and military personnel characteristics. MS or PhD in Psychology.

24 HUMAN FACTORS SYSTEMS ENGINEER

Advanced design of manned-space vehicle sub-systems which are directly related to human factors such as cabin arrangements, instrument displays, radiation protection, support-restraint devices, psychological-physiological instrumentation and flight/crew control devices. Engineering degree with applicable experience on high speed aircraft or space vehicles.

25 INTERNAL THERMAL ENVIRONMENT ENGINEER

Responsibilities are mainly in thermodynamics systems design of orbiting satellite vehicles including active and passive temperature controls. This will also include thermal test programs and component thermal studies. Physics, Chem E or ME with 3 or more years of heat transfer experience.

26 INTERPLANETARY AND LUNAR TRAJECTORY RESEARCH ASSOCIATE

Conduct analytical and computer studies in applied mechanics, applied mathematics, celestial dynamics and analytical dynamics. Requires PhD in Mathematics, Astronomy or Applied Mechanics.

27 INERTIAL EQUIPMENT ENGINEER

Analysis, refinements and application of various types of inertial equipment to space navigation and control problems. Background in the design and development of various inertial devices such as floated-integrating gyros, accelerometers and synchros plus engineering degree.

28 LIFE SUPPORT ENGINEER

Design and development of systems and components to protect, sustain, and enable men to perform in space and other unnatural environments. ME, Chem E or Physicist with experience in areas of air conditioning, refrigeration, and design of life support equipment.

29 LOGIC CIRCUIT DESIGN ENGINEER

To provide high level technical evaluation of digital techniques as applied to automatic programming system for check-out equipment and airborne instrumentation. EE with broad digital background from system philosophy to final design.

30 MANUFACTURING ENGINEERING RESEARCH & DEVELOPMENT ENGINEER

Advanced study of fabrication and process methods to meet future program needs. Direct experimentation and investigation in the areas of fundamental manufacturing research. ME or EE with 10 years of experience in the manufacturing of electronic and mechanical devices for aircraft or space vehicles.

PERSONAL DETAILS

Name _____

Home Address _____

City _____

State _____

Telephone _____

U. S. Citizen Yes ☐ No ☐

Education

Undergraduate

College _____

Degree _____

Year of Graduation _____

Graduate

College _____

Degree _____

Year of Graduation _____

Position Objective (primary job preference, level of responsibility, salary expectations)

_____

_____

_____

_____

_____

_____

_____

PROFESSIONAL EXPERIENCE

(Two most recent or most applicable jobs)

Company _____

_____

Position _____

Years of experience (from) _____

(to) _____ Salary _____

Assigned Duties _____

_____

_____

_____

_____

Company _____

_____

Position _____

Years of experience (from) _____

(to) _____ Salary _____

Assigned Duties _____

_____

_____

_____

_____

GENERAL ELECTRIC

MAIL THIS CARD

Simply circle the appropriate numbers of those positions that meet your professional interests and qualifications, fill in the questions on the back of the card and mail it to us. The card should be folded, then sealed or stapled; no postage is required. We will contact you just as soon as we have reviewed this information.

I am interested in the following position(s)

Projects Engineering 40, 41, 50
Reliability Engineering 10, 11, 48, 49, 53
Systems Design 42, 58, 59
Advanced Systems 2, 8, 16, 22, 24, 28, 35, 47, 60
Thermodynamics-Aerophysics ...2, 4, 19, 25, 38
Aerodynamics-Flight Mechanics ...1, 18, 26, 37
Instrumentation & Communication.....3, 6, 7, 8, 12, 15, 29, 36
Navigation, Control & Power ..6, 12, 14,15, 27, 29, 34, 35, 36, 47, 51
Ground & Space Support.....6, 12, 13,14, 20, 21, 29, 33, 36, 52
Life Support Systems.....23, 28
Missile Arming & Fuzing...6, 14, 15, 27, 58, 59
Structures Engineering 54, 55, 56, 57
Applied Mathematics 5, 9
Quality Systems Engineering.....13, 29, 33, 46
Quality Control Engineering....6, 17, 43, 44, 45
Manufacturing Engineering 30, 39
Materials Studies 31, 32

GENERAL ELECTRIC

FIRST CLASS
PERMIT No. 22246
PHILADELPHIA, PA.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

Postage Will Be Paid By

Mr. Douglas G. Curley
Missile & Space Vehicle Department
General Electric Company
3198 Chestnut Street
Philadelphia 4, Pennsylvania

31 MATERIALS STUDIES ENGINEER

Requires ability to conduct basic research in metallurgy, ceramics or plastics in establishing new materials for development and application to advanced space vehicles being subjected to extreme environments. PhD or the equivalent in experience required.

32 MATERIALS AND PROCESSES ENGINEER

Analyze future materials requirements, plans programs for developing and evaluating processes, and advise in the preparation of materials quality standards. Chemical or metallurgical degree with experience in such fields as Plastics, Metallurgy and Physical Chemistry.

33 MECHANICAL/ ENVIRONMENTAL TEST EQUIPMENT ENGINEER

Assume responsibility for the design, development, procurement and coordination of operating procedures on a variety of mechanical and environmental test equipment such as temperature chambers, vibration equipment, etc. ME with 3-10 years of applicable experience.

34 NAVIGATION AND CONTROL SYSTEMS DESIGN ENGINEER

Responsible for the integration, coordination and project engineering of special navigation and control systems including attitude control, orbit control and space power. Requires broad control background, EE or ME and five or more years experience.

35 NAVIGATION AND GUIDANCE ANALYSIS ENGINEER

To conduct analytical studies on inertial guidance and control for space vehicles including such applications as space rendezvous and soft interplanetary landings. Background in closed-loop systems, EE or Physics and five or more years experience.

36 OPTICAL SPECIALIST

Planning and development of optical subsystems and components; theory and application of physical and geometric optics; infrared, visible and ultra-violet wave lengths; celestial guidance equipment and wide-angle optical sensors. Physics or Engineering degree with 2-10 years experience.

37 ORBITAL DYNAMICS ENGINEER

Will conduct studies leading to design, stability and maintenance of satellite systems orbits including effects of perturbation on vehicle attitude and position. Requires engineering or Physics degree with 2-5 years of applicable experience.

38 PLASMA PHYSICIST

Perform investigation associated with the generation and diagnosis of plasma; study the interactions of plasma with magnetic fields and microwave radiation and many-bodied phenomena in plasma. Requires PhD or the equivalent in experience.

39 PRODUCIBILITY ENGINEER

Work directly with design engineering to establish manufacturing feasibility of design concept. Will act as the manufacturing engineering liaison-man to design engineering in the resolution of problems in the production phase. EE or ME with 10 years of combined engineering and manufacturing experience.

40 PROJECT ENGINEER

Responsible for project direction of all work on assigned programs. This includes interpreting customer requirements, technical integration, establishing program direction and funding, measurement of technical progress. Requires engineering background combined with strong administrative capabilities.

41 PROJECT PLANNING ENGINEER

Coordinate engineering activity to insure that overall assigned program is properly planned and followed. Function includes the conversion of requirements and limitations of a program into realistic plans. Requires engineering background combined with the desire to grow into project engineering.

42 PROPOSAL SYSTEMS ANALYSIS ENGINEER

Responsible for providing the systems analysis and support of proposal effort within the Engineering Operation through the first stage of design. Broad technical background in aircraft or missile field with AE, EE, or ME.

Optical Data Correlation Methods Studied

By Barry Miller

Glendale, Calif.—Optical data correlation techniques which may provide means of recognizing terrain for future airborne navigation or automatic landing systems are being explored here at Space Electronics Corp.

Referred to as Simultaneous Multiple Image Correlation (Simicore), the techniques make possible rapid, automatic identification of sensed patterns by comparing each one with a large number of anticipated, stored patterns.

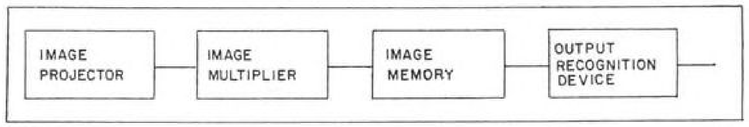
To demonstrate the feasibility of Simicore techniques, which are applicable in a number of fields, Space Electronics recently built a language translation device capable of sensing a Russian word, then displaying its English equivalent. Although the device's vocabulary currently does not exceed 20 words, its successful operation buoys confidence of its developers in the data correlation under study.

Simicore systems are composed of four parts—an image projector, multiplier, memory and output recognition devices. In operation, a light image, corresponding to a bit of data such as a radar pulse return, a pattern of dots or a letter of the alphabet is projected onto the image multiplier which effectively multiplies the single image into a multitude of identical and much smaller images. Multiplication is achieved by special fiber optics or lens mosaics arrangements

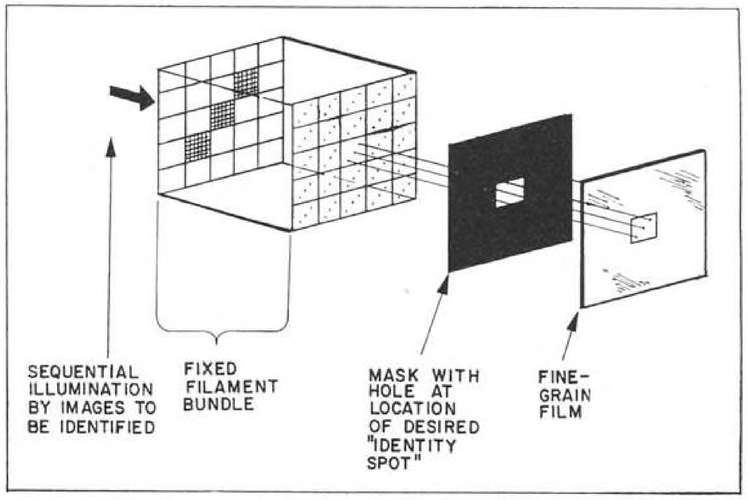
Each of the tiny, reduced-resolution replicas of the input image appearing in a plane surface pattern at the multiplier's output is projected simultaneously onto photographic film transparencies in the image memory. The memory is adjacent to the output of the image multiplier.

Stored on the transparencies are a vast number of anticipated patterns. Consequently, each sequentially sensed input image is simultaneously compared with all of the stored images. Some light flux passes through each transparency, but the one which corresponds to the input image passes a greater amount of light than do the others. This light exceeds the threshold level of a conventional photo detection tube which provides an output indication.

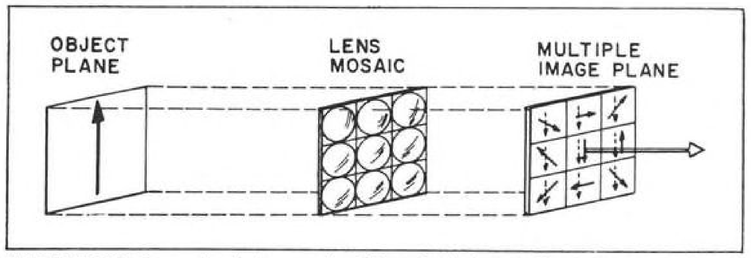
Should Simicore be employed in an automatic aircraft landing system, it might operate in roughly the following fashion: radar, optical or infrared photographs of a given airport and surrounding terrain might first be secured from different aspects and different displacement distances from the runway. These would be stored on film in the memory of the Simicore system. When an aircraft approaches the airport, its sensing device surveys the area and the acquired images are projected on the input face of the multiplier in the airborne Simicore system. These images are almost instantaneously and in parallel compared with all the stored images. Location of a spot in the output might indicate aspect and displacement of the aircraft's heading from the runway. For a fixed altitude range-azimuth scan, for example, horizontal displacement of the spot might provide left or right indication on glide path, vertical dis-



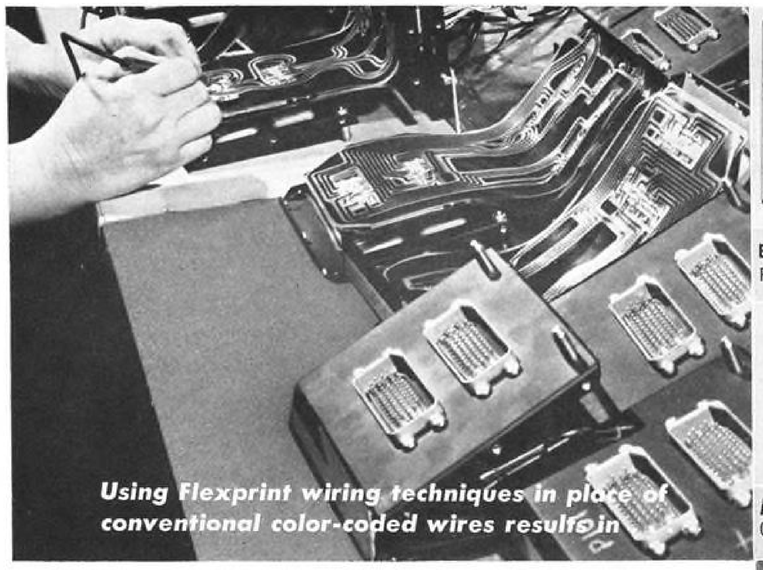
OPTICAL data correlation techniques, known as Simultaneous Multiple Image Correlation (Simicore), employ an image multiplier which reproduces a multitude of tiny replicas of each input image. These replicas are simultaneously compared with images stored on transparencies. Light flux passing through image to be identified and its identical stored image is recognized and image is identified in output.

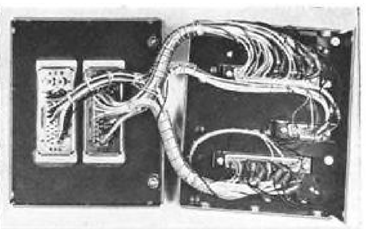


TRANSPARENCIES of images to be stored in Simicore memory are sequentially exposed through image multiplier on fine grain film. Photos of or images corresponding to airport areas can be stored for matching in use as part of automatic aircraft landing system.



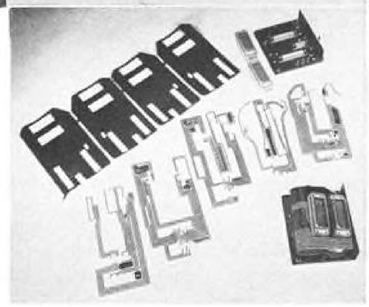
UNIDENTIFIED image (vertical arrow in object plane) is reproduced into nine identical images by illustrated lens mosaic multiplier. These are compared with many different images on transparencies in image plane. Matching images permit optimum amount of light to pass and be identified.



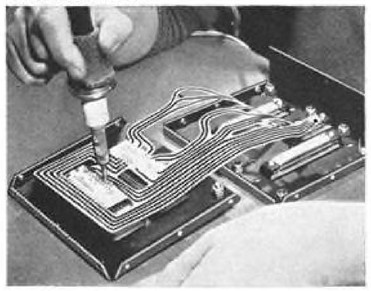


BEFORE — A Costly, Time-Consuming Assembly Problem Using Conventional Wiring

AFTER — Wiring Errors Eliminated; Weight, Cost and Time Saved Using Flexprint Wiring



Five Flexprint cables and 4 copper shields cut 50% of material-labor costs. Each cable is an accurate printed circuit, clearly numbered for easy, progressive assembly. Conductors of Flexprint wiring are totally encapsulated within the insulation except at termination. Terminations are exposed copper pads, pierced to fit pin connectors. The four unitized shields fold between the cables and maintain constant coupling effects.



Assembly gets off to a fast start! One-piece Flexprint cables are self-positioning. They locate conductors and terminations with flawless accuracy. Each pierced termination pad automatically fits itself over its own connector pin. Wiring errors are almost impossible! And soldering becomes a high-speed operation because each connection is *completely* visible, not hidden in the connector or lost in a tangle of wires. Assemblers can see at a glance that each connection is tight and right.

50% reduction in wiring costs of this electrical assembly

Originally, 82 color-coded wires were involved in the manufacture of airborne junction boxes by John Oster Company, Chicago.

A switch to Sanders Flexprint wiring — flat, flexible printed circuitry — replaced the 82 wires with 5 Flexprint cables and reduced total installed costs of the finished component by 50%. Here's how this money-saving switch was accomplished:

BEFORE FLEXPRINT WIRING, assembly of junction boxes for an airborne electrical system required a costly sequence of assembly line operations: each box called for the selection of 82 color-coded wires . . . cutting them to various lengths . . . lacing and cabling . . . identification and positioning . . . then soldering into tight corners. Opportunities for human error and mounting costs were inherent in the job, as in most electrical assembly work. With conventional wiring one more trouble source occasionally cropped up — closing the junction box created strains on the folded harnesses, and was apt to cause broken connections.

WITH SANDERS FLEXPRINT WIRING, five flat, flexible cables and 4 shields replaced the bulky harnesses (shown). Complete flexibility lessens — virtually eliminates — the likelihood of broken connections when the junction box is once assembled and closed.

WHAT CAN FLEXPRINT WIRING DO FOR YOU? It costs nothing to find out. Just send dimensional drawings, sketches or artwork of your current wired assembles with the following information:

1. Electrical specifications
2. Termination requirements
3. Environmental conditions
4. Approximate quantity

We'll send you a proposal specifying estimated costs and delivery date. Or, if you'd prefer, we'll send you a new brochure describing Flexprint wiring in detail.

FLEXPRINT®

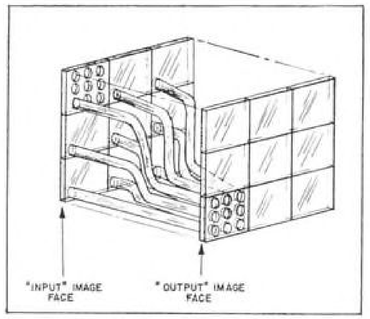
PRODUCTS DIVISION

SANDERS ASSOCIATES, INC.

NASHUA, NEW HAMPSHIRE

Inglewood, California Washington, D. C.

® Trademark Sanders Associates, Inc.; Patents pending in U.S. and abroad.



IMAGES can be multiplied by mixing optical fibers so that one strand from each of many imagined boxes of input face terminates in every one of the output boxes.

placement would be the approximate position on the glide slope.

Simicore is expected to be capable of viewing large numbers of images simultaneously and supplying an almost instantaneous estimate of off-course displacement. Time elapsed from sensing to output indication may not be much greater than input and output response delays because there'll be no mechanical or electrical delay through the multiplier. The multiplier itself, the unconventional portion of this unusual system, would vary in size according to the application, but typically would be two inches square at its ends, and five inches in length, Space Electronics estimates.

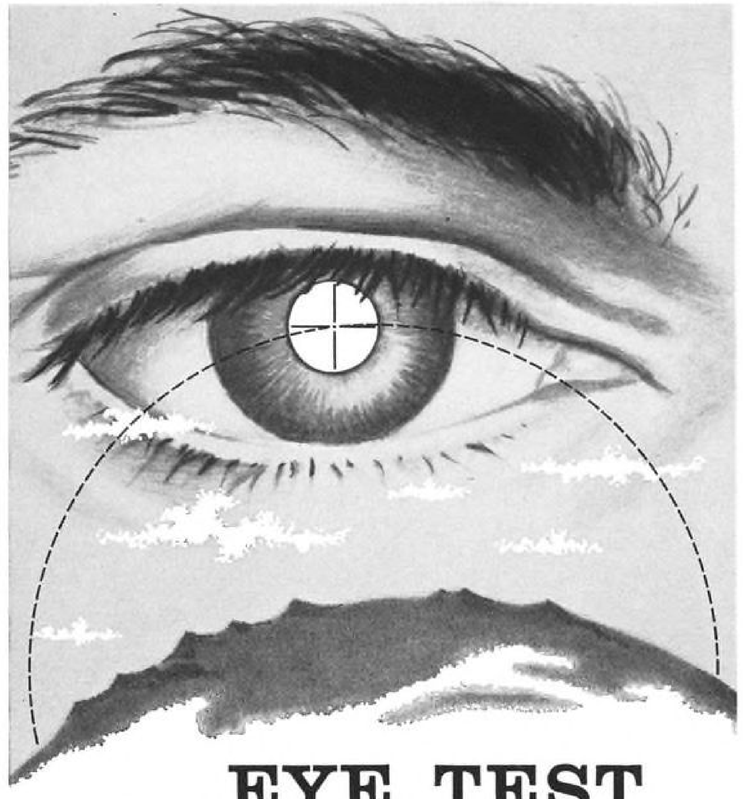
In the automatic landing system application, an ILS outer marker might be expected to bring the aircraft to the vicinity of the runway, thereby minimizing the number of pictures to be stored.

Different films for different landing locations could be inserted automatically into position before the multiplier output.

Two Image Schemes

Two image multiplication schemes are being considered by Space Electronics in connection with Simicore studies. The first of these employs fiber optics (AW Nov. 21, p. 79) and is regarded by the company as the more promising because of the high inherent optical efficiency of the optical fibers. The second technique is based on lens mosaics and appears more immediately practicable because of present difficulties in properly assembling optical fibers for the multiplier.

Unique properties of fiber optics makes this new technology appealing for these correlation studies. Bundles of optical fibers are capable of transmitting complete images from one point to another by total internal reflection within each fiber. A near perfect image is transmitted as long as the fiber order



EYE TEST FOR RADAR

B&L optical-electronic-mechanical capabilities assure accuracy in missile tracking system

The strength of our missile defense program depends in part on extreme accuracy of radar tracking.

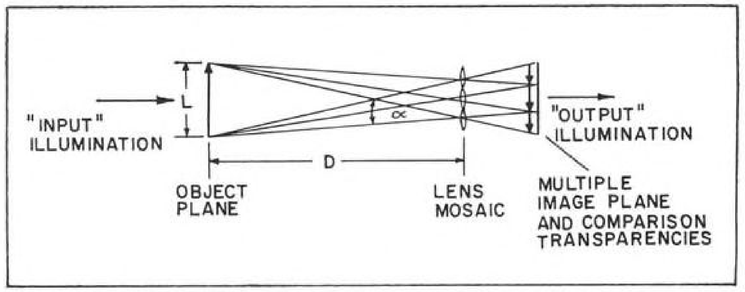
Bausch & Lomb has developed a camera lens for boresighting a radar antenna—in essence, this lens checks the performance of radar just as one's vision is checked in an eye examination.

Accuracy of this lens system easily meets the most extreme requirements.

The same skills that made possible this missile track radar camera lens are available to assist on your project. Write us for full details. Bausch & Lomb Incorporated, Military Products Division, 99411 Bausch St., Rochester 2, N. Y.

BAUSCH & LOMB

SINCE B&L 1853



FOR LENS mosaic multiplier the distance between the mosaic and the object plane is roughly five times the object height as a result of limiting the angle of view of any lens element to 0.2 radians.

at the output ends of the bundle duplicates that at the input face. Each fiber in the bundle, which may be composed of thousands of fibers, carries a small portion of the image. Fibers can be twisted or turned without distorting output images. Loss due to absorption in the fibers is low for short lengths; efficiency exceeds that of a lens.

By an unusual arrangement of fibers, Space Electronics believes it can multiply a single input image into many duplicate images. This can be accomplished as indicated for a simple case in an accompanying rough sketch. Here the output face of a fiber bundle is divided into a multitude of squares, resembling a vast checkerboard pattern. The input can be imagined to be similarly divided into a multitude of squares not necessarily equal to the number of squares in the output.

Then, the order of the fibers is mixed. One fiber from each of the imagined input squares can be terminated in every output square, respective column and row sequence of the input fibers being preserved within each output square. Recall that in each fiber bundle of the size under study (2 in. square on the original end) there are on the order of hundreds of thousands of fibers (depending on fiber diameters which may be 20 to 50 microns or less). If now the number of imagined input squares is made exceptionally large (each input square diminishingly small), the number of fiber samples in each fixed size output square becomes exceptionally high. This "sample" of the entire input face on which images are to be projected makes possible the reproduction on small scale of each image in every output square with some loss in resolution.

Every small square in the output equals in size one of the transparencies prepared beforehand and stored on film in the memory. The number of squares in the output must at least equal the number of stored transparencies so that the input replica is simultaneously compared with every bit of stored data.

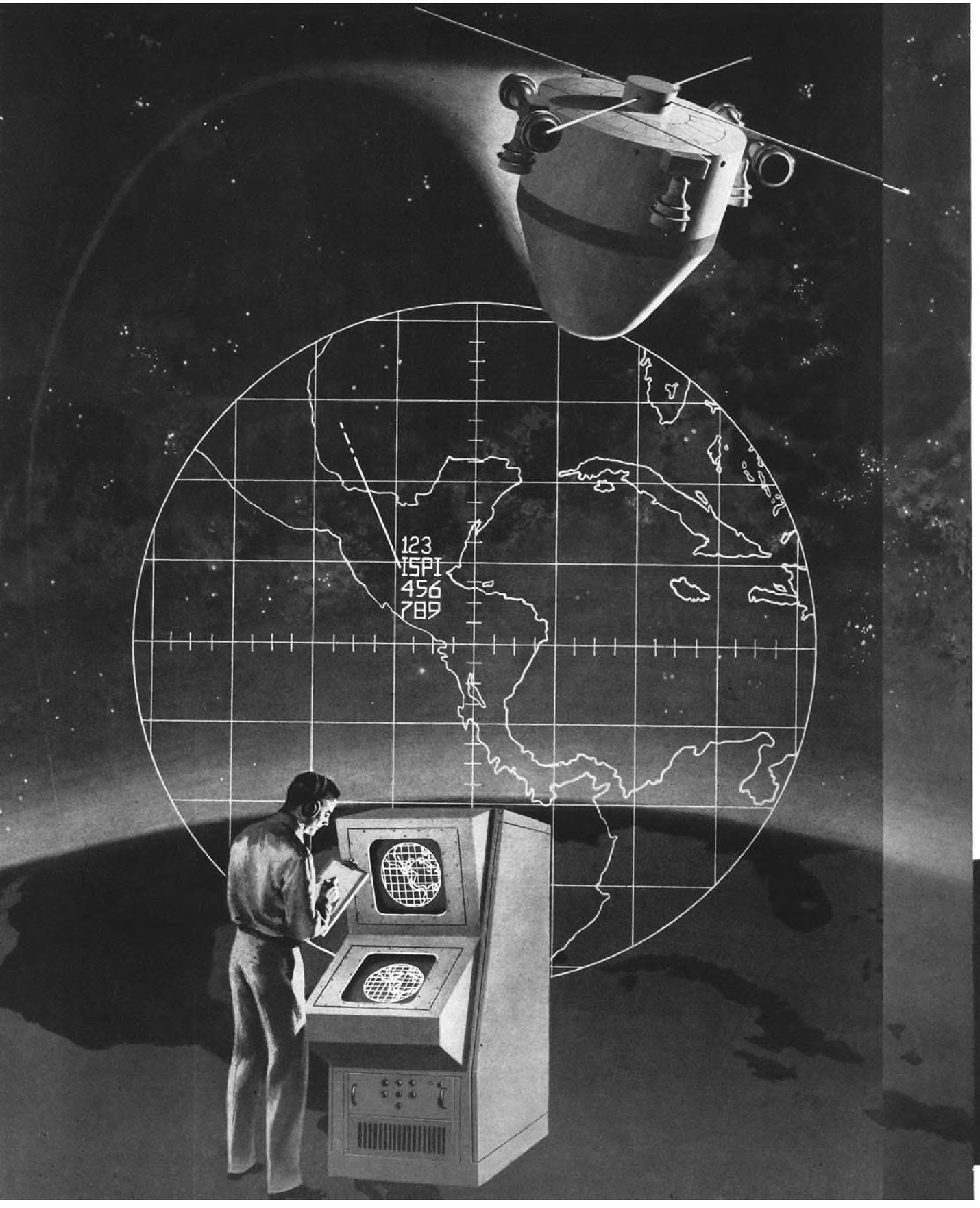
Space Electronics believes that the burden of stranding and assembling fibers for the described multiplication can be eased by quasi-random stranding. In this assembling arrangement, the column and row sequence of the fibers need not be preserved in the output as long as at least one strand from each of the imagined input boxes appears in each output. Under these conditions, the duplicate outputs are scrambled images, unlike their single originating input. The elements stored on the transparencies must be similarly scrambled for correlation to be achieved. Such a random mixing of the fibers, the company hopes, would simplify fiber bundle assembly and retain multiplication characteristics.

Transparencies of areas or figures to be correlated later can be prepared beforehand with the aid of the multiplier. Transmission can be exposed through the multiplier and all squares but one in the output masked off. A fine grain film is exposed by this image of the unmasked square. The input face is then exposed in sequence to the entire set of images as the mask moves so it exposes a new output square for each exposure. Thus, the fine grain film will contain each of the dissected images on a different square. Where quasi-random stranding is employed in the multiplier, the scrambled images corresponding to those to be obtained in later flight operation would be secured beforehand with the multiplier and stored in the memory.

Lens Mosaic System

In its second approach to the multiplication of images, Space Electronics uses a multilens mosaic which forms the multitude of identical, reduced-size images of the input. As in the first approach, these images are similarly cast on the prepared transparencies of the areas to be identified. The demonstration Russian language translator made by Space Electronics employs 1,024 mosaic lenses in a 32 by 32 array.

Practical data correlation devices which may emerge from these studies are expected by Space Electronics to be:



NEW MARQATRON

BY MARQUARDT/POMONA

Produces Instant Visual Read-Out From High Speed Processed Data

Now, any eye—skilled or unskilled—can read the true, meaningful answers of the fastest, most complex computer, and do so at the push of a button! This is made possible by the MARQATRON, an automatic data processing and display development by the Pomona Division of The Marquardt Corporation. MARQATRON establishes the basis of human understanding—instantly—of the vast data provided by computing systems. It establishes a comprehensive human-machine relationship by converting collected data into readable alpha-numeric and geometrical patterns. By this, the viewer can quickly adapt human intelligence, decision and control over any and all conditions that are reported.

The MARQATRON presents commercial and military situation data in visual images on a cathode ray screen. Operators view this reporting and are able to control or alter the characteristics of the test or operation.

In MARQATRON's original application in the U.S. Army Missile Master Program, surveillance information was converted into readable displays on screens enabling defense officers to make immediate decisions in relation to the use of all missile ordnance.

A modified MARQATRON is currently being used by Bendix on the Eagle Program, helping to determine the behavior of an experimental aerodynamic vehicle under specified operational conditions.

The adaptability and the uses of the MARQATRON are limitless in the field of data processing and display and large scale projection systems. New applications are now in development by Marquardt's Pomona Division. For detailed data, contact Dr. Wendell B. Sell, Vice President, Pomona Division, The Marquardt Corporation, 2709 North Garey Avenue, Pomona, California.

Engineers and scientists experienced in these or related fields will find it rewarding to discuss their career futures with Marquardt. The company's growth is a parallel to the atmosphere of challenge and accomplishment that has existed since the firm's beginning.

POMONA DIVISION

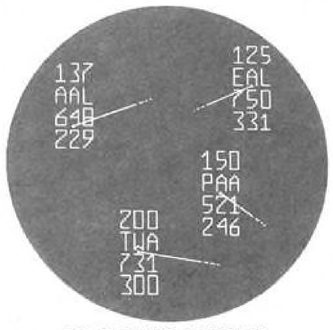
THE Marquardt CORPORATION

2709 NO. GAREY AVENUE, POMONA, CALIFORNIA

ASTRO ◆ COOPER DEVELOPMENT DIVISION
◆ OGDEN DIVISION ◆ POMONA DIVISION
◆ POWER SYSTEMS GROUP

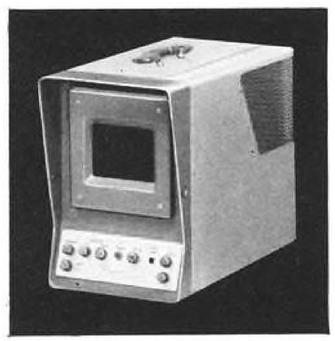
CORPORATE OFFICES: VAN NUYS, CALIFORNIA

COMMAND CONTROL
Visual displays for satellite tracking, defense intercept and missile training.



AIR TRAFFIC CONTROL
Accurate positional data for enroute approach, ground control, and for identification of air traffic.

PAGE PRINTING FORMATS
Temporary readout of multichannel data for visual program verification.



A Portable Marqatron—no larger than a motion picture projector—is available for field use.

- **Relatively uncomplicated.**
- **Light weight.**
- **Compact.**
- **Potentially inexpensive.**

The inherent simplicity of the multiplier, without mechanical moving parts or scanning devices, could make it attractive in several airborne and space applications. At present, devices embodying these techniques (especially fiber optics) would be expensive. If plastic fibers, which are available at low costs, could be used the winding operation for the multiplier would cost about $100. Surfaces of these fibers are not now smooth enough for good internal reflection, however.

In the lens mosaic system the view angle of any lens is kept to about 0.2 radians to sidestep excessive aberration problems leading to a loss of resolution. The ratio of the height of the object plane to the distance from lens to object plane is therefore about 0.2. To avoid overlapping of images the distance from the mosaic to the object plane is the number of lenses in the mosaic times the distance between lens mosaic and multiple image plane.

As in the fiber optics multiplier, an image representing an unknown bit of data is projected on the object plane and a number of images equal to the number of mosaics are simultaneously produced on the image plane and projected against transparencies contiguous to this plane. When projected image and associated transparency are identical, the light flux passing through the transparency exceeds predetermined levels and identifies the unknown bit of data.

Robert M. Stewart and Frank W. Lehan are responsible for the data correlation studies at Space Electronics.

FILTER CENTER

▶ **Welding Avionic Modules**—Making and instructing others how to make welded avionic modules (AW Aug. 24, 1959, p. 104, and Oct. 10, p. 73) is one of the specialties of newly organized WEMS, (Welded Electronic Modules) Inc., 4807 W. 118th Pl., Hawthorne, Calif. The company is partly financed by Unitek, manufacturer of welding machines, and is currently negotiating contracts with Bendix Corp. and Lockheed Aircraft for training personnel in the use of electronic discharge welding techniques for making high-component density avionic modules.

Robert S. Hood, WEMS president, says he and most of the company's other personnel worked on welded modules for the Titan ICBM and satellite systems while at Space Technology Laboratories.

▶ **Firm Enters Defense Field**—First small defense contract was obtained recently by Bissett-Berman Corp., offshoot of Ramo-Wooldridge Division of Thompson Ramo Wooldridge, Inc. Company plans to specialize in research, development, limited production of military oriented systems and techniques related to intelligence, ballistic missile defense and bionics. Headed by Bernard Berman and Thomas B. Bissett who were, respectively, director-special projects and director-Signal Equipment Laboratories, at Ramo-Wooldridge, the corporation is half owned by A. O. Smith, Milwaukee home appliance manufacturer. Firm's address is 12248 Santa Monica Blvd., Los Angeles.

▶ **Burnout Protection Diodes**—Silicon diodes packaged in an unusual manner which enables them to withstand exposure to temperature extremes will be mass produced starting about the first of the year by the new Waltham, Mass., production facility of Unitrode Transistor Products, Inc., Calabassas, Calif. Electrical equivalents of the 1N649 and 1N540 series, the new diodes are packaged as follows: the silicon is bonded on both sides to refractory metal pins and hard glass is then sealed to pin and silicon, effectively making diode without a cavity. Coefficients of expansion of the metal and the semiconductor are roughly matched. The diode will not rectify above 300C but is extremely useful for transient pulse production. Unitrode says the diode can operate through alternate dipping into molten solder and then immersion in liquid nitrogen.

▶ **New Communications Company Seeks Business**—Ryan Communications, Inc., newly organized Ryan Aeronautical Co. subsidiary which plans to specialize in communications and counter-countermeasures has opened at 7225 Alabama Ave., Canoga Park, Calif. and is seeking its first contract. Company is headed by Dr. Fred E. Bond and Harold Meyer who are co-managers of the Communications Systems Department at Space Technology Laboratories in Canoga Park.

▶ **Sign on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

- **International Telephone and Telegraph Corp.** will operate and maintain the eastern extension of the DEW line from Cape Dyer on Baffin Island to Iceland during Fiscal 1961 under a $1,080,265 contract from USAF.
- **Collins Radio Co.** will supply VHF transmitters, receivers and navigation receivers for five Armstrong Whitworth

AW 650 Argosy transports to be operated by Riddle Airlines. The Riddle order to Collins is for $98,408.

• **Garrett Corp.'s** AiResearch Mfg. Co. will produce ground air conditioners for use with Westinghouse's TPS 22 and TPS 27 search radar systems under an initial contract for $150,000.

NEW AVIONIC PRODUCTS

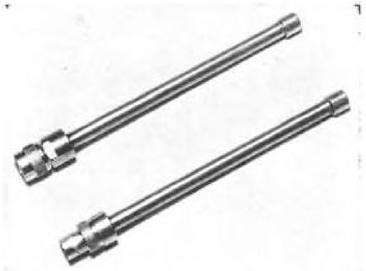
• **Plug-in resistor,** with banana plug male and female connections at either end, for use in computer patch boards or as a probe resistor, is available in resistance values of 1,000 ohms to 1 megohm with standard color code rings to show resistance value. Standard tolerance is 0.1%. Manufacturer: Resistance Products Co., 914 South 13th St., Harrisburg, Pa.

• **Trimming potentiometer,** Model 3051, for operation at temperatures up to 150C, is available in resistance values of 20,000 ohms to one megohm in power rating of ¼ watt at 50C. The metal film pots provide infinite resolution, weigh approximately 0.1 oz. and measure approximately 1¼ x ¾ x 0.2 in. Manufacturer: Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

• **Silicon power diodes,** Series BC-100, in ceramic cases designed for operation at temperatures up to 180C, are rated one ampere at 50C and are available with peak reverse voltages of 50 to 1,000 v. Diodes measure 0.11 in. dia. x 0.25 in. long and are available in numerous configurations. Data sheet giving application data is available. Manufacturer: Bradley Semiconductor Corp., 275 Welton St., New Haven 11.

• **Turns counting dial,** Model 30, in which shaft position is indicated in 1/100 of a turn increments. Dial measures 1⅛ in. diameter, 1 in. in depth and is designed for ¼ in. shaft mounting. When a full turn is completed, the

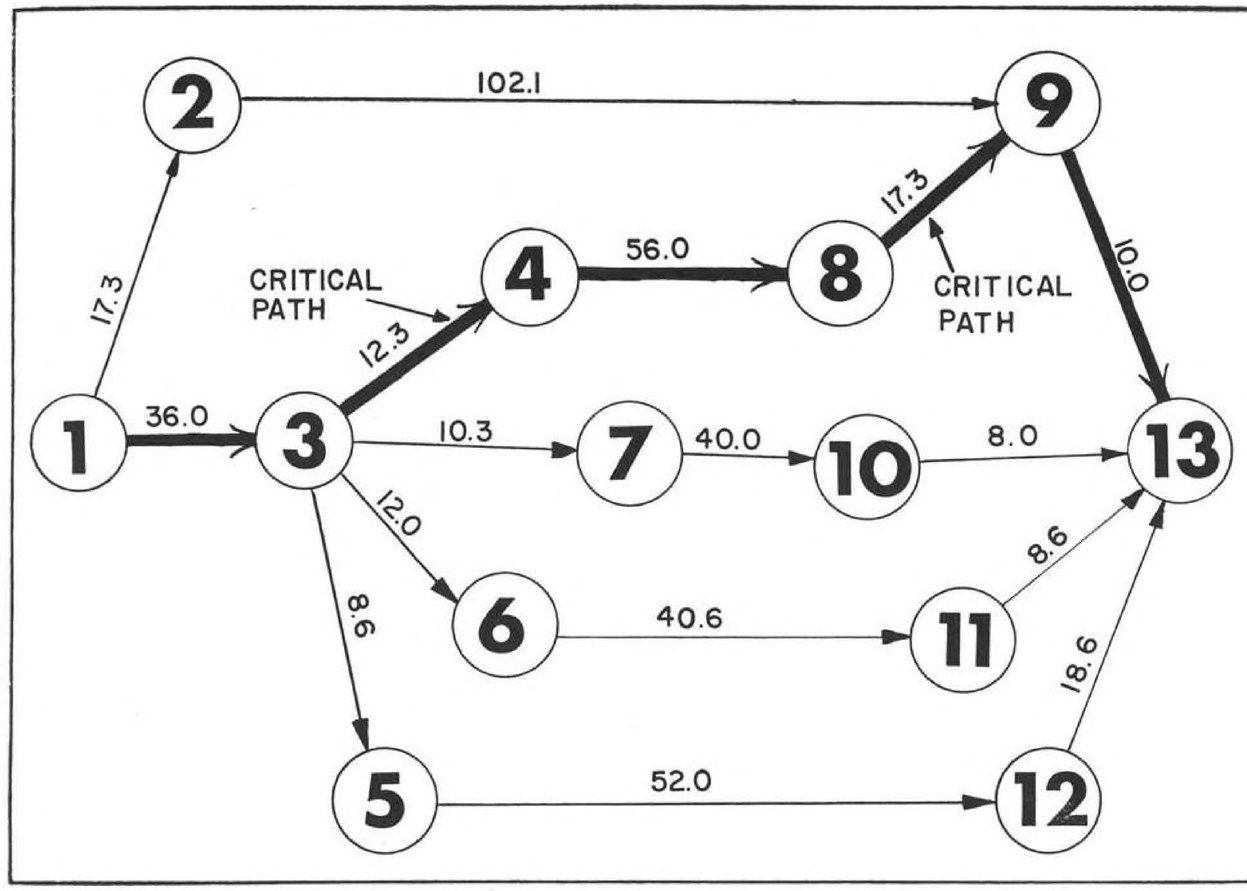
single number appearing in the viewing window advances while knob rotates less than a single scale division. Dials are priced at $5.75 in quantities. Manufacturer: Spectrol Electronics Corp., 1704 So. Del Mar Ave., San Gabriel, Calif.



• **Microwave terminations** (above), Model RDL-6C, operates in 2 to 12 kmc. range with maximum vswr of 1.1, is available with plug or jack connector. Priced at $45, the termination can be obtained on two weeks' delivery. Manufacturer: Radar Design Corp., Pickard Dr., Syracuse 11, N. Y.

• **Crystal controlled transmitter,** transistorized, weighing only 4 oz. is intended for use in biomedical telemetry applications where light weight, small size are required. Device measures 2¼ in. long, approximately 1 in. diameter. Output is 50 milliwatts nominal, 100 mw. on special order. Modulation frequency range is 100 cps. to 200 kc. Standard temperature operating range is −20C to 80C, with wider ranges available on special order. Manufacturer: Vector Manufacturing Co., Inc., Southampton, Penna.

MANAGEMENT



PERT/PEP FLOW CHART. Events (each major milestone of progress) are: 1—program go-ahead; 2—initiate engine procurement; 3—complete plans and specifications; 4—complete fuselage drawings; 5—submit GFAE requirements; 6—award tail assembly subcontract; 7—award wings subcontract; 8—complete manufacture of fuselage; 9—complete assembly of fuselage-engine; 10—receive wings from subcontractor; 11—receive tail assembly from subcontractor; 12—receive GFAE; 13—unveil aircraft.

PERT/PEP Management Tool Use Grows

By Philip J. Klass

Washington — The most effective management tool yet conceived for planning and evaluating progress in the development of complex weapon systems, a tool pioneered by the Navy with its Polaris program, is rapidly being applied to major weapon systems by the Navy, Air Force and Army. Industry is adopting the technique on a voluntary basis as its value becomes apparent.

Navy calls the technique Program Evaluation Review Technique, or PERT. The Air Force version is PEP, an acronym for Program Evaluation Procedure.

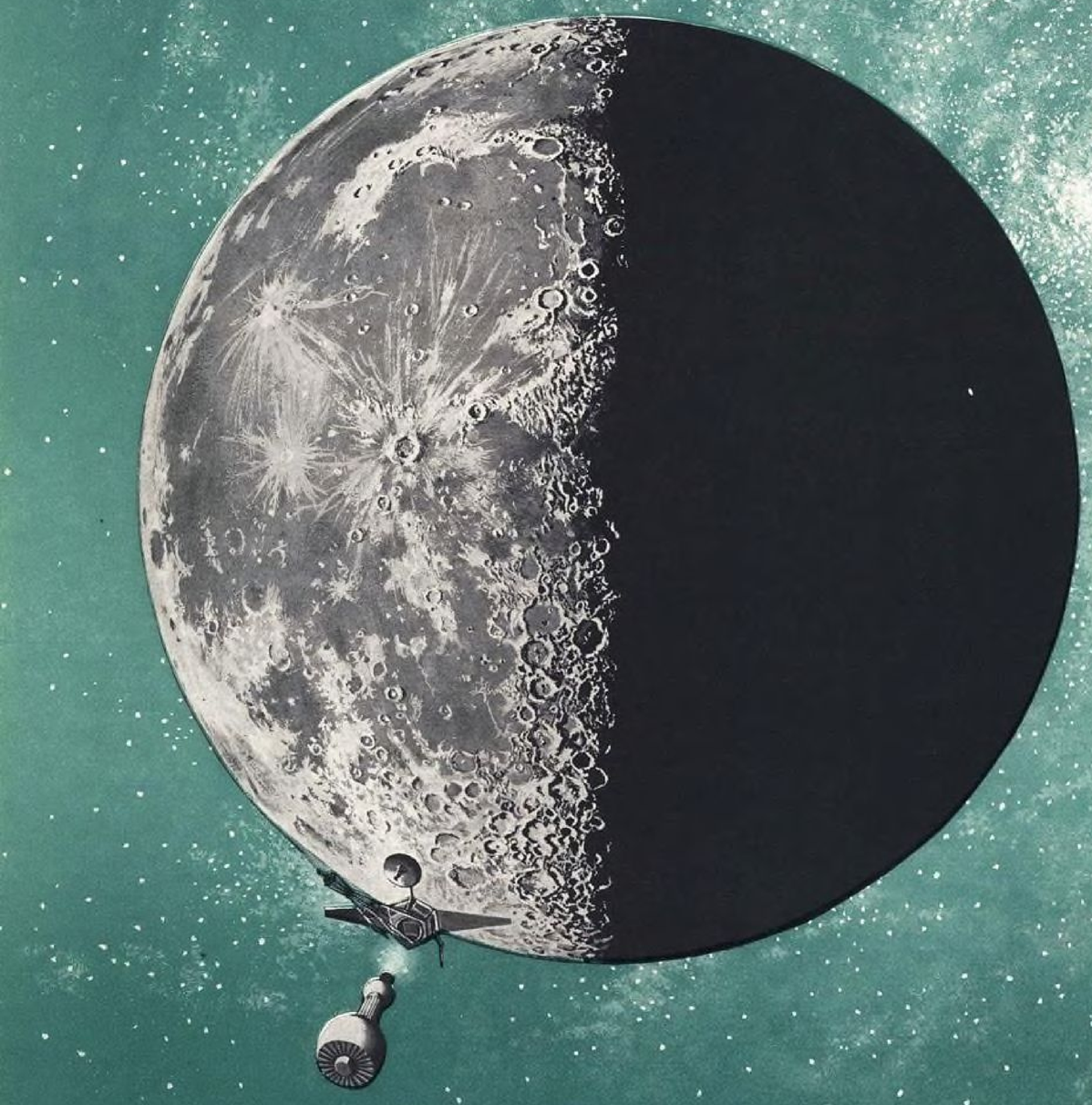
PERT/PEP provide military and industrial managers at all levels with computer-prepared situation summaries at biweekly intervals which clearly pinpoint critical and potentially critical elements in the program and their probable effect on the over-all system schedule.

First Air Force application of PEP is being made on the Skybolt (GAM-87A) air-launched ballistic missile program. The technique also is being considered for use on the B-70, Dyna-Soar and other major Air Force programs.

Navy has expanded use of PERT to its Eagle air-to-air missile program and to the Missileer aircraft which will carry the Eagle. Navy also has told prospective bidders for developing its new Typhon anti-aircraft missile to plan on using the PERT technique. Army is applying PERT to its Nike Zeus anti-ICBM missile program.

Originally, PERT was applied only to major contractors on the Polaris program, but today more than 45 contractors in the program are using it. The expanding use of PERT/PEP by all three services suggests that within several years most major defense firms will be employing the technique on a mandatory basis for one or more programs. Once a company sees its value, observers believe this technique will spread to other contractor efforts on a voluntary basis.

General Electric's Light Military Electronics Department, (LMED), Utica, N. Y., was one of the first to see the value of PERT and to adopt it on a voluntary basis before the de-



LUNAR PROBE

The moon — lacking an erosive atmosphere — may hold the key to the history of the solar system. Because of this lack of atmosphere, oceans, and wind, lunar explorations may help solve fundamental, universal questions.

Logically, the moon will be the first objective in the exploration of space. Initially the moon itself will be photographed and instrumented; then manned observation stations will be established for astronomical and meteorological purposes. In time, the moon will serve as an intermediate station enroute to other planets — step by step into infinite space.

The National Aeronautics and Space Administration's Lunar Program will utilize Lockheed's AGENA B satellite to play a significant part in forthcoming lunar explorations — as well as a host of other scientific space missions. The NASA lunar launch in 1961-62 will utilize the highly reliable Lockheed AGENA as second stage to carry the RANGER spacecraft. The AGENA will provide the extremely critical guidance and controls necessary to place the RANGER on the required lunar impact trajectory.

The lunar probe application demonstrates the versatility, reliability and success of the AGENA vehicle in Lockheed's satellite and spacecraft programs. Developed for the Air Force for use in the DISCOVERER program, the AGENA is utilized in the MIDAS missile defense alarm system and the SAMOS surveillance satellite system. Noted for a record of outstanding accomplishments, the AGENA is credited with being the first to be placed on a polar orbit; first to achieve a precise, predicted and nearly circular orbit; first to attain attitude control on orbit; first to eject a reentry capsule which was successfully recovered. The AGENA can be modified for a variety of space missions such as navigation, geophysical investigations, long-range communications and deep space probes.

Lockheed's capability in satellites and spacecraft, manifested by such an achievement as the AGENA, encompasses the entire field. It includes current and long-range programs such as interplanetary probes, global and space communication systems, and manned space travel.

Engineers and Scientists: The accomplishment of such programs offers challenging opportunities to engineers and scientists in the research, design, development, test and operation phases of these programs. If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. K-17, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • HAWAII

partment became involved in the Polaris program. Today LMED is using PERT for all of its major development programs as well as in preparing proposals and bids. Westinghouse Air Arm Division, which was introduced to PERT through its participation in the Polaris program, is also an enthusiastic booster for the technique and is now applying it to many other non-Polaris projects.

In the days when weapons were far less complex, it was possible for a prime contractor, such as an aircraft manufacturer, to keep reasonably close watch on the progress of key elements in the weapon's development. Today a weapon system requires many parallel subsystem developments, each usually carried on by a different contractor, all of which must closely mesh at various stages in the program if it is to meet its timetable.

Within each subsystem development program there usually are parallel subsubsystem developments, frequently carried out by different contractors, which also must be integrated.

Warning Signs

An apparently unimportant event at a subsystem level, which could easily escape the attention of an over-all weapon system manager, could mean a major system delay six months later unless corrective measures are taken immediately.

For example, a two-week delay in the shipment of a tiny bearing for a gyroscope might seem unimportant to the system manager of an ICBM missile program. But this may result in a four-week delay in shipment of the inertial guidance system and a four-week delay in delivery of the missile for flight test. This could result in a three-month delay in actual flight testing because of a shortage of launch facilities when the missile finally is delivered.

It is the scheduling and monitoring of thousands of items which make up a complex weapon system, many of them involving research and development which itself is difficult to schedule and/or predict precisely, that makes weapon system management so difficult and the PERT/PEP technique so valuable.

Using linear programing techniques adapted to include statistical (probability) concepts, and digital computers to speed the analysis of interrelationships between the thousands of weapon system elements, PERT/PEP provides situation summaries which pinpoint these factors:

• **Critical elements** at the current instant, near future and throughout the remainder of the program. Criticality is measured in terms of the probability of elements being available when required to mesh with related elements of other subsystems needed to meet over-all weapon system schedule.

• **Effect of slippage** or gain in schedule. A small change in the achievement of an objective in one subsystem can have a major impact on the over-all system schedule, while a large change in another element's schedule may have little or no impact. The PERT/PEP situation summaries tell management what effect unexpected slippage or progress in one part of the program will have on other parts and on the whole.

• **Incompatibilities in schedules** of interrelated subsystems. PERT/PEP can predict and emphasize potential trouble spots months or years before they might otherwise be apparent to management. A GE spokesman says that in practically every instance where LMED has applied the PERT technique to programs already under way, it has discovered future schedule problem areas which were unknown to project managers.

• **Effect of trade-offs** in funds, manpower, performance or time on over-all program schedule. When program or subsystem managers contemplate a reallocation of resources, to accelerate a program or operate under changed funding, PERT/PEP can quickly give them quantitative figures on the effect of such changes on the program completion, enabling them to make decisions on a scientific basis.

Many of the advantages of PERT/PEP stem as much from the detailed planning which must precede the use of the technique as from the subsequent information which it provides to management.

The first step is to make a detailed analysis of the over-all weapon system development program, listing every major milestone of accomplishment, called events, that must be achieved, and their chronological order. This normally would be prepared jointly by the military program manager and the prime contractor. Each major subsystem contractor and sub-subsystem contractor prepares a similar analysis for its portion of the program.

The progress milestones selected as events must be well-defined and should occur at an instant in time which is precisely determinable. For example, "begin engine tests" or "complete engine test report" would be suitable events, but "conduct engine tests" would not because it extends over a long interval of time.

A very simple example covering the development of a new airplane, which Wright Air Development Division uses to illustrate the operation of PEP, lists the following major events:

(1) **Program** go-ahead received.
(2) **Initiate** procurement of engine.
(3) **Complete** plans and specifications.
(4) **Complete** final fuselage drawings.
(5) **Submit** GFAE requirements.
(6) **Award** subcontract for tail assembly.
(7) **Award** subcontract for wings.
(8) **Complete** manufacture of fuselage.
(9) **Complete** assembly of fuselage and engine.
(10) **Receive** wings from subcontractor.
(11) **Receive** tail assembly from subcontractor.
(12) **Receive** GFAE.
(13) **Unveil** aircraft.

Program Flow Chart

The next step is to lay out a program flow chart, or network, in which the events are shown as circles whose positions roughly represent their chronological order. The events (circles) are then connected by lines which show interrelationships and sequence of events. These interconnecting lines represent work effort or activity needed to progress from one progress milestone (event) to the next.

The next step in the procedure is to obtain estimates of the time required for each activity, usually measured in weeks. This is the time required to progress from one event to the next. These estimates will come from the best available source, usually as close as possible to the man charged with performing or supervising the work.

Recognizing that engineering development, unlike repetitive routine manufacturing operations, cannot be predicted with great precision, PERT/PEP asks for three different estimates for each activity:

• **Most likely:** This is the estimated time required, assuming no unexpected problems will develop and that solution will not prove easier than now anticipated.

• **Optimistic:** This estimate, smaller than the most likely estimate, is based on the time required if everything goes better than one normally has a right to expect.

• **Pessimistic:** This figure, longer than the most likely estimate, represents the estimated time if problems prove more difficult to solve than envisioned. However, it does not take account of possible catastrophic events such as fire.

In computing the probable time required to carry out the program, PERT/PEP does not use any one of these three estimates, but computes its own expected time which reflects the probable time based on a statistical weighting of the three estimates provided by the project engineer or supervisor.

Schedule Adjustments

If the three estimates show that little time will be gained if things go better than expected, but that considerable additional time will be required if things go badly, the PERT/PEP technique uses an expected time that is somewhat longer than the most likely, but less than the pessimistic estimate. If the three estimates indicate that there will be little time lost if things go badly, but considerable time may be gained if things go well, then the PERT/PEP expected time will be somewhat shorter than the most likely estimate.

This expected time computation is made by giving both the optimistic and pessimistic time estimates one-quarter the weight of the most-likely, and then taking an average of the three. For example, if the most-likely estimate is 40 weeks, the optimistic is 36 weeks, and the pessimistic is 60 weeks, the expected time estimate would be 42½ weeks. If the three estimated times were 20, 40 and 44 weeks respectively, the computed expected time would be 37 weeks.

This computation normally is carried out by the digital computer as the first step in its PERT/PEP operations.

The next step in the computer program is to total all of the individual expected activity times along every possible path in the network running from the starting event to the final event. Having done this, the computer then examines the total activity times of the many possible paths to find the longest, which is called the critical path.

The critical path represents that sequence of activities/events which will require the greatest expected time to accomplish. There may be more than one critical path, or a single one which subsequently divides into two critical paths.

The computer also calculates what is called slack time for each of the non-critical paths between initial and end events. Slack time represents the difference between the total expected activity time required for any specific path and the total for the critical path. It is a measure of the spare time that exists at the moment in each of the other sequence of events.

Computing Slack Time

The computer also calculates the expected slack time for each event along many paths in the network.

If the total expected activity time along the critical path is greater than the time available to meet the customer's requirements, then the program is said to have negative slack time. The number of weeks of negative slack time is a measure of how much acceleration is required.

With the foregoing information, plus customer-required completion date and starting date, the computer can prepare situation summary reports of great value to program managers. One particularly useful form is a tabulation of network events in order of their slack time. The list is headed by critical events which have negative, zero or little slack time, followed by those with increasing amounts of slack time. This pinpoints those events, and their associated activities, which are in trouble or potential trouble.

The PERT/PEP situation summaries pinpoint for program managers those activities of a contractor which are part of the critical path(s) and those which have considerable slack time, permitting the managers to shift manpower and/or funds, where feasible, from one to the other.

If a contractor proposes a change in the program, its effect on the expected program completion date can be quickly determined by inserting the resulting changes in activity times and network events in the computer.

Every two weeks, PERT/PEP reports are updated with latest estimates, which reflect any changes that have taken place in the previous two-week period. Contractors must report whether or not they have accomplished events previously scheduled for that period, plus any changes in estimates for future events.

These are entered into the computer and it quickly calculates and prints out the latest situation summary.

Where the PERT/PEP situation summary for the over-all weapon system deals with major milestones in the program, similar networks for subsystems use a finer grain network structure in which the events might be termed yardstones. At the subsystem level, the events are still finer grain inchstones.

Normally, the top program managers will concern themselves only with the milestone events and situation summary. But where a problem area develops or is forecast in a particular subsystem or subsubsystem, the lower echelon situation summaries come under scrutiny.

Complex Systems

If weapon system developments were only a little more complex than the example given earlier, there would be little justification for the use of PERT/PEP. But in the development program for the stellar-inertial guidance system of Skybolt, there are about 1,000 events and this is only one of about 45 industry PEP networks involved in the whole Skybolt program.

By means of PEP, the Wright Air Development Division Skybolt System Program Office will be able to monitor as many major events in the Skybolt guidance system development on a bi-weekly basis as WADD monitored in the entire Navaho missile program, where progress reports were handled manually on a three-month cycle, according to P. R. Murray, technical director for guided missiles in WADD's Systems Management Directorate.

Yet the format of PEP situation summaries permits WADD project managers to quickly spot problem areas despite the vastly increased detail. For example, a month ago the PEP summary for Skybolt revealed negative

PERT/PEP Terminology

New words and new meanings for existing words are coming into use by defense contractors as the Navy expands its PERT program evaluation review technique and the Air Force launches its similar PEP program evaluation procedure. These include:

• PERT-ed, PEP-ed: The application of the PERT or PEP management technique to a particular program. For example: The Skybolt has been PEP-ed. The Polaris is PERT-ed.

• Event: The major milestones of progress or accomplishment in a weapon system, subsystem or sub-subsystem. An event must be a milestone which is clearly definable and which is reached and passed in an instant of time.

• Network: A chart which gives pictorial representation of chronological sequence and interrelationships of all program events.

• Activity time: The time required to advance a program from one event (milestone) to the next event.

• Critical path: The sequence of interconnected events and activities between start of the program and its completion which will require the greatest time to accomplish.

• Slack time: The maximum schedule slippage in an activity which can be tolerated before it affects over-all system completion date.

Rigging Safeguards

With knowledge how the PERT/PEP computer program calculates probable schedule times from three different contractor estimates of activity time, a contractor, or his engineers, might be tempted to trying rigging these estimates to make the computed schedule match the customer's requirements. While it might be possible to beat the system for a short time, the very large number of progress milestones employed in PERT/PEP, and the requirement that the contractor report every two weeks whether he has achieved these well-defined milestones, will quickly disclose any attempt to rig the system.

slack time on one small component in the missile's flight control system—an item which would never have come to top-level attention under previous management techniques, according to Robert B. Copeland, chief of plans and programs office at WADD's Systems Management Directorate.

Another PEP situation summary revealed negative slack time due to shipping time for a critical item using conventional surface transportation. Although the shipping date is many months away, WADD already is making plans now to provide airlift for the item.

USAF-Navy Variations

A major difference, at present, between Navy and Air Force in use of new technique is that major Polaris contractors send their PERT estimates to Navy, which performs network computations, then sends situation summaries back to the contractors. Air Force has its prime contractor perform network computation, then send situation summaries to USAF.

Because most major defense contractors have digital computer facilities, and because the PERT/PEP program requires only a modest amount of computer time, many Navy contractors perform their own computations to corroborate those made by Navy.

Both Navy and Air Force concede that some contractors were less than receptive to the PERT/PEP technique when the requirement was first imposed. There was concern that it would increase the burden of progress reports and paper shuffling already imposed on engineering personnel. But experience to date indicates that this is not the case and that PERT/PEP may reduce the cost of progress reports.

Instead of requiring a lengthy editorial effort to describe the present program status, a contractor need send in only a tabulation which shows events accomplished and scheduled revisions on specific events, using network and event code numbers. An interesting byproduct advantage, WADD's Murray points out, is that schedule information on classified projects can be discussed over regular telephone circuits by referring only to event and network numbers.

If a contractor objects to the effort initially required to prepare the program network (flow chart), it is pointed out to him that he has committed himself to developing a complex system by a given date and surely he must have some detailed plan of operation. The network is only a symbolic representation of this plan.

When WADD personnel read an AVIATION WEEK report that certain Skybolt contractors were attributing program delays to the added workload imposed by PEP (Oct. 3, p. 27), they decided to investigate the validity of this complaint. Their study showed that a total of 5,300 manhours had been spent to date on PEP, but only 700 of these involved engineering effort. This is "less than one-tenth the engineering manhours spent during the same period in authorized coffee break time," according to a WADD spokesman.

Navy experience indicates that cost of PERT averages about 0.1% of contract price, slightly higher for smaller contracts. This cost does not take into account savings and earlier weapon availability, intangibles on which it is difficult to put a price tag. On one smaller Polaris subsystem, where the total contract amounted to $1.8 million, the contractor charged Navy only $3,000 for its PERT efforts and data over an 18-month period, according to Capt. K. M. Tebo, chief of program evaluation branch, Navy Special Projects Office.

After initial familiarization with PERT/PEP, most corporate and engineering managers become as enthusiastic over the technique as the military services.

They find that the need to prepare program networks forces all parties involved to do more detailed planning and analysis than they formerly did.

General Electric's LMED uses the technique for planning programs on which it is preparing proposals or bids, even when not required by the service, and submits the program network with its proposal. In at least two instances, LMED used its program network and analysis to convince a military customer that the delivery date it had requested was unrealistic and that no contractor could meet it, according to an LMED spokesman. Westinghouse Air Am Division also is an enthusiastic booster, both for program management and in preparation of proposals.

This prompts one observer to speculate that the time may be near when the military services will require bidders on major weapon system programs to include one or more PERT/PEP program networks with their proposals. This would enable contracting officers and military project engineers to better evaluate each bidder's present understanding of the problem to be solved and the reasonableness of his time and dollar estimates.

The new management tool has led to considerable inter-service and inter-company exchange of information and ideas as the PERT/PEP enthusiasts seek to expand the number of converts. Wright Air Development Division spokesmen freely credit Navy's PERT program as the basis of Air Force's PEP. The Navy points out that the Special Projects team set up in 1958, which developed the original PERT concept, included representatives of Lockheed and the consulting firm of Booz, Allen & Hamilton.

Navy has encouraged Polaris contractors, who developed PERT programs for use on a particular type computer, to make these programs available to other companies to save them the expense of developing their own programs. Aerojet-General has a PERT program for the IBM 704, Lockheed has programs for the IBM 709 and 7090, and Sperry Gyroscope has one for the Univac II.

Hughes Aircraft is developing a PERT program for use with low-cost punch card machines.

Wright Air Development Division is using a Remington Rand 1103A computer for PEP analyses, as part of its familiarization process and as a double-check on contractor computed situation summaries. The computer can handle 4,000 events in less than an hour. WADD expects to shift over to a new IBM 7090 which will have greater storage capacity and operates approximately six times faster than the 1103A.

General Electric's LMED has a traveling road show, explaining the operation and advantages of PERT, which it has presented to other GE departments, to its own suppliers, and even to some of its competitors.

PERT/PEP Briefing

Navy's Special Projects office has prepared a 28-min. color-sound movie which describes the principles of PERT and how it is used on the Polaris program. Copies of the film can be purchased for $150 from Merit Productions of California, 10044 Burnet Ave., San Fernando, Calif. Navy also gives industry briefings at bi-weekly intervals. Interested companies can contact Capt. K. M. Tebo, Special Projects Office, Munitions Bldg., Washington, D. C.

Wright Air Development Division also holds bi-weekly briefings for industry on its PEP program. For reservations, write to Robert B. Copeland, Plans & Programs Office (WWZPC), Systems Management Directorate, Wright Air Development Division, Dayton, Ohio.

NASA's Pacific Office

Pt. Mugu, Calif.—National Aeronautics and Space Administration is establishing a test support office at Pacific Missile Range headquarters here to arrange NASA space operations using Pacific Missile Range.

A skeleton staff of six people will be on duty when the test support office is officially opened later this month. The office is to be part of the launch operations directorate of George C. Marshall Space Flight Center, Huntsville, Ala., and will provide NASA direction for the launch of Scout and Thor-Agent B1 vehicles as well as others still in the planning stage. The office will be headed by Navy Cmdr. Simon J. Burttschell, assigned to NASA by special arrangement with the Navy.

Contrary to the practice at Atlantic Missile Range, all NASA shots in PMR will be launched by contractor crews.

Pulsed Plasma Unit Fired in 18.5-hr. Test

Washington—Plasma accelerator developing 0.1 oz. of thrust has been fired continuously for 18.5 hr. in a test of a repetitively pulsed propulsion system by General Electric Missile and Space Vehicle Department.

The accelerator, which fired at the rate of 3,000 pulses per min., is a T-shaped tube with electrodes at both ends. Power source of 2,500 watts ionized nitrogen gas was injected into the tube, causing current to flow between the electrodes. Magnetic accelerator exhausted the flow into a vacuum chamber.

GE said the test simulated the thrust required to stabilize the attitude of a spacecraft for about two years.

Automated Missile Depot

Los Angeles—USAF expects to award four study contracts in the first phase of an effort to completely automate its new missile inertial guidance subsystem depot at Heath, Ohio. The depot will handle overhaul and repair of guidance systems for the Atlas, Titan, Minuteman, Hound Dog and Skybolt missiles.

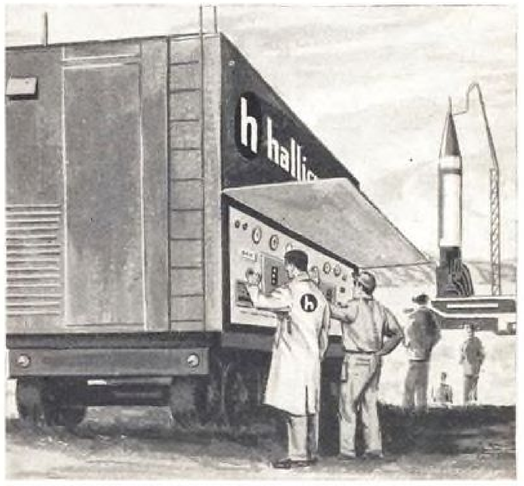
About 73 companies attended a recent bidders' briefing but only a handful of firms, believed to include Nortronics, Packard Bell, International Business Machines, Bendix, Hughes, Radio Corp. of America, Minneapolis-Honeywell, Stromberg Carlson, Kearfott and Otis Elevator submitted bids to Gentile Air Force Station in Dayton, Ohio.

The four study contracts to be awarded shortly are expected to lead to system specifications for automatic computer control of the depot. Equipment which will evolve will be designated VATE (Versatile Automatic Test Equipment). Kearfott estimates cost of the depot automation will run about $22 million.

A number of potential bidders attending the briefing were disturbed by the procurement officer's statement that Air Force expects industry to share cost of the studies and that dollar-a-year proposals are anticipated.

Every breakthrough in military electronic equipment design creates new, complex and urgent problems in installation, modification, testing, maintenance and personnel training. Hallicrafters radical new "Blue Streak" project—utilizing quick-reaction techniques—*offers experienced Hallicrafters support teams to assist key military personnel . . .* pinpoints problems in advance . . . solves them on the spot with new levels of speed and economy.

from hallicrafters' "quick-reaction" experience...



TEAMWORK IN MAINTENANCE: Hallicrafters mobile test vans and in-house repair of black boxes sets new standards in speed and reliability.

...a hard-hitting

Looking for a challenging new opportunity?
For this expanding program, we have openings for qualified aeronautical electronic equipment systems and installation engineers. For full details in confidence, contact William F. Frankart, Director of Engineering.

HALLICRAFTERS REGIONAL SALES ENGINEERS

William E. Peugh—Joseph A. Small
4401 W. 5th Avenue, Chicago 24, Ill.
VAn buren 6-6300

Thomas H. Pretorius
7558 S.E. 15th St., Oklahoma City, Okla.
PErshing 7-2456

Merle J. Long
513 E. Manchester Blvd., Suite 201, Inglewood 1, Calif.
ORchard 2-6861

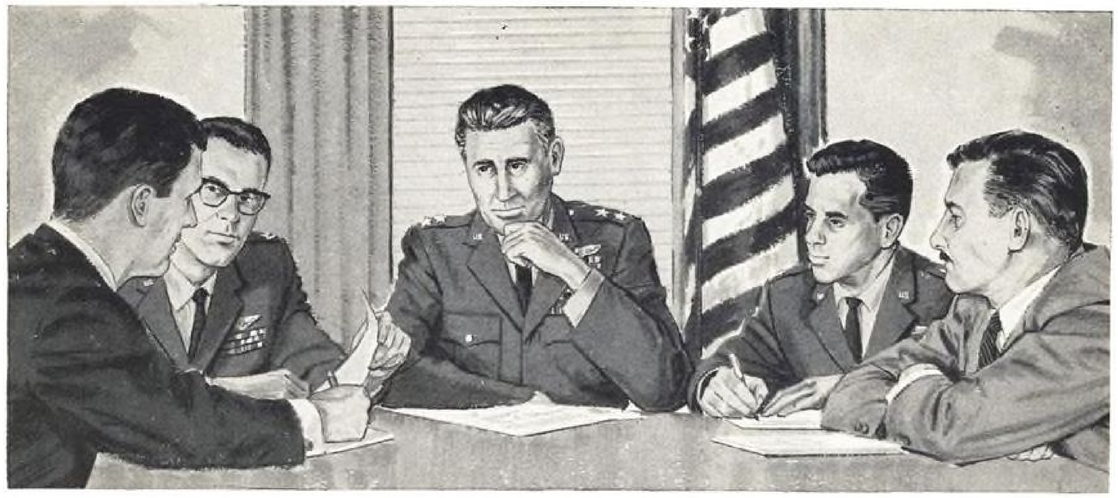
H. Kenneth Hudson
626 Lakeview Dr., Falls Church, Va.
CLearbrook 6-4978

Leopold Sternlicht
2 Kolton Dr., Rome, N.Y.
FF 7-7430

James R. Spencer
Box 435, Lincroft, N.J.
SHadyside 7-2369 (Red Bank, N.J.)

Earl L. Giffin
Box 568, Far Hills Br., Dayton 9, O.
AXminster 8-5239

TEAMWORK IN PLANNING: Hallicrafters "BLUE STREAK" Teams provide electronic industry technology in support of military programming groups for SAC aircraft at OCAMA and other materiel commands.



TEAMWORK IN MODIFICATION: Modernization of RF transmission systems completed in 30% less time through "BLUE STREAK" team assistance to base maintenance groups.

TEAMWORK IN INSTALLATION: Advanced ECM equipments are installed by "BLUE STREAK"-SAC teams with a minimum of down time. Maintenance and operational training is speeded up, too.

new striking force for electronic technical support

hallicrafters *blue streak project*

For further information on Hallicrafters facilities and experience in military electronics research, development and production, please write to: THE HALLICRAFTERS CO., MILITARY ELECTRONICS DIVISION, CHICAGO 24, ILLINOIS.

AERO COMMANDER 680F has new engines for higher power and speed. Nacelle air intakes have been repositioned. Price is $113,500.

Higher Powered 680F Has Wide Regime

By Herbert J. Coleman

Newark, N. J.—Aero Commander, Inc., has fitted its Model 680F with two 380-hp. fuel injection engines that give the executive transport a high degree of speed, performance and built-in safety.

New Lycoming IGSO-540 engines are the major change in this latest addition to the Aero Commander line. Sixteen airplanes have been delivered, at a basic price of $113,500.

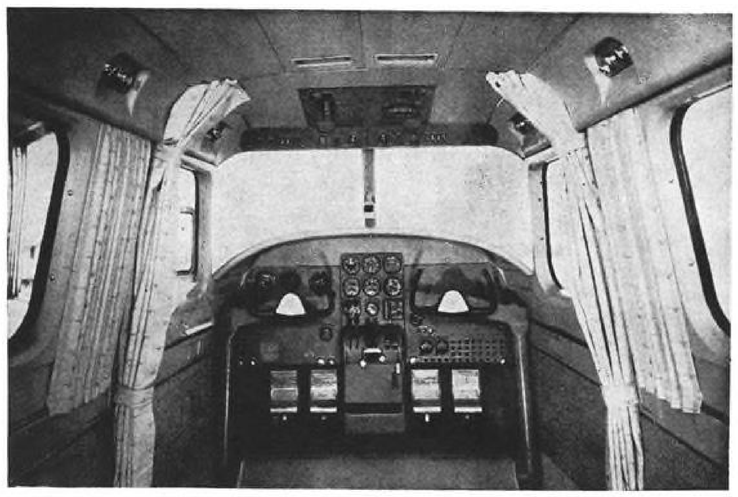
External changes are confined to the low drag "speed-line" flat nacelles. Forward air intakes have been lowered for updraft intake in which the exhaust is rerouted for dumping over the top.

Flight performance is markedly improved over, say, the Commander 500A (AW July 11, p. 148), which is powered by two Lycoming 260-hp. engines. New Model 680F has high cruise speed, service ceiling and useful load, plus power to spare.

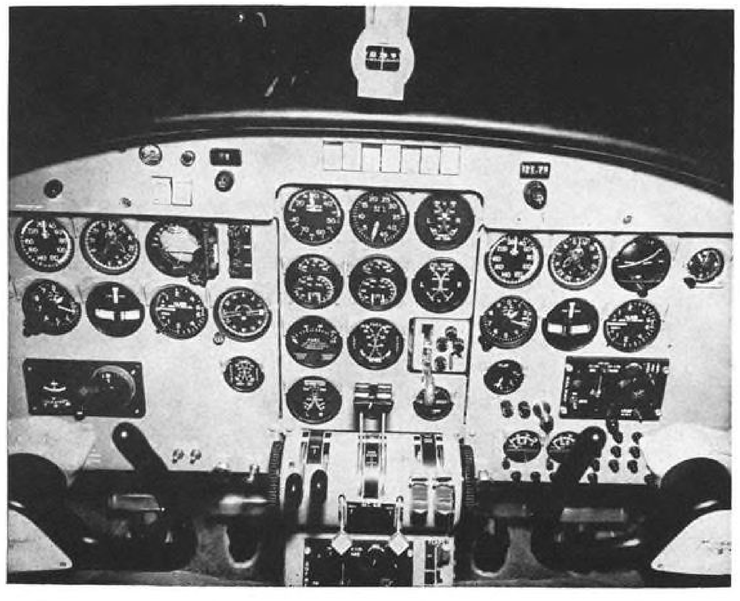
Engines are horizontally-opposed, six

LANDING GEAR retracts flush into nacelle after a 90-deg. turn.

GEAR has just started retraction cycle in this view of a takeoff. Unstick speed is 80 mph.



SEATS are removed (above) to show cockpit size. Panel below has dual instruments.



cylinder powerplants fitted with fuel injection and superchargers. They turn two 93-in. Hartzell three-blade propellers. Maximum gross weight is 8,000 lb.

Aircraft flown for this report was a 680F—N61611X—owned by Air Carrier Supply, Aero Commander dealer at Newark Airport. With this AVIATION WEEK pilot was Paul Blanton, Aero Commander, Inc., product manager stationed at the company's home base at Bethany, Okla.

Weather was clear and ground temperature at 50F when we cranked up the engines after little priming. Left engine is started first. Auxiliary hydraulic pump (for 500 psi. pressure) is activated when master switch is turned on.

Starting sequence is simple. Aero Commander has positioned the switches horizontally on the upper panel so that the master switch is at far left; 100-amp. generators, boost, primers, tank selector and starter-magnetos follow in sequence to the right. For shutdown, the pilot merely works from the right to left.

Power Steering

The 680F features power steering on the nose wheel, in which slight taps on the rudder pedals turn the gear; more pressure gives braking action. It is a fairly sensitive system but is easy to master and eliminates taxiing by use of the throttles. There is no rudder control on the ground.

Center fuel tank is used for starting, takeoff and initial flight. Total fuel capacity is 223 gal.

At the Runway 4 run-up block, we checked propeller controls at 1,500 rpm. by moving the levers to full-feathering position on the quadrant; magnetos were checked for 125 rpm. maximum drop at 2,200 rpm. Alternate air source also is checked at this point; reaction is rpm. drop and rise in induction air temperature. Power check is made at 3,000 rpm.

Recommended takeoff procedure for the 680F is use of one-quarter flap and cowl flaps full open (electric flap switches are directly in front of the pilot). Nose and rudder trim wheels are overhead and indicators are on the left pilot panel.

First indication of the power-packed 680F performance comes on the initial roll. Acceleration is remarkably fast; rotation, Blanton said, should be at about 80 mph. but the airplane reached 90 before we started the back pressure.

Surface wind was gusty at about 20 kt. and we were off the ground in about 1,100 ft. with the recommended 120 mph. best climbout speed established shortly after the gear and flaps were retracted. Takeoff power of 45 in. manifold and 3,400 rpm. was reduced to 36 in. and 2,750 rpm., producing a climb rate of about 1,500 fpm.

At secondary climb speed of 140 mph., the Commander was gaining altitude at a rate of 1,100 fpm. and we leveled off at 12,500 ft. where, at 70% of power, the plane trued out at 244 mph. Power settings were 31 in. and 2,600 rpm. with mixture set at auto lean. Fuel consumption at this power worked out to about 27 gph.

In various other power regimes, the 680F did slightly better than its published figures. For example, the 60% power setting of 30.6 in. and 2,500 rpm. produced a calibrated airspeed of 196 mph. and a true airspeed of 238, about 3 mph. better than specifications for a 10C condition.

(Airspeed for the 680F must be calibrated from the indicated airspeed.

Aero Commander 680F

Specifications and Performance

Maximum gross weight	8,000 lb.
Dry, empty weight	4,800 lb.
Useful load	3,200 lb.
Maximum speed (sea level)	255 mph.
Maximum speed (15,000 ft.)	290 mph.
Cruise speed (75% power, 10,000 ft.)	244 mph.
Stall speed (gear, flaps down)	71 mph.
Range (55% power, 30 min. reserve)	1,400 mi.
Normal fuel capacity	223 gal.
Service ceiling (two engines)	28,500 ft.
Service ceiling (single engine)	16,100 ft.
Rate of climb (two engines, sea level)	1,660 fpm.
Rate of climb (one engine, sea level)	400 fpm.
Takeoff distance (50 ft. obstacle)	1,380 ft.
Landing distance (50 ft. obstacle)	1,330 ft.

680F Dimensions

Airplane

Height	14 ft. 6 in.
Length	35 ft. 1.25 in.
Span	49 ft. 6 in.
Tread	12 ft. 11 in.

Cabin

Height	53 in.
Width	52 in.
Length	129.5 in.
Cu. Ft.	177 in.

Baggage Compartment

Height	41 in.
Width	47 in.
Length	31 in.
Cu. Ft.	32 in.

COMMANDER 680F is parked near company headquarters at Bethany, Okla.

since the static pressure tube has been moved rearward and does not give exact readings at higher speed. At 191 mph. indicated, calibrated airspeed is 5 mph. faster.)

Most economical cruise is attained at 45% power, pulling 22.6 in. and 2,500 rpm. for a true airspeed of 192 mph. Fuel consumption at this rating is about 13 gph.

Flight regimes under simulated emergency conditions are impressive. With the right engine feathered and pulling full METO power at 3,200 rpm. on the left engine, the 680F will climb at 300 fpm. clean and holds altitude with a 95 mph. airspeed with gear and full flaps down.

There is ample stall warning, both in fuselage buffeting and the cabin horn. There is a tendency to drop off on the right wing but recovery can be made almost instantly with little appreciable loss in altitude.

Blanton demonstrated a recovery in which he put the 680F into a power-off stall, held the airplane steady with rudder and aileron and, using a smooth power advance to about 20 in., recovered in less than 30 ft.

Aileron control is excellent in all regimes, particularly in the stall areas. In one maneuver, turning into a dead engine, the ailerons were deliberately "aggravated" with no appreciable adverse results.

Instrument letdown characteristics are very good. With 10 in. and 90 mph., the 680F lets down at about 1,000 fpm.; using one-quarter flaps the letdown is 500 fpm.

The airplane maintains a high degree of controllability in all areas. In a 30 deg. bank, little back pressure is needed to maintain altitude and slight rudder pressure keeps the ball in the center.

For landing, the 680F is flown downwind at 120 mph. with gear down and half flaps. On final, flaps are placed in full down position and a 110 mph. glide established for best landing attitude.

The low cabin configuration at first misleads pilots who are used to sitting higher in multi-engine aircraft and there is a tendency to level off high on the flareout. A couple of landings solves this, however.

After the landings, Blanton demonstrated a high performance takeoff in which engines are run up to 3,000 rpm. with brakes engaged. Brakes are then released and throttles advanced to 45 in. Nose is pulled off the ground at about 60 mph. The Commander climbed at a steep angle—about 30 deg.—and we reached 1,200 ft. before passing the far end of Newark's Runway 4. Climb speed was 110 mph.

This aircraft was fitted with a Scott oxygen console, located behind the co-pilot on the right fuselage bulkhead, as part of its standard equipment. System is the constant flow type in which an altitude gage is set to the correct flight altitude. Oxygen is stored in a 48.8 cu. ft. cylinder located in the baggage compartment. Masks are plugged into seven outlets on the console.

Wing and propeller de-icing equipment is optional. The 680F takes the Bendix lightweight inflatable boot system and propeller de-icing system consists of adding rubber shoes to each blade.

PRIVATE LINES

Brantly Helicopter Corp., Elkhart, Ind., has increased production of its Brantly B-2 helicopter (AW May 16, p. 111) to two aircraft per week to cut a growing backlog of orders. M. L. Alson, vice president-sales, said the firm has taken orders at the rate of 12 per week since September and the B-2 now is back-ordered through next May; price is $19,950. The company now has 30 U.S. dealers and nine more in the international market. Alson predicted production will go to four B-2s weekly within the next 12 months.

Army Aviation Center has leased 16 new Cessna Model 180s from Dixie Air, Inc., distributor in Tuscaloosa,

Ala., for use in basic flight instruction courses at Ft. Rucker.

Beech Aircraft distributors selling $1 million or more of the company's products in 1960 totaled 27, with six selling more than $2 million worth, and three in the $3 million category. They are: Atlantic Aviation Service, Inc., Philadelphia, Pa.; Butler Airplane Sales, Chicago, Ill.; Combs Aircraft, Inc., Denver, Colo.; Francis Aviation, Lansing, Mich.; Golden Gate Aviation, Inc., Oakland, Calif.; J. R. Gray, Inc., Dallas, Tex.; Norman Larson Co., Van Nuys, Calif.; Ohio Aviation Co., Vandalia, Ohio; Southern Airways Co., Atlanta, Ga.; Youngstown Airways, Inc., Youngstown, Ohio; SouthAire, Inc., Memphis, Tenn.; Alamo Aviation, Inc., San Antonio, Tex.; Flightcraft, Inc., Portland, Ore.; Robert Graf, Inc., Omaha, Neb.; Piedmont Aviation, Inc., Winston-Salem, N. C.; Topeka Aircraft Sales & Service, Inc., Topeka, Kan.; Tulsair Distributors, Inc., Tulsa, Okla.; Roscoe Turner Aeronautical Corp., Indianapolis, Ind.; Young Aviation Corp., St. Louis, Mo.; Cutter-Carr Flying Service, Albuquerque, N. M.; Elliott Flying Service, Davenport, Iowa; Page Airways, Inc., Rochester, N. Y.; United Airplane Sales, Inc., Wichita, Kan.; Gopher Aviation, Rochester, Minn.; Travelair GmbH., Bremen; Aeromex.

U. S. Business & Utility Aircraft Shipments

September, 1960

Make & Model	No. of Units	Net Billing Price
Aero Commander 500A, B	4	$1,439,000
560E	0	
680E, F	12	
720	0	
Beech Super 18	6	$2,888,000
Model 33 Debonair	7	
Model 35 Bonanza	24	
Model 50 Twin-Bonanza	3	
Model 65 Queen Air	9	
Model 95 Travel	6	
Callair Model A-5	0	$7,000
Model A-6	1	
Cessna 150	3	$2,799,000
172	14	
175	24	
180	21	
182	43	
210	14	
310	22	
Lake LA-4	3	$70,000
Mooney Mark 20	15	$230,000
Piper PA-18 Super Cub	30	$2,249,000
PA-22 Tri-Pacer	29	
PA-23 Apache 160	11	
PA-23 Aztec 250	26	
PA-24 Comanche 180	13	
PA-24 Comanche 250	20	
PA-25 Pawnee	8	
Totals	368	$9,682,000

Total U. S. business and utility aircraft shipments for the first nine months of Calendar 1960 amounted to 5,658 units having a factory net billing total of $114,676,000 compared to 5,615 units totaling $97,532,000 in the same period in 1959. Piper Aircraft shipments above cover commercial airplanes—the company in addition during September, 1960, shipped eight PA-23 Aztec light twins "off-the-shelf" to U. S. Navy, bringing its total factory billings for the month to $2,607,740.

IMMELMANN: THE "EAGLE OF LILLE"

LEACH HERITAGE OF THE AIR—12

Just as the German monoplane reared up to loop and turn sideways, the F.E. 2B opened fire. The Fokker E. III bucked and shuddered. In seconds, its tail section broke apart, the rear of the fuselage ripped off and both wings collapsed. At the controls as his ship plummeted to earth near Annay on the Western Front was the master of the Immelmann turn.

It was shortly after 9 p.m. on June 18, 1916. Oberleutnant Max Immelmann, the "Eagle of Lille," had finally kept his date with death. The Royal Flying Corps credited 2nd Lt. George R. McCubbin of No. 25 Squadron with the kill.

Immelmann had scored his first victory in 1915 while assigned to Flying Section No. 42 at Douai. It was there he formed a friendship with Oswald Boelcke, destined to become one of his country's greatest aces.

Both men achieved fame flying the highly successful Fokker monoplane, first German aircraft to be equipped with Fokker's synchronized machine gun, a weapon that gave Germany unqualified supremacy in the air for many months.

In the winter of 1915-16, Immelmann raised his score to 13 victories and earned Germany's highest award for bravery — the Pour le Merite. In April, he received a Fokker equipped with three machine guns, but the strain threw his synchronization gear out of order and splintered the prop with bullets. Immelmann landed the plane just before vibration tore it to pieces. Again on May 31 he was shot down by his own gun — but he survived the crash without a scratch.

By June 18 Immelmann had shot down his 15th victim. That evening he took off for a short patrol with two companions. They met two F.E. 2B biplanes out on their last patrol of the day.

Pitted against each other 8,000 feet above Annay were two of the war's outstanding aircraft.

The cumbersome F.E. 2B was remarkable for its sturdy construction and excellent field of fire in all forward directions. Powered by a 120-hp. Beardmore engine, it was equipped with a Lewis gun mounted on the front of the observer's cockpit.

Fokker's highly maneuverable E. III carried an Oberursel UR II engine delivering 110 hp. and mounted a single air-cooled Spandau machine gun. Steel tubing was used throughout the basic structure.

For nearly half a century there has been conjecture about Immelmann's death. Some sources claim that the German ace was a victim of his own artillery fire and others suggest that Immelmann overstrained his ship.

In 1916, Oswald Boelcke declared: "Immelmann lost his life by a silly chance. All that is written in the papers about a fight in the air . . . is rot."

Leutnant Heinemann, who was flying with Immelmann when the ace met his death, later drove to the scene of the crash and examined the wreckage. He afterward wrote: "Once again Immelmann shot his own propeller to pieces. . . ."

But George McCubbin had the last word: "Our bullets not only got him, but his prop as well."

Heritage of the Air

One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men — and the wood, wire, linen, and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation celebrates its 40th year in electronics with the presentation of this Heritage of the Air series.

★ ★ ★

Technical Director for Heritage of the Air is Lt. Col. Kimbrough S. Brown, USAF.

British Accident Investigation Report—Part I:

British Review BEA Crash at Munich

Following is Part I of a report by an independent body, headed by E. S. Fay, set up by the British Minister of Transport and Civil Aviation to review Capt. James Thain's representations about a takeoff accident Feb. 6, 1958, at Munich, involving a BEA Elizabethan transport of which he was pilot. A German Commission previously had announced its findings of the causes.

On the afternoon of Feb. 6, 1958, the British European Airways aircraft G-ALZU crashed while taking off from the airport at Munich. A Commission of Inquiry appointed by the Federal Republic of Germany duly inquired into the causes of the accident and issued a report dated Jan. 31, 1959; the English translation of this report was subsequently published by Her Majesty's Stationery Office for the Ministry of Transport and Civil Aviation (C.A.P. 153). As will amply appear hereinafter, both the captain of the aircraft, Capt. James Thain, and the British Airline Pilots' Assn., (BALPA) disagreed with certain of the findings of the German Commission of Inquiry, and your predecessor, the then Minister of Transport and Civil Aviation, on June 10, 1959, appointed us to be an independent reviewing body with the following terms of reference:

"To consider the representations made by and on behalf of Capt. Thain with regard to the accident to BEA Elizabethan G-ALZU at Munich on Feb. 6, 1958: and, having regard to those representations and to the report of the German Commission of Inquiry on the said accident, to report to the Minister whether or not in their opinion Capt. Thain took sufficient steps:

- **"To satisfy himself** that the wings of the aircraft were free from ice and snow;
- **"To ascertain whether** or not in the conditions prevailing at the time the runway was fit for use;
- **"To ascertain the cause** of the difficulties encountered on the first two attempts to take off before making a third attempt."

As soon as Capt. Thain's representatives were ready to meet us, we held a preliminary meeting with them, which took place on July 16, 1959, and at that meeting it was decided to commence the hearing of the representations on Sept. 28, 1959. In the meantime, however, certain fresh evidence had been submitted to the German Commission of Inquiry with the request that they reopen their proceedings. In consequence of information received from Germany, Capt. Thain's solicitors on Sept. 8, 1959, asked us to adjourn the proposed hearing to a date to be fixed, and this we did. On Feb. 17, 1960, we were requested to fix a fresh date for the hearing and accordingly we announced that this would commence on Apr. 4, 1960.

At the same time, Capt. Thain through his solicitors expressed a preference for a public as opposed to a private hearing, and as this accorded with our own views, we decided to hold our inquiry in public. Before this commenced, the German Commission determined not to reopen their own proceedings and their detailed reasons for so doing, dated Mar. 14, 1960, were before us in translation. The hearing took place on 4th, 5th, 6th and 7th of April, 1960, at 10 Carlton House Terrace, London, S.W.1. Capt. Thain was represented by Mr. James Comyn as counsel, instructed by Messrs. Evan Davies & Co., Solicitors.

The purpose of the hearing was to enable Capt. Thain to make the representations which it was our duty to consider. The representations so made took the form of (a) a body of documentary evidence placed before us, (b) the oral evidence of a number of witnesses, and (c) the submissions of counsel. It is important here to emphasize that we were in no sense a Court of Inquiry into the causes of the disaster, nor had we any statutory powers as regards evidence or otherwise. Our function was to consider and to test the representations made to us on behalf of one party alone. The absence of any party charged with the duty of presenting an opposite view upon controversial matters might have rendered the hearing difficult, but Capt. Thain and his counsel took the course of putting before us all the facts in their possession, whether they told for or against the representations; this greatly facilitated our task and we wish to pay tribute to the objectivity and sense of public duty evidenced by this course of action.

While not required to find the causes of the accident, we could not judge Capt. Thain's actions, as our terms of reference require us to do, without ascertaining the surrounding circumstances. There was no dispute as to the majority of the relevant facts but, as will appear, considerable controversy over some which were most material. In the following part of this report, we set down, as the necessary background to dealing with the matters put to us, the facts so far as they are not in controversy.

The aircraft G-ALZU was an Airspeed Ambassador, a type assigned the class name of "Elizabethan" by the British European Airways. It had been constructed in 1952. The Elizabethan is a high-winged monoplane powered by two Bristol Centaurus 661 engines; it has a tricycle landing gear. Since no question arises as to any defect in the aircraft, no further details need be given save to mention that the port engine was fitted with a Peravia recorder; this is a power-driven roll of waxed paper used to record, against a time base, data as to altitude, engine speed, and manifold pressure. The Peravia recording was recovered after the crash and throws some light on the course of events.

The aircraft was on the return stage of a charter flight between Manchester and Belgrade, carrying the Manchester United football team and journalists and others, the total number of occupants, including the crew, being 44. It landed at Munich in order to refuel. The captain in charge of the aircraft was Capt. Thain and his first officer was Capt. K. G. Rayment, who was fatally injured in the crash. On the outward journey to Belgrade, Capt. Thain had flown the aircraft; on the return, including the attempted takeoffs from Munich, Capt. Rayment flew the aircraft and Capt. Thain acted as copilot. In fact, Capt. Rayment was senior to Capt. Thain; he came to be serving under him owing to the fact that a first officer originally rostered to accompany Capt. Thain on the flight had dropped out and Capt. Rayment came in as his substitute.

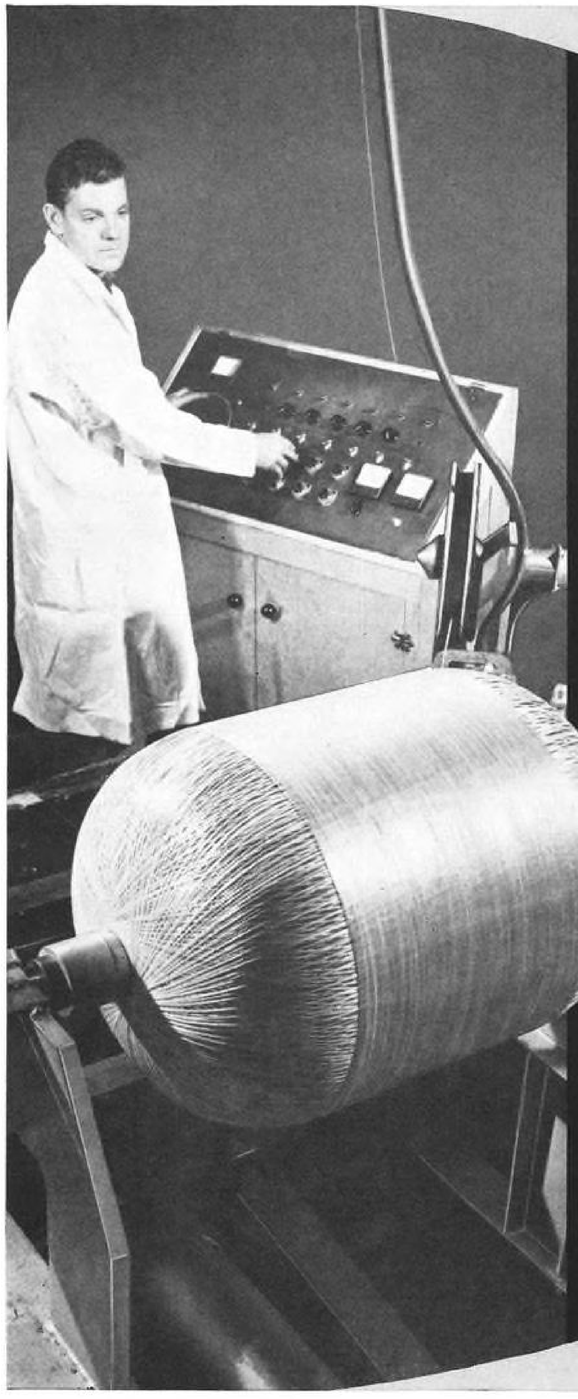
Flight Plan

Capt. Thain had in the past flown with Capt. Rayment but on those occasions Capt. Thain's rank was that of first officer and he had flown under Capt. Rayment's command. The aircraft had flown from Belgrade at a height of between 14,500 and 16,500 ft. at temperatures in the region of −21C to −25C. During the descent to Munich through cloud, the wing deicing equipment was operated: this comprises a petrol-burning heater used to supply hot air to the interior of the leading edge of the wing, and is fitted with a device which automatically cuts out operation at about 90 kt. and thus comes into operation on landing.

The aircraft arrived at 1417 hr., i.e., 2:17 p.m. local time. (In this report all times given are local time, which was one hour in advance of GMT.) It was snowing at the time, and snow and slush were lying on the ground, including the runway; the screen temperature was in the vicinity of freezing point. The aircraft made a normal landing and after arrival at the apron Capt. Thain went first to the Meteorological Office for briefing on the next leg of the flight, and next to the Air Traffic Control Office: Capt. Rayment reported to the BEA office. Meanwhile, refueling commenced at 1425 hr; the aircraft's wing tanks had a capacity of 1,000 gal. and they were filled, 726 gal. being taken on in the process. Mr. W. N. Black, the BEA station engineer, assisted in the refueling, which finished at 1438 hr. The wings were not swept or de-iced; Capt. Thain's decision in this respect will be examined in detail later.

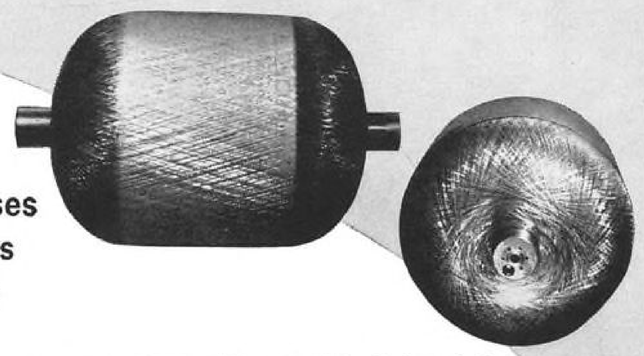
At 1519 hr., the aircraft obtained clearance to taxi to the runway, and at 1530 it commenced its first attempted takeoff. The aircraft accelerated to approximately 105 kt. when Capt. Rayment abandoned takeoff because the boost on both engines was fluctuating. Brakes were applied and the aircraft came to rest approximately 450 yards from the far end of the runway. It received permission to back-track, returned

TAPCO POWER SYSTEMS



NEW ADVANCEMENT IN WINDING LARGE REINFORCED PLASTIC CONTAINERS

Write on your company letterhead for TAPCO's Reinforced Plastics brochure.



- **Solid Rocket Motor Cases**
- **Liquid Propellant Tanks**
- **Other Pressure Vessels**

The TAPCO Group is now producing pressure vessels of higher quality than has previously been possible in the industry. Advent of the unique electronically-controlled helical winding machine illustrated at left is part of the reason.

This machine, designed and built by the TAPCO Group, allows complete, automatic control of the rate, speed, stress, and winding angle of each individual filament, and infinite adjustment over any given operable range. The usual need for design compromise is eliminated, and the following advantages are obtained:

- Uniform finish of end domes — elimination of material pileup.
- Reduction of weight.
- Maintenance of exact filament path — no bends, no kinks in fibre.
- Optimum winding angle allowed.
- Optimum strength-density ratio maintained.
- Each fibre held under identical stress, even around end domes.
- No fibre shifting when vessel is loaded.

TAPCO is capable of winding pressure vessels 72" in diameter to virtually any length, approaching within 10-15% of theoretical optimum stress levels around end closures, and 1-2% along cylindrical portions.

This capability is a new high point of TAPCO's seven years of experience in reinforced plastics. Programs for the missile industry include the Pershing TEL blast deflector, plastic nozzle components for all stages and all motors under development for an advanced missile program, the booster nozzle and internal insulation for Super Talos, and plastic components for the Polaris second-stage nozzle and the Sidewinder booster motor.

Each reinforced plastics project at TAPCO is handled by an outstanding project engineering team under the direction of a program manager. Each customer deals directly with the manager of his program—the man responsible for product quality and performance, for meeting delivery dates, and for introducing continuous cost-reduction programs after startup.

We invite you to write or call us to help you with your design, development, or manufacturing requirements concerning reinforced plastics.

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

DEPT. AW-21160 • CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS FOR THE AIRCRAFT, MISSILE AND SPACE, ORDNANCE, ELECTRONIC AND NUCLEAR INDUSTRIES

TRW

Advanced projects at TAPCO offer excellent career opportunities for qualified engineers and scientists. Write Manager of Staffing.

to the starting point, and at 1534 hr. commenced its second run. On this occasion, the throttles were opened more slowly and the starboard engine boost was steady, but at about 85 kt. the port boost gage "fluctuated quite a lot" (Capt. Thain's phrase) and went above the permitted maximum of 60 in. Capt. Thain thereupon ordered the takeoff to be abandoned and decided to return to the apron for consultation with the station engineer. The aircraft rolled to the far end of the runway and taxied back to the Terminal Building, arriving at 1539 hr. Capt. Thain took over the controls while taxiing.

Mr. Black knew that boost surging was not an uncommon phenomenon on Elizabethan aircraft at Munich, owing to the airfield's height of 1,732 ft. above sea level. He so informed the pilots, and advised that the normal way of dealing with it was to inch the throttles back to maintain the required 57½ in. of boost. The pilots thereupon decided to make one further attempt at takeoff. The passengers had been offloaded; they were recalled and the aircraft again cleared to taxi to the runway at 1556 hr. Neither pilot had left the cockpit during the aircraft's 20-min. wait on the apron.

The aircraft reported "rolling" on its third and last attempted takeoff, by R/T at 1603.06 hr. It never became airborne; 54 sec. later, the radio operator called Munich control but before he had time to complete his identification, the transmission was cut short. The aircraft had traversed the entire runway and the continuation stopway, broken through the boundary fence and struck a house, after which it broke up. The last R/T message ended with the loud noises associated with the collision with the house.

German Report

The German Commission of Inquiry was able to narrow down its search for the causes of the accident to a detailed investigation of three possible factors:

- **Rolling friction** caused by snow on the runway;
- **The effect of slush** on the free running of the wheels;
- **Alteration in aerodynamic** efficiency caused by wing icing.

On the first factor, snow on the runway, the Commission found that the snow had subsided into a layer of slush not more than 1 cm. thick and that this slush on the runway did not increase rolling friction to such an extent that the accident could be attributed to it.

On the second factor, the Commission found that there could have been no packing of the twin wheels with ice such as to exert a braking effect, basing themselves on the fact that nothing of the kind had been detected after the first two abortive takeoffs, that no mark attributable to such a condition had afterward been found on the one surviving tire, and that other aircraft with similar landing gear had taken off without difficulty from the airport that afternoon.

On the third factor, the Commission decided that the wings of the aircraft had, at the material time, acquired a layer of rough ice some 5 mm. thick, with a roughness height of 3 mm., and that this prevented the aircraft from attaining the lift coefficient required for unsticking within the length of the runway. This they there-

fore found was the decisive cause of the accident.

In view of the representations made to us, it is necessary to set out in some detail the evidence upon which the Commission based its findings upon the first and third factors. On the question of slush on the runway, the German report refers to the following sources of evidence:

• **Twenty-one reports of incidents** involving slush together with five reports of such incidents submitted by BEA were examined. "These reports may be summarized to the effect that the extent to which takeoff is impeded depends on the thickness of the slush and the type of aircraft. Aircraft with nosewheels are affected to a greater extent than aircraft of tailwheel design, because, in slush, the nosewheel causes an increasing nose-heavy moment as the rolling speed increases and this must be overcome by the pilot by means of considerable force on the elevator control. All experience goes to show, however, that it may be assumed that takeoffs can be made with nosewheel aircraft without danger up to a slush-depth of at least 5 cm."

• **The head of the aircraft** meteorological office, Dr. H. K. Muller, showed "that the basis of data concerning snowfall and temperature, established from the records, by 1600 hr. a total of 4-5 cm. of snow must have fallen, which, on the runway, would have subsided to form a layer of slush approximately ¾-1 cm. thick."

• **Herr Kurtz Bartz,** traffic manager of the Munich-Riem Airport Co., had driven with a colleague along the runway immediately after the time of the first two abortive takeoffs: "We found that the entire runway was covered with slush approximately ½-¾ cm. deep. None of it was snow, but it was a jellified, watery mass covering the entire runway. We began from the east and drove off the runway at the west end. We did not merely stop, but got out and established the fact that the tracks left by the aircraft consisted purely of water." (It is convenient to adhere that when, after the publication of the German report, Capt. Thain made further representation to the Commission of Inqury, a further statement was taken from Herr Bartz in which he said, "We checked not only the middle, but also each side. We got out to make spot checks on both sides. I am certain that there were no accumulations of slush or water on the runway or on either shoulder, which might have constituted a state different from that of the rest of the runway. On the right of the runway there is a natural fall-away which quickly drains off the water. On the left side of the runway special drainage has been constructed.")

• **Capt. E. R. Wright,** who had landed a BEA Viscount at Munich at 1558 hr. on the day in question, estimated the slush depth at 1 to 1½ in. in places and stated that parts were merely wet and free from slush. (The report commented that as Capt. Wright was judging from his pilot's seat during the process of landing, he could not have obtained a precise impression of the deposit of slush.)

• **Prof. Dr. H. Schlichting** presented a report into the technical aspects of the matter, in which he showed that, assuming a rolling friction coefficient μ increased from 0.03 to 0.06, the rolling distance required for a normal takeoff may be increased by approximately 110 m. (equal to 120 yards).

• **Sixteen aircraft landed** and took off on the afternoon in question; none of their captains reported any impediment worthy of serious consideration.

• **Capt. Thain,** in his first statement, made two days after the accident, stated that he was satisfied with the condition of the runway.

Upon the question of wing icing, the Report refers to the following sources of evidence:

• **Chief Inspector of Accidents** and his assistants inspected the wreckage shortly after their arrival in Munich at 2200 hr. or some 6 hr. after the accident, during which time further snow had fallen. They found the aircraft covered with a layer of 8 cm. of powdery snow; on the wings this could be pushed or blown from the surface without difficulty, and underneath there was found to be a very rough layer of ice about 5 mm. thick. From numerous spot checks, they concluded that the entire wing surface was covered with such ice, save only behind the two engines over the width of the slipstream, where there was snow but no ice. The ice had not blended with the superimposed snow.

• **Two witnesses** whose duties took them on to the wings during refueling (Mr. Black, the station engineer and Robert Wiggers, employed by the petrol suppliers) had seen melted snow running off the wings; Wiggers saw snow lying on the wing outer sections. Capt. Thain also saw water running from the trailing edges of the wings.

• **Two witnesses** (Schombel and Wöllner) who watched the aircraft prior to its last departure from windows fairly high up in the terminal building, stated that on leaving the apron, the wings, outboard of the engines, were covered with a thick unbroken layer of wet snow.

• **Meteorological evidence** showed that sufficient snow had fallen during the period between 1400 and 1600 hr. to furnish a layer of ice 5 mm. thick, and that conditions of temperature and humidity were such that by 1600 hr. the snow could have turned to ice.

Ice Formation

Upon the data summarized above, the Commission found firstly that the 5 mm. ice layer could have formed before the accident. They then considered whether it could have formed after the accident. During this period, the temperature was below freezing, and falling snow would be dry and would not blend with any ice on which it fell. If, however, it fell on a wing warmed by the fires generated by the crash, it would melt and, as time went on, would refreeze. The Commission felt that the outbreaks of fire near the remains of the wing were too small and too quickly extinguished to have melted the falling snow, and that the major outbreaks were downwind and too far away to have had this result. They regarded as conclusive the fact that no ice was found on the wings immediately behind the engines, pointing out that if post-accident melting and refreezing accounted for the layer of ice under the snow, such a layer must have been formed under the snow in this position.

We were provided with copies of the technical report prepared by Dr. Schlichting. This commences by setting out the basic facts as follows:

"The investigation at the site of the accident and the testimony of witnesses and persons involved in the accident of the British aircraft "Elizabethan" G-ALZU on Feb. 6, 1958, at the Airport of Munich-Riem have led to the following main conclusions:

(1) "The aircraft did not leave the ground throughout the takeoff run, i.e., at no time were all three wheels off the ground.

(2) "The engines worked satisfactorily.

(3) "The attitude of the aircraft, while traversing the second half of the runway, was as normally associated with unstick (tail wheel touching the ground, angle of attack = 8.3 deg. to 9.3 deg.).

(4) "At the time of the accident the runway was covered with a layer of snow and slush from 2 to 4 cm. thick, furthermore it may be fairly certainly assumed that the major part of the wing was covered by a layer of ice of about 5 mm. thick."

It examines the course of a normal takeoff run, and finds that the aircraft should in normal conditions reach the takeoff speed of 119 kt. in 1,000 metres (1,100 yards). It examines a number of factors affecting acceleration and unstick speed, of which we need concern ourselves only with slush and icing. As to slush, the report states:

"There are no data available about the way in which the coefficient of rolling friction μ is affected by the present of slush on the runway. . . . It is possible that, due to the displacement and scattering of the slush by the wheels, the coefficient μ is a

function of the speed, although μ is normally independent of speed. In the absence of more certain information μ is assumed to be constant. Instead of $\mu = 0.03$ it is assumed that, with slush, the coefficient becomes either 0.06 or 0.10, i.e., the presence of slush is assumed to double or treble the rolling friction respectively."

The technical report finds that with normal rolling friction doubled, the rolling distance to unstick is increased by 110 metres (120 yards), and with it trebled, the distance is increased by 270 metres (300 yards). The drag effect of icing, it finds, increases rolling distance to a given speed only slightly, but its effect on the lift characteristics increases unstick speed from a minimum of 110 kt. to 120 kt. or more. The Report concludes with the following summary:

"Exact information about the takeoff run of the crashed aircraft cannot be given, since the precise runway and wing conditions at the time of the accident are not known. Although the takeoff calculations which were carried out are only based on more or less accurate assumptions and estimates, the following statements can nevertheless be made, based on the results of these calculations:

(1) It is very unlikely that the slush on the runway alone could have resulted in an excessive rolling distance.

(2) Slush on the runway combined with icing of the wing could lead to an excessive rolling distance (about 1,500 metres).

(3) The takeoff run of the crashed aircraft may have approximately taken the following course:

Because of the slush on the runway and because of the drag increase due to icing of the wing the rolling acceleration was appreciably below the normal value. This led to to the fact that when the safety speed V_1 of 117 kt. had been reached, a distance of about 1,500 metres had already been covered, so that the end of the runway had already almost been reached. Since, however, due to the icing of the wing, the unstick speed had not yet been reached, the pilot could not lift the aircraft off the ground. As is shown by the tail wheel tracks the pilot evidently attempted to leave the ground right up to about 180 metres short of the end of the runway. Since no further distance in which to stop was available for abandoning the takeoff, the catastrophe could no longer be avoided."

Thain Statement

Capt. Thain made a written statement to the German authorities on Mar. 6, 1958. The portion of the statement dealing with the final run records that Capt. Rayment opened the throttles to about 28 in. of boost with the brakes on, released the brakes and opened the throttles to full power. It continues:

"At about 85 kt. the port boost started to surge. I called "port surging slightly" and pulled the port throttle level back until the surging was arrested, the reading was about 54 in. and then advanced the lever again until it was fully open and indicating 57½ in. The starboard indication had remained at 57½ in. throughout. I called "full power again" and glanced at the temperatures and pressures. I then looked at the airspeed indicator, the speed was 105 kt. and I called "105," the boost remained

B.F.Goodrich

BOEING 720 uses BFG wheels and disk brakes, and dimpled fabric tread tires qualified for speeds as high as 300 mph.

NORTH AMERICAN A3J

NORTHROP T-38

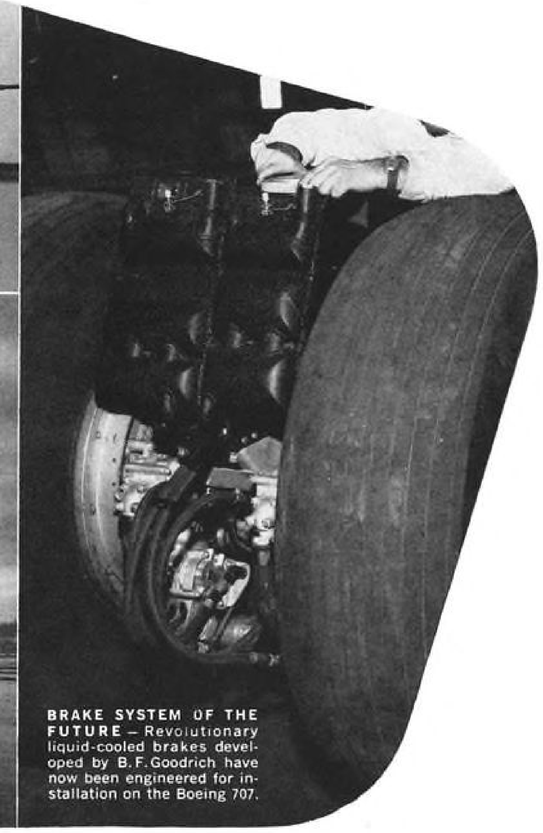
DOUGLAS A3D

TEMCO TT-1

LOCKHEED ELECTRA is equipped with BFG wheels and brakes, tires, air-duct seals, erosion shoes, propeller heating elements.

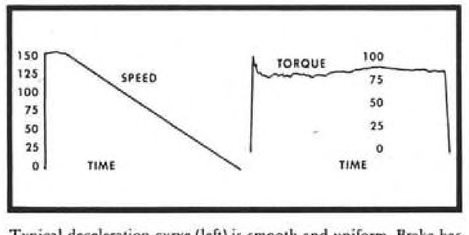
LOCKHEED JETSTAR, equipped with BFG wheels and brakes, can operate from short runways built for slower, piston-powered planes.

BOEING 707 makes smooth stops with BFG wheels and brakes, rolls on high speed fabric-tread tires.



BRAKE SYSTEM OF THE FUTURE – Revolutionary liquid-cooled brakes developed by B.F.Goodrich have now been engineered for installation on the Boeing 707.

For faster, smoother stops



Typical deceleration curve (left) is smooth and uniform. Brake has an automatic adjuster which maintains proper lining clearance and fluid pressure. With vibration eliminated, torque (right) is constant during stops. Multi-disk design for jet aircraft absorbs high energy without chatter.

BFG disk brakes and wheels are used as original equipment on these high performance aircraft because of their demonstrated capacity for fast, chatter-free stops. The secret is a thermally balanced design, incorporating special 360° sintered metal linings, developed by B.F.Goodrich.

This design equalizes heat distribution so that deceleration is smooth and uniform. Constant high torque is always available throughout the life of the lining. Damaging vibration is eliminated.

B.F.Goodrich experience is now being applied to advanced projects—including the B-70 tire, wheel, and brake subsystem; wheels and brakes for missile carriers; and associated projects. For information, contact *Dept. AW-11D, B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Troy, Ohio.*

they use B.F.Goodrich brakes

B.F.Goodrich aviation products

constant at 57½ in. The needle of the ASI was flickering slightly and when it indicated 117 kt. I called "V_1" and waited for a positive indication of more speed. Capt. Rayment was adjusting the trim of the aircraft. (Up to this point, while I had not looked out of the cockpit, I had not experienced any feeling that the acceleration had been other than normal under the circumstances.) The needle hovered at 117 kt. and then dropped 4 or 5 kt. I was conscious of a lack of acceleration, the needle dropped further to about 105 kt. and hovered at this reading.

"Suddenly, Capt. Rayment called out ". . . we won't make it." I looked up for the first time and saw a house and a tree, all this time my left hand had been behind the throttle levers. I raised it and banged the throttles but they were fully forward. I believe Capt. Rayment was pulling the control column back, he called hurriedly, "undercarriage up" and I selected up and then gripped the ledge in front with both hands and looked forward. The aircraft's passage was very smooth as if we had become airborne and it looked as if we were slowly turning to starboard. I remember thinking that we couldn't possibly get between the house and the tree. I lowered my head and then the aircraft collided."

It should be interpolated that as a safety measure the aircraft operated on the "variable decision takeoff technique" which involved calculating in respect of any takeoff, firstly a decision speed (described as V_1) at which the aircraft would be capable either of continuing and taking off with one engine inoperative or of being brought to a standstill within the distance available, and secondly a takeoff speed (described as V_2) at which the aircraft should be flown off. In the circumstances of this take-off, V_1 was at 117 kt. and V_2 at 119 kt.

Runway Slush

The Commission accepted Dr. Schlichting's report, noting that "the error . . . according to which there were 2-4 cm. of slush on the runway, is of no account as far as the results are concerned, because the expert was referring to the quantity of snow that had fallen, and at the desire of the Commission, he had undertaken calculations based on various rolling-friction coefficients." They stated that, "General flying experience and aerodynamic calculations are thus in agreement about the fact that an aircraft with such a degree of ice accretion as the aircraft involved in the accident would not, in the conditions obtaining at Munich on Feb. 6, be capable of taking off and flying within the takeoff area available." This, however, would not explain the deceleration which Capt. Thain noted. As to this, their report notes that Capt. Thain could not indicate either the point along the runway at which he observed the decrease in speed reading or the point at which V_1 was attained, and continues:

"Judging from the sequence of his whole account, however, the drop in speed can only have set in towards the end of the runway. Capt. Thain stated that during the process of takeoff he at first only watched the instruments and did not look out of the aircraft. Only when he perceived a drop in speed did he look out. He then saw that they were in alarming proximity to the aerodrome boundary. Capt. Rayment's exclamation, made at about the same moment, "We won't make it," would naturally only have been made when they were already in a zone of the runway where catastrophe was seen to be unavoidable. There is therefore much to suggest that the drop in speed occurred approximately at or beyond the 1,800 m. mark. According to captain's account, the aircraft first attained V_1, maintained, for a while, the speed it had reached, and only then lost speed appreciably. A certain interval must therefore have elapsed between the attaining of V_1 and the drop in speed. At 117 kt. a rolling distance of about 400 m. is covered in 6.5 sec. and a rolling distance of about 200 m. in 3.2 sec. The interval during which V_1 was maintained would probably have lain within these values. If we proceed from this, and assuming that the drop in speed occurred within the zone beyond the 1,800 m. mark, then it is highly probable that V_1 was indeed attained between 1,400 m. and 1,600 m., as the expert has calculated.

"Capt. Thain's statements thus provide a certain confirmation of the expert's calculations, as far as there can be any question of precise confirmation, considering the element of uncertainty in Capt. Thain's reconstruction of what happened. Under these circumstances the Commission considers it amply certain that V_1 was attained between 1,400 m. and 1,600 m. and was maintained or exceeded at any rate to within the region of the 1,800 m. mark. Nevertheless, although the nose was pulled up and the emergency tail bumper was at times on the ground, the aircraft could not be raised off the ground."

The Commission's report notes that there may be some uncertainty about the objective accuracy of Capt. Thain's observation of the airspeed indicator, having regard to the "unnerving catastrophe" which supervened. But, they say:

"It is entirely possible that the drop in speed of which Capt. Thain spoke so definitely did indeed occur. There is then the further doubt as to where it occurred and why it happened. There is much to suggest that the aircraft slowed down at the point on the runway at which the tracks of the locked wheels were visible after the accident. The loss of speed reported by Capt. Thain would then have the perfectly natural explanation that, in the final section of the runway, Capt. Rayment saw disaster approaching and braked the landing wheels sharply. All four landing wheels were locked, as could still clearly be seen during the Commission's inspection in Munich. A simultaneous locking of all the wheels, however, can hardly have occurred except as a result of braking. But if this were the case it is not out of the question that a misunderstanding between the two pilots played a part at this juncture, for, whereas Capt. Rayment (probably) applied the brakes, Capt. Thain, in the hope of averting the catastrophe at the last moment, did exactly the opposite, viz. (as he stated during interrogation), pushed the throttle lever forward as far as possible. Thus the measures taken by the crew to avert the accident or make it less serious canceled each other out."

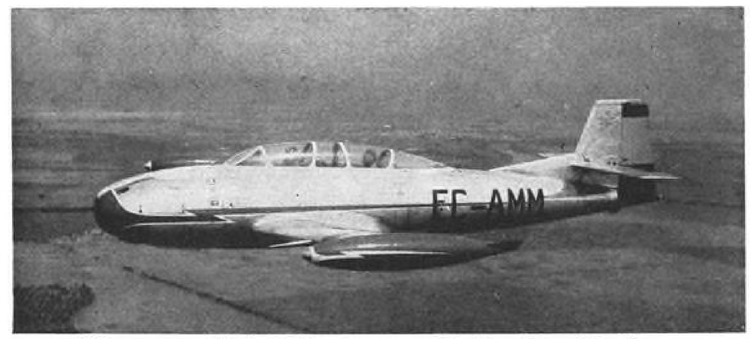
Commission Summary

The Commission summarized the results of the inquiry as follows:

"During the stop of almost 2 hr. at Munich, a rough layer of ice formed on the upper surface of the wings as a result of snowfall. This layer of ice considerably impaired the aerodynamic efficiency of the aircraft, had a detrimental effect on the acceleration of the aircraft during the takeoff process and increased the required unstick speed. Thus, under the conditions obtaining at the time of takeoff, the aircraft was not able to attain this speed within the rolling distance available.

"The decisive cause of the accident lay in this. It is not out of the question that, in the final phase of the takeoff process, further causes may have had an effect on the accident."

The finding that the aircraft attempted to take off with its aerodynamic efficiency impaired by the formation of ice on its wings, constituted a serious criticism of the commander of the aircraft and pointed to a



Hispano HA-200 Saeta Twin Jet Trainer

Hispano HA-200-R1 Saeta, a two-seat advanced trainer powered by two Turbomeca Marbore IA turbojet engines, may find a market outside Spain. Saeta is manufactured by La Hispano-Aviacion, S.A. and was designed under the direction of Prof. Dr. Willi Messerschmitt, working at San Pablo Airport, Sevilla. Company reportedly has received "offers from abroad" to purchase numbers of its Saetas. Hispano plans to develop a supersonic, single-seat version of the Saeta to serve as a fighter-interceptor.

breach of Article 17(2) of the Air Navigation Order, 1954, which provides:

"Before the aircraft flies or attempts to fly the person in command shall satisfy himself . . . (vi) . . . that the wings and control surfaces are free from ice and hoar-frost."

Neither Capt. Thain nor BALPA accepted the above-mentioned finding. Among other moves, the association, on Capt. Thain's behalf, submitted certain arguments and fresh evidence to the German Commission and requested that it reopen the inquiry. The gist of the submission was that the evidence did not establish the presence of ice on the wings and that the behaviour of the aircraft could and should be accounted for by the retarding effect of slush on the runway, and did not point to icing. The fresh evidence consisted of statements (a) by three persons who took part in rescue operations and stated that they saw no ice on the wings when, immediately after the accident, they took part in extricating Capt. Rayment from the wreckage, and (b) by two air traffic controllers, Erich Laas and Kurt Gentzsch, who watched the last takeoff from the control tower.

The latter both spoke of the aircraft making a normal run for the first half of the runway; the nosewheel then left the ground but after some distance it touched down again, leaving the ground, according to Laas, once more before the end of the runway. (Gentzsch did not speak of the nosewheel again leaving the ground, but thought the aircraft rolled to the end of the runway and then unstuck). This was submitted as consistent inter alia with a nose-heavy pitching moment caused by running into deeper slush or by frozen slush retarding the free running of the wheels.

The German Commission on Mar. 14, 1960, issued a written decision that the facts, evidence and other points to which their attention had been drawn, did not justify the reopening of the proceedings. To this was appended a detailed statement of their reasons, a translation of which was before us. We conceive this document, although subsequent in date to our Terms of Reference, to form part of the Report of the German Commission to which we ought to have regard and we accordingly now refer to its contents.

Evidence Reviewed

The Commission first dealt with the fresh evidence of the rescuers; they pointed out that none of the three spoke of the part of the wings outboard of the engines since they were concerned with the part adjacent to the fuselage and their evidence did not conflict with the finding of the court. They also dealt with an argument advanced by Capt. Thain that the fire-extinguishing powders used after the crash would have lowered the freezing point of water and would account for the absence of ice on the slipstream portion of the wings when examined 6 hr. later. This point, as developed before us, will be examined later; the Commission rejected the argument in the following passage:

"These considerations put forward by Capt. Thain are based on the assumption that the wings, at least in the region of the engines, were so heavily sprayed with extinguishing agents as to make it possible for the melting-point of the snow to drop to —3C at this spot. All available reports regarding the fires and the activities of the fire-fighting services, however, show that these parts of the wreckage lay outside the main centers of fire. In the vicinity of the aircraft only a few minor fires on the ground broke out and were fought with extinguishing agents. There is no indication that on the upper surfaces of the wings (particularly in the region of the engines) any extinguishing measures were necessary or extinguishing agents deposited."

They next dealt with a submission that slush or water might have collected on the outer edges of the runway on account of its camber and, as the aircraft's course was not down the center of the runway, might account for increased retardation at some point. They said:

"The fact that the runway has a slight camber is not new to the Commission. The effect of this camber is that any possible melted snow can drain off better from the runway. On one side of the runway the maneuvering area shows a natural fall-away. On the other side special drainage has been constructed. Provision is thus made on both sides for the further draining-off of the water. Since the amount of precipitation which fell prior to the accident was by no means great, it appears out of the question that any quantities of water or melted snow worth mentioning should have collected anywhere. What is more, the witness Bartz stated that on the day of the accident he not only checked the condition of the center of the runway but also made

spot checks on both outer edges of it. He was therefore able to say with certainty that he did not find any slush or water collected there."

The Commission reported that the statements of Laas and Gentzsch had been before them from the outset and their observations from a considerable distance had been considered, together with the evidence as to tracks on the runway and the evidence of Capt. Thain. BALPA, however, had submitted in writing the argument that the evidence of Laas and Gentzsch showed that the angle of attack necessary for unsticking, and the necessary speed for this, were never simultaneously attained throughout the entire takeoff process, and that wing icing could not therefore have caused the accident; and that these witnesses' statements suggested rather inability to unstick owing to restriction of free running of the wheels.

With regard to this submission, the Commission expressed the following views and reasoning:

(a) They had concluded, on the evidence of Capt. Thain and others, that speed V_1 was attained between 1,400 and 1,699 m. and maintained or exceeded to 1,800 m. The question to be considered was therefore whether between 1,400 and 1,800 m. the aircraft attained the necessary angle of attack for unsticking with clean wings.

(b) It was highly improbable that, so near the end of the runway, Capt. Rayment would not have attempted to unstick.

(c) A witness named Meyer, whose statement was appended, observed the track of the emergency tailwheel up to about 100 to 150 metres short of the end of the runway—he had walked back about 40 metres along the runway and could not see the beginning of the tailwheel track, and:

"It is thus confirmed that before the 1,800 m. mark (i.e. over the rolling distance on which V_1 was exceeded) the aircraft had the angle of attack otherwise necessary for unsticking, for a period not precisely ascertainable but at any rate ample."

(d) The evidence of Laas did not conflict with the above as he saw the unsticking of the nosewheel towards the end of the runway; Gentzsch was clearly wrong in thinking the aircraft unstuck, and if his statement negatived the unsticking of the nosewheel before the end of the runway, the track of the tailwheel showed him to be wrong. Of the statement that the nosewheel unstuck for a short time in the middle of the runway, they said, "If we assume that this observation is correct (and the over-all impression made by the statement as well as the witness' experience suggest this), then we must ask ourselves whether his statement really differs decisively from those of most of the other witnesses. According to the Commission's former and present opinion, this is not the case, for when this witness speaks of unsticking in the middle of the runway, it does appear that the nosewheel first left the ground for a short time at about 900 m. and very soon afterward (Gentzsch says 60-100 m.) touched the ground again. Laas could not say exactly where the nosewheel afterward left the ground again, but he stated that it occurred, at any rate, before the end of the runway was reached and that he had the impression that it was primarily only a question of putting the nose down in order to gain speed. This indicates that the second part of his statement tallies with the observations of the other witnesses and that they merely disregarded the first brief unsticking of the nosewheel at 900-1,000 m. In other words, Laas and all the other witnesses are agreed in principle that the nosewheel unstuck within the second half of the runway, towards the end of the runway. All the statements, however, including that of Laas, are vague, inexact and mutually at variance concerning precisely for how long, on what section [of the runway] and at what angle of attack this occurred. The reason for this uncertainty would lie, on the one hand, in the fact that the aircraft was already at a considerable distance from the witnesses and, on the other hand, that in assessing all these statements it must be remembered that when watching the takeoff the eye-witnesses did not yet know that it would culminate in an accident and they consequently did not pay conscious attention to every detail of the takeoff process. If these points are taken into consideration, the statements of all the eye-witnesses can easily be brought into line with the conclusion in (b) and (c), viz. that the pilot tried to unstick the aircraft between 1,400 and 1,800 m."

(e) The Commission therefore concluded that the assessment of the witnesses' statements failed to show that the pilot did not try to unstick although between 1,400 and 1,800 metres V_1 was exceeded and V_2 almost attained.

Airborne Converter

Airborne teletype frequency-shift converter, Type 700B-1, permits up to 100 words per minute teletype service in aircraft equipped with single sideband or AM radio receiver. Converter, which is completely transistorized, will accommodate doppler shift for aircraft speeds up to 600 kt. Device, which provides single channel of half-duplex service, is contained in a ½ ATR size case, weighs 12 lb. Manufacturer: Collins Radio Co., Western Div., Burbank, Calif.

Further Evidence

The Commission further dealt with the evidence of Laas and Gentzsch as to the earlier unsticking of the nosewheel in the following passage. This is a matter to which we attach importance and the Commission's observations are given in full:

"The statements of the witnesses Laas and Gentzsch also fail to justify the further opinion advanced that restriction of the free rotation of the under carriage [wheels] (Fahrwerkshemmung) (whether due to slush or other causes) might have been a contributory cause of the accident. The observation that the nosewheel left the ground for a short time at about 900 m. but soon afterward touched down again can be explained by the fact that V_1 had not yet been attained and Capt. Rayment was possibly reducing, for a while, an angle of attack which perhaps appeared to him somewhat excessive. Capt. Thain's remark that a "nose-heavy pitching moment" might have come into play here, can, it is true, be accepted in theory. This is contradicted in practice, however, by the fact that any braking action which could have put the nose down against Capt. Rayment's will must have occurred abruptly and Capt. Thain would have been bound to have become aware of it physically, or, at any rate, from the speed reading. His statement, however, makes no mention of it. Another point telling against this is the fact that the aircraft afterwards gained speed normally, exceeded V_1 and almost attained V_2 as Capt. Thain mentions in his statement. It is out of the question that the sinking of the nosewheel observed by Laas and Gentzsch at about 1,000 m. should be identical with the drop in speed from 117 kt. to 105 kt. observed by Capt. Thain, since from the sequence of events in his statement it can be seen that this drop in speed can only have occurred just short of the end of the runway."

The Commission finally dealt with a further submission by BALPA that, in the prevailing conditions, 5 mm. of ice could not have been produced on the wings by the snow which fell during the time the aircraft was at Munich. They said it was not relevant to inquire whether the snow and slush had turned completely to ice, as the aerodynamic assessment of the aircraft's performance did not depend on whether the layer was wholly, or only partially, ice. Moreover, the wings were supercooled by high altitude flight when the sleet fell upon them.

At the public inquiry it was submitted on behalf of Capt. Thain that we should give an affirmative answer to each of the three questions posed in our Terms of Reference. Of these, the first (whether Capt. Thain took sufficient steps to satisfy himself that the wings of the aircraft were free from ice and snow) occupied the greater part of the time spent in the hearing. Capt. Thain's counsel accepted that if in fact ice had been present on the wings during the third and fatal takeoff attempt, it would be difficult for us to say 'yes' to this question, and he led evidence and submitted arguments with a view to establishing that no ice was or could have been present on the wings at that time. This involved inviting us to say that the findings of the German Commission were wrong in this respect. We refer later to the question of the extent to which we feel our Terms of Reference enable us to disagree with those findings, but we say at once that this was clearly a relevant submission and was one properly put in the forefront of Capt. Thain's case.

Counsel also appreciated that a finding by us of no ice would not conclude the

first point in his favor, because theoretically circumstances might be such that although no ice formed, the prevailing conditions should have led a prudent pilot to take steps toward satisfying himself which might not have been taken. His submissions here were that Capt. Thain had done all that a reasonable captain could have been expected to do in the material circumstances.

Runway Check

A similar submission was made with regard to the second question (whether Capt. Thain took sufficient steps to ascertain whether or not in the conditions prevailing at the time the runway was fit for use). If the German report was correct in finding that the slight depth of slush on the runway had so little retarding effect as not materially to have affected the takeoff run, we would be unlikely to reach an adverse finding on this question, but the answer became much more debateable since it was submitted that both the state of the runway and the effect of that state were different from that found by the German Commission. This was, in part, derived from the cardinal submission that there was no wing icing, because that submission had necessarily to be accompanied by the argument that the unusual behavior of the aircraft must be attributed to a cause or causes other than icing, and the cause suggested was the drag effect of slush on the runway. If this submission was correct, the state of the runway was an effective cause of the accident and the submission made on the second question was that at the relevant date little was known about slush hazards and that in the then-prevailing state of knowledge Capt. Thain had acted reasonably in the steps he took as regards the runway although they led him to the belief, erroneous if his case was accepted, that it was safe to use. The submission, previously made, that ice had had a braking effect on the aircraft's wheels was not pursued before us, and we think it clear from the evidence of wheelmarks, given below, that this suggestion could not be supported: we refer particularly to the evidence that all the main wheels, after being locked, commenced to run freely at the same point, a fact consistent with brakes being released but quite inconsistent with retardation by ice packing the undercarriage.

On the third question (whether Capt. Thain took sufficient steps to ascertain the cause of the difficulties encountered on the first two attempts to take off before making a third attempt) we were presented with evidence as to the course of events, and it was submitted that Capt. Thain had correctly diagnosed the trouble and acted reasonably in deciding upon a third attempt.

The witnesses called before us were the following:

- **Capt. E. R. Wright,** captain of the BEA Viscount which landed at Munich 5 min. before the Elizabethan's final run.
- **W. N. Black,** the BEA station engineer at Munich.
- **Capt. R. T. Merrifield,** who gave evidence both as chairman of BALPA and as captain of a BEA Viscount which visited Munich two days after the accident.
- **Dr. H. L. Penman,** Ph.D., M.Sc., F.Inst.P., head of the Physics Department of Rothampstead Experimental Station, as to ice formation.
- **R. F. Jones,** a principal scientific officer at the meteorological office, Air Ministry, who attended the German Inquiry as meteorological adviser to the British accredited representative.
- **J. R. D. Kenward,** Superintendent of Performance and Analysis, Engineering Department, BEA.
- **G. M. Kelly,** a senior inspector, Accidents Investigation Branch, the British accredited representative at the German Inquiry.
- **Mrs. R. V. Thain,** B.Sc., as to the effect of fire extinguishing powder on the freezing point of water.
- **Capt. James Thain.**

In addition we were furnished with a large number of documents, including statements of some of the witnesses before the German Inquiry and including two papers, one prepared by Capt. Thain and one by BALPA, setting out reasoned submissions on matters in issue. We find it convenient in considering the evidence to classify it by subject-headings, and mention will be made hereafter of such of the documents as contributed materially to the views which we have reached. We now turn to a detailed consideration of the relevant facts, as a necessary preliminary to answering the three questions.

Meteorological Conditions

Two reports of the airport meteorological office at Munich, as furnished to the German Commission, are set out. On comparison of these with the times of the aircraft's stay at Munich, it will be seen that snow is recorded as falling continuously from arrival to last attempted departure, the fall being described as 'moderate' up to 1550 hr., 13 min. before the last run started, and as 'slight' thereafter. The witnesses spoke of the snowfall as having practically ceased at the time of the third run. The screen temperature, it will be noted, fell from +0.1C just before the aircraft's arrival to −0.2C at 1600 hr., just before its final run; and was recorded as precisely zero at 1500 hr., or 19 min. before clearance for takeoff was first obtained. The snow was lying on the ground but melting. Its condition on the runway will be considered later; at the apron it was slushy and footprints became filled with water.

Mr. Jones informed us that radio sonde observations made at 1300 hr. showed that at approximately 500 ft. altitude above the airfield the temperature was −0.2C and at approximately 2,000 ft. was −3.2C; at that time the screen temperature (2 metres above the ground) was +0.2C. It followed therefore that falling snow would not, at the material time, have encountered an ambient temperature above zero and commenced to melt until at or very near the ground. The German observers had described the snow at about the time of the accident as "wet snow, with big flakes" but Mr. Jones thought it unlikely that there was any water content in the snow, saying "it is quite common to refer to big flake snow as being wet. It is also easy to imagine it as such, because it frequently falls on a surface which is itself just above nought and it melts on impact."

The amount of snow falling during the

aircraft's stay can be judged from the fact that in the 7 hr. ending at 2114 the recorded precipitation was 5 mm. (the measurement is of the water equivalent). This 7-hr. period embraced 4 hr. of 'moderate snow' and 3 hr. of 'slight snow' and during the Elizabethan's stay of under 2 hr., most of it in 'moderate snow', Mr. Jones thought that probably not more than 2 mm. of precipitation could have fallen. We agree with his assessment, as regards the precipitation at the meteorological enclosure, which was 100 to 200 yards from the apron. Snowfall may vary in density within relatively small distances, and this assessment may not hold good of the runway, some 1,000 yards away from the apron. It is also important to note that temperatures may vary within short distances: Dr. Penman said "temperatures at the same level above ground can vary by several tenths of a degree quite easily . . . so that a temperature of 0C in the screen might be appreciably more or even appreciably less on the apron."

Wing Temperatures

The Elizabethan had flown from Belgrade at temperatures below —20C and had the wings not been artificially heated they would have been substantially below zero on arrival. We accept Capt. Thain's evidence that the wing heaters had been used on the descent to Munich, and indeed it would have been surprising if in the prevailing conditions they had not. During operation of the heaters the leading edges of the wings would have been well above zero, and probably substantial areas of the wing surface as well. The heaters cut out during landing and thereafter any residual heat would diffuse through the wings. We think it unnecessary to attempt further evaluation of the effect of the wing heaters in view of what we now have to say about the effect of refueling.

Wing Tanks

The wing tanks of the Elizabethan are of integral construction. Shortly after arrival 3,300 litres of fuel were uplifted; this is 726 gal., and the tank capacity is approximately 1,000 gal. Since, as we were informed, the aircraft was refueled to full tanks, the balance of some 274 gal. had arrvied with the aircraft and its temperature had been influenced by the supercooling at high altitude and by the use of the wing heaters. This temperature is problematical, but the temperature of the 726 gal. uplifted can be assessed. The fresh petrol came from bowsers which had been standing in the open, and the German Commission had information from the fuel suppliers that its temperature was "not above about 0.0C." The greater part of the volume of the wings consisted of petrol, in direct contact with the metallic structure of the wing, and of that petrol nearly three-quarters was at approximately the same temperature as the ambient air. Whatever the effect of super-cooling at altitude, and of the wing heaters, the temperature of the wings soon after refueling can have differed only fractionally from the prevailing air temperature.

The refueling commenced at 1425 hr. and finished at 1438 hr. It was at 1500 hr. that the screen temperature was recorded as precisely zero. It appears to us that in these circumstances the temperature of the upper surface of the wings must have then been in the vicinity of freezing point. Owing to the possibility of a fractional difference between air temperature at the screen and at the apron, and to the impossibility of assessing the exact temperature of the uplifted fuel, it is not possible to be precise to a tenth of a degree, but we do not think the wing can have differed from the screen temperature by more than half a degree.

Two of the witnesses at our inquiry, Mr. Black and Capt. Thain, gave evidence relating to the state of the wings. We were furnished with the written statements made to the German Inquiry by five further witnesses on this matter. A photograph of the aircraft taken from a window in the Terminal Building at 1550 hr. was reproduced in the German report, and a print of this photograph was supplied to us; it was taken from above and shows the starboard wing surface. This body of evidence falls into two groups, dealing respectively with the two periods when the aircraft was standing on the apron.

Aileron Check

As to the first period from 1417 to 1519 hr., Mr. Black said that his duties in connection with refueling took him on to the mainplane surfaces from shortly after arrival for about 25 min., during which he walked out as far as the wing lettering (registration letters on the starboard wing and corporation letters on the port wing) to check the ailerons. It was snowing lightly and the

PROBLEMATICAL RECREATIONS 42

All Droons are the same size and shape./ All Green Slackens are the same size and shape./ Twenty Droons just fill a Muldruff./ All Wallaxes contain Green Slackens./ A Green Slacken is 10% bigger than a Droon./ A Wallax is smaller than a Muldruff./ What is the largest possible number of Green Slackens in a Wallax?

—University of Cincinnati Engineer

Our subsidiary, Litton Systems, Inc., numbers among its facilities a laboratory for research in advanced communications techniques at 221 Crescent Street, Waltham, Massachusetts.

ANSWER TO LAST WEEK'S PROBLEM: The solution is fussy, but the chances are 161:154 that Jill is a liar.

wings were wet with melted snow, but there was no trace of snow adherence at any point: "When I was up on the wing, the wing was quite clean and as the snow was contacting the wing the snow was melting immediately on contact." Capt. Thain, on leaving the control office, met Capt. Rayment and afterward walked toward the aircraft and, in his own words, "studied the snowfall on the starboard wing."

His evidence continued: "I had to wait till I got fairly close before I could really identify any snow, and when I got close to the leading edge or to the wing, I saw a thin film of partially melted snow on the wing. It had thawed in places, and I could see the water from the melted snow running off the trailing edge right the way along. I continued walking toward the door, and found that two airport hands were trying to pump some water into the aircraft, but they had not got a suitable connection for the water hosepipe, and the chap could not stand up because of the slush on the ground. I stood there assisting him, and at the same time, with my face toward the direction of the trailing edge of the starboard wing. I suppose I stood there for about three minutes or perhaps four minutes." His position at that time, he added, was between the fuselage and the starboard engine nacelle, and during the three or four minutes he watched the thawed snow running off the trailing edge of the wing. Refueling had then ceased. The third witness on this part of the matter was Robert Wiggers, a refueler employed by the fuel company, whose written statement to the German Commission said "Refueling took place in driving snow. I noticed that the inner section of the wings was clear of snow, whereas there was snow lying on the outer sections."

More Observers

During the second period when the Elizabethan was stationary on the apron (1539 to 1556 hr.) it was observed from the second floor of the terminal building by three, perhaps four, persons attending the Air Navigation Services School at the airport. The three were Siegfried Schombel, Hubertus Wollner and Johannes Bogen; the fourth was Heinz Tismer, whose statement does not indicate his position. All four made statements that they observed the starboard wing from about 50 yards distance and saw snow lying on it. The German Commission attached particular weight to the statements of Schombel and Wollner, who gave oral evidence before them. Schombel's written statement includes this observation: "After the mechanic had given the "all clear" signal for taxiing, the snow remained lying on the wings, in spite of the slipstream. It was sticky wet snow." Wollner stated "I can testify with absolute certainty that there was wet snow on the outer section of the right wing. I cannot remember if there was any snow on the center section." The photograph mentioned above was taken by another student at the Air Navigation Services School and the print, which we examined, is consistent with the above statements. The wing surface is of unpainted metal, with the exception of the lettering and of a narrow band of anti-corrosive paint behind the engine exhaust. The photograph shows a distinct change in the color of the wing surface at the edge of the propeller slipstream, the outboard portion showing white while that behind the propeller is darker; moreover the registration letters do not appear in the print, either from some photographic effect of refracted light or because they were covered by snow. There were three ice indicator marks on the starboard wing, narrow black lines painted on the forepart of the wing, outboard of the propeller slipstream, and extending some distance back from the leading edge. These are visible in the photograph, plainly so at the leading edge but becoming less distinct as the eye proceeds across the wing surface.

Mr. Black did not examine the wing surface at this period. He walked round the aircraft but the wing surface was above his eye level. (As the German Report accurately stated "from outside the aircraft the wing surfaces cannot be seen at all from the front unless one stands in a raised position, and from the rear they can be seen only from quite a distance.") When the aircraft taxied away and reached a sufficient distance for the wing surface to be seen Mr. Black observed, according to his recollection, that the mainplane was clear of snow except for the wing tips. He told us he could not explain why there should be snow on the wing tips and not on the rest of the wing.

Capt. Thain did not leave the cockpit during this second visit. Speaking of Capt. Rayment and himself, he said "We both looked out of our respective windows and studied our respective wings and we found that we had lost that very thin film of partially melted snow which I had observed walking out to the aircraft, and from my seat the wing appeared quite clean." The engine nacelle interrupted his view of the inboard portion of the wing, but he could see the ice indicator marks and further outboard; his eye level was below the wing level, but he could see the leading edge, and, because of the curvature of the wing, he could also see the upper surface for the first tenth or twelfth part of its width. He emphasized that of the part of the wing within his vision he could see the metal with no snow upon it.

It may be possible to deduce the presence or absence of wing icing immediately prior to the accident from observed facts as to (i) the performance of the aircraft on its final run, or (ii) the condition of the wings after the accident. We deal later with the first of these sets of facts but can say at once that no useful conclusion as to icing can in our view be drawn from them. The second, however, is of prime importance: the German Commission attached considerable importance to deductions from what was ascertained after the crash, and a large portion of our Inquiry was taken up in submissions and evidence designed to show that the German conclusions were in this respect erroneous.

Wreckage Inspection

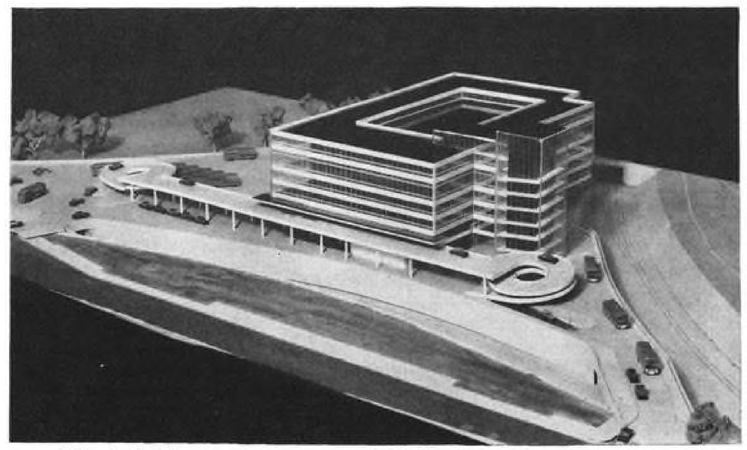
The evidence of Capt. Reichel, the West German Chief Inspector of Accidents, and his two assistants as given in the German Report, has already been summarized above. Their inspection of the wreckage was made by the light of arc lamps 6 hr. after the accident, and of the intervening period slight snowfall was recorded in the first 1½ hr. and moderate snowfall thereafter. The temperature at 2200 hr. was −3C. We were told by Mr. Jones and Mr. Kelly that the evidence of the German investigators was that they brushed powdery snow off the wings in places and exposed a layer of ice underneath. We inquired how the depth of that ice, stated as 5 mm., was measured, and we were informed that it was not measured. According to Mr. Kelly's evidence "Capt. Reichel . . . described how he had swept the snow off with his hand and found a rough layer of ice. That was all he said to begin with. Later on . . . he was asked to give some estimate of the depth or thickness of the ice and he said 5 mm. . . . I understood Goetz to say he examined the wing at one or two places simply by pushing his hand underneath the snow and feeling about with his fingers and he said at certain parts of the wing there was a rough layer of ice under the snow."

News Film

Mr. Kelly had seen a news film, which chanced to have been taken at the time of the inspection, showing Capt. Reichel brushing powdery snow off the trailing edge of the wing; he said "it would be possible to state that there was a layer of rough ice there, but I should not think you could make any accurate assessment of its depth without taking some such action as digging a pin in it or scraping it off and measuring it, and I have not heard that that was done at all." No evidence was proffered to us to controvert the German finding that the ice layer had not blended at all with the superimposed snow. As to the finding that there was no ice under the snow in the place behind the engines, the only criticism offered was that the whole wing was not examined but that the findings were based on "spot checks" made, according to counsel, in seven different places, and that these might be insufficient for the formation of a true picture.

We think that the primary facts as found by the German Commissions must be accepted, save that the depth of the rough ice layer is not established as 5 mm. and may have been substantially less. These findings of course relate to a time at or after 2200 hr. We also had the evidence, in written statements, of the three individuals who took part in rescue operations and whose testimony had been furnished to the German Commission after their Report. Karl-Heinz Seffer, aircraft mechanic of the German air force, in the process of freeing Capt. Rayment from the cockpit, climbed first on to the fuselage and then on to the starboard wing between fuselage and engine; he crossed this wing to its trailing edge, near the fuselage, where he got down. He said "While I was doing this I did not notice any deposit of ice on the fuselage or on this part of the wing. I was wearing rubber boots. I am particularly inclined to assume that there was no deposit of ice, because if there had been I would probably have slipped. I cannot say whether there was any ice on the wings outboard of the engines, nor did I notice any snow on the wings." His father, Otto Seffer, employed in the airport traffic service, stood on the upper surface of the fuselage: "There was no ice to be seen, if only because everything was smashed up." Gerd Skwirblies, PAA aircraft engineer, opened the port side of the fuselage, near the pilot's seat, with an axe. "At the spot at which I opened up the fuselage, there was, for certain, no ice. My companions were wearing rubber boots and were moving about on top of the fuselage, near the cockpit, without slipping. From this I conclude that there was no ice on the top of the fuselage either. Whether there was ice or snow on the wings, I cannot say. I was not looking for that. But I seem to remember that the leading edge of the wing was free of ice." These statements tend to establish that there was no ice behind or inboard of the engines immediately after the crash, which is not in conflict with the findings of the investigation at 2200 hr.

(Part II of this report will appear in a subsequent issue of AVIATION WEEK.)



Model Shows Proposed BEA London Terminal

Entry to the new British European Airways terminal at Kensington, London, as shown on this model, will be by a roadway raised to second-floor level on a steel and concrete deck. Building will be 96-ft. high and will cost $9.9 million. Subway will run under the structure. Designer is Sir John Burnet, Tait & Partners, London.

WHO'S WHERE

(Continued from page 23)

Changes

Joseph W. Antonides, chief of engineering services, and **Carl A. Steinhagen**, chief of engineering planning, Hamilton Standard Division of United Aircraft Corp., Windsor Locks, Conn.

George N. Krassner, product manager-astronautics equipment, Electronics Division of Stromberg-Carlson, a division of General Dynamics Corp., Rochester, N. Y.

Norman Hiestand, manager of the newly created Military Magnetics Department, Varian Associates, Palo Alto, Calif. Other scientists appointed to the new department: **Dr. James Arnold**, applied research; **Dr. Jean Rabier**, systems engineering; **T. L. Allen**, magnetometer engineering.

Dr. R. H. McFee, director of research, Advanced Research and Products Division, Aerojet-General Corp., Azusa, Calif.

James C. Smith, Jr., director of Chrysler Corp.'s Advanced Projects Organization, Detroit, Mich.

Percy Halpert, division manager, Sperry Phoenix Co. division of Sperry Rand Corp., Phoenix, Ariz.

Irvin B. Charnock, senior pilot, Ryan Electronics Division of Ryan Aeronautical Co., San Diego, Calif.

David M. Fleming, director of the newly formed marketing organization of United Technology Corp., Sunnyvale, Calif.

Paul W. Holt, assistant general manager-programs, Sikorsky Aircraft Division of United Aircraft Corp., Stratford, Conn. Also: **Oliver B. Chittick**, divisional controller; **George B. Hauslaib**, assistant staff accountant.

Frank J. Vargo, chief engineer, Airtronics International Corp., Ft. Lauderdale, Fla.

Thomas M. Robertson, manager of anti-submarine warfare planning, Vitro Laboratories, Silver Spring, Md.

Desmond E. Lally, director of marketing, Elastic Stop Nut Corp. of America, Union, N. J. Also: **Donald B. Sorenson**, general sales manager; **James B. Duke**, manager of aircraft and missile sales; **Bruce F. Linck**, assistant director of marketing.

Dr. Heinrich A. Schulze, head of the newly established Reliability Office at the George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Ala. Also: **George W. Noel**, head of the newly established Branch Audit Office at the NASA Marshall Space Flight Center.

Andrew P. Young, director-international sales and services, Raytheon Co., Waltham, Mass.

Charles Clauer, Jr., sales manager, Switlik Parachute Co., Trenton, N. J.

David H. Brown, general manager, Bendix-Pacific Division of The Bendix Corp., North Hollywood, Calif., succeeding **R. C. Fuller**, who continues as group executive in charge of Bendix-Pacific and Bendix Computer operations.

John W. Calvert, manager-marketing services, The Garrett Corp., Los Angeles.

Maj. Gen. James F. Whisenand, deputy chief of staff for plans, Air Research and Development Command, USAF, Andrews AFB, Md.

LIVE in Southern California!

GAS TURBINE ENGINEERS

Outstanding openings now for qualified

DESIGN ENGINEERS

CONTROLS ENGINEERS

COMBUSTION ENGINEERS

AEROTHERMO ENGINEERS

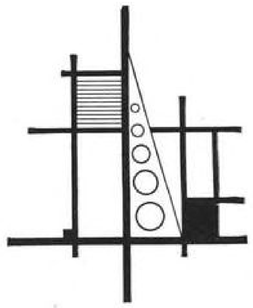
for development projects and for production projects

SOLAR OFFERS PERMANENT employment in a relatively new and exciting field with a tremendous growth potential. Solar is a vigorous, medium-size company founded in 1927. Solar gas turbine engines have already won an international reputation. There is an excellent balance between commercial and military contracts.

Living in San Diego is delightful. This favored area is smog-free, with the finest climate in the United States, and has unmatched recreational and cultural activities.

Applicants with BSME or AE plus 3 or more years experience are preferred. Inquire *now* for responsible positions in our rapidly expanding programs in gas turbines and airborne controls. Replies will be kept confidential. Write, giving resume, to LOUIS KLEIN, Department **E-705**, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY
A subsidiary of International Harvester Company



New, Important Openings at Martin for WEAPONS SYSTEMS ENGINEERS

Expanding missile and space programs such as Titan, Apollo, and Dyna Soar have created a number of immediate openings for senior engineers and specialists with five or more years experience in the following fields:

AERODYNAMICS
LIQUID ROCKET PROPULSION
STRUCTURAL DYNAMICS
STRESS ANALYSIS
THERMAL ANALYSIS
GUIDANCE & NAVIGATION

Also several positions for engineers with two or more years experience.

- Work in the environment of the leader in missile/space technology.
- Live in beautiful Maryland countryside bordering the Chesapeake Bay.

WRITE: Mr. D. C. Parsons, Manager
Professional Employment
Dept. 21
The Martin Company
Baltimore 3, Maryland

MARTIN
BALTIMORE

BIG THINGS ARE HAPPENING AT BOEING / WICHITA & WE NEED THE MEN TO MATCH THEM

If you are a qualified senior engineer in any of the three categories shown here, please contact us. Degree and experience required. Write in confidence to: Mr. Melvin Vobach, Dept. CN5, Boeing Airplane Company, Wichita 1, Kansas.

FLIGHT TEST ENGINEERS Rapidly expanding Flight Test Programs offer opportunities for experienced engineers in Program Planning, Program Operation and Program Analysis. Current programs include: (1) Aerodynamic Tests, including turbofan performance and missile drop characteristics. (2) Air Conditioning. (3) Bombing and Navigation. (4) Electrical Systems. (5) Electronics. (6) Equipment. (7) Special Programs, including structural integrity and missile platform development and evaluation tests. Positions are in Test Operations, Ground Operations, Instrumentation, Planning and Analysis.

OPERATIONS AND RESEARCH ANALYST B. S., M. S., or Ph. D. in Math, Physics, Electrical or Aeronautical Engineering to obtain data on the anticipated operational environment of the devices under study by New Product Development staff. Devise analytical models or procedures for estimating the operation and utility of new weapons system. Studies compare new product developments with competitive products, and demonstrate the anticipated utility to the customer.

DESIGN ENGINEERS FOR ANTENNA AND MICROWAVE COMPONENTS Experienced Electrical Engineers familiar with microwave components and circuitry, and/or antenna design are urgently needed. Positions are available in research and development programs, involving ECM and radar systems for airborne military application. This work requires a high degree of skill and a complete familiarity with both theoretical and practical aspects of these fields. A new and completely equipped microwave and antenna laboratory is available for this work.

BOEING / WICHITA

Please send me complete information about Boeing / Wichita and your new "Opportunities Brochure."

NAME

ADDRESS

CITY STATE

I have a degree(s) in the following:

EMPLOYMENT OPPORTUNITIES

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITION VACANT

Wanted Fixed wing or helicopter pilots and helicopter or fixed wing A & E mechanics. Write Umbaugh Aircraft, Fairchild Plant, Hagerstown, Md.

SELLING OPPORTUNITIES AVAILABLE

Mfgrs. Reps. contacting military, airlines, nefl.-missile industry in Dayton, N. Y., Wash., Miami, KC, Chicago, San Diego, L. A., SF, Etc. Acoustical microphone mask for jet engine ground crews. No competition. Advise lines, coverage, etc. RW-5701, Aviation Week.

Swedlow Inc., long a leader in the fields of aircraft transparencies and reinforced plastics is expanding its eastern sales organization. Qualified full time representatives needed for New England, Washington-Baltimore area, North Central States and Mid North West. Degree or equivalent business experience with or in in the aircraft or missile field. Technical background desired. Must be willing to travel. Submit resume to RW-5711, Aviation Week.

SELLING OPPORTUNITIES AVAILABLE

Salesmen—Engine Accessories, Airframe Parts: Sales & Service. Corporates, F.B.O., Airlines. N.Y.C. area. Own car. SW-5707, Aviation Week.

POSITION WANTED

Salesman Pilot B.B.A. degree accounting major engineering background northern Ohio location. PW-5695, Aviation Week.

SELLING OPPORTUNITY WANTED

Prominent Sales Engineering Agency, Interested representing Equipment Manufacturing to their O.E.M. and Airline Customers throughout Midwest and Southwest. Facilities brochure available. RA-5697, Aviation Week.

Don't forget the
BOX NUMBER
When answering the classified advertisements in this magazine don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.

WHERE TO BUY

Featuring additional products, specialties & services for the aviation field

FASTENERS FOR AIRCRAFT AND MISSILES
Immediate Delivery—AN—N.A.S.—M.S.—6 Digit
CERTIFIED TO GOVERNMENT SPECIFICATIONS
Bolts—Nuts—Rivets—Screws—Studs—Internal and External Wrenching Bolts—Dowel and Lock Pins
Mercury air parts co., inc.
9310 West Jefferson Blvd., Culver City, Calif.
Telephone—UPton 0-5923—Teletype—CVR CY 4136
TOUGH SPECIALS 10 DAY DELIVERY
MANUFACTURERS OF PRECISION HARDWARE

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED RATE:
The advertising rate is $31.00 per inch for all advertising appearing on other than on contract basis. Contract rates on request.
AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.
EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE:
$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $2.70 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.

Send NEW Ads or Inquiries to Classified Adv. Div. of Aviation Week, P. O. Box 12, N. Y. 36, N. Y.

FOR SALE
LEASE OR LEASE PURCHASE
Boeing Model 377
STRATO CRUISER
14 AIRCRAFT
FROM
$75,000.00
Flyaway
U. S. Certificated 112 seat configuration, full overseas equipped. Long range. 20 NTSO engines. Large Inventory of Supporting Aircraft and Engine Spare Parts.
WILLIAM STEINER
Phone: TOpaz 2-9355 or GArfield 6-4481
13010 Ardis Ave. Downey, California

SPECIALISTS
in all types of
INTEGRAL & CELL AIRCRAFT FUEL TANKS
Also wide experience in all types AIRCRAFT DE-ICER BOOTS
For immediate & dependable service we have a crew of experienced men for travel.
SEABOARD TANK SEALING CO.
340 Locust Ave. Oakdale, L. I., N. Y.
Tel: SAyville 4-5948

FOR SALE

5-55 Helicopters, 8-place or cargo plus crew completely overhauled, licensed and refinished, like new. Four available. N. A. Kalt. P. O. Box 1738, San Antonio, Texas, CApital 4-8434.

For Sale Allison Model V1710, 1100 H.P. aviation engines. Inspection invited, attractively priced. Vimalert Company, Inc., 807 Garfield Ave., Jersey City, N. J.

PBY 5A. This amphibian is converted for cargo—passenger use. FS-3404, Aviation Week.

CONVAIRS
Airline and Executive
Several of Both Available
Convair Trade-In
DOUGLAS DC-3
200 M.P.H. A12 Autopilot
Trades Accepted
DOUGLAS DC-6
DC-6A DC-6B
Finance or Lease
Also Grumman Twin Beech and Lockheeds in Stock
Contact:
Frederick B. Ayer & Associates, Inc.
250 Park Avenue, New York 17, New York

SALE OR LEASE
DOUGLAS DC-4AE
PASS/CARGO
Now available from owners, a long range, U. S. certificated DC-4 with 76 seats on track. This aircraft has 3,000 hours T.S.O. with low time P & W R-2000-7M2 engines. Gross T.O. 73,000 lbs., fully winterized, overseas radio, cargo door. Recently on Atlantic charters, contact:
NATIONAL AERO LEASING CO., INC.
P. O. Box 48-184 INTERNATIONAL AIRPORT
Miami, Fla.
Tel.—Newton 5-0734 Cable: Airland

"SEARCHLIGHT
IS
Opportunity Advertising
—to help you get what you want.
—to help you sell what you no longer need.
Take Advantage Of It
For Every Business Want
"Think Searchlight First"

DC-6 AIRFRAME PARTS
FOR SALE
Send for List And Quotations
FUZZY FURLONG
Box 2283 Miami 59, Fla.

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, NOVEMBER 28, 1960

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

LETTERS

Czech Centrifuge

I noted with extreme interest your notation of "Czech Centrifuge Turns at 6 Million rpm," (AW Oct. 10, p. 59).

It may be of interest to note that in early 1956, a centrifuge was built and operated by a co-worker and myself to a speed of over 1 million rps. or 60 million rpm. This device was then used for the remainder of the year to obtain data on the self diffusion rates of metals at room temperature using rotational speeds of 12 and 24 million revolutions per minute for periods of several hours. This was also a magnetic suspension and drive device with the rotor operating in a vacuum chamber.

Could it be that our foreign friends read our open literature and use it for their own investigations while we are so busy churning out "new" data that we haven't time to review published information until it is forcibly called to our attention by our friends?

This may be another example of our friends' "firsts" but it certainly lends thought to the idea that some of our previously published information may still be useful and should not be passed off as old hat.

LCDR J. J. Connelly, Jr., USN
Chevy Chase, Md.

Noise Suppression

In your issue of Nov. 7 on p. 146 you published a letter entitled "Jet Noise Challenge." This letter contains some mistaken notions, both technical and ethical in nature, which I would like to correct if possible.

Your writer quotes Dr. Bolt as saying "science offers no panacea for protecting communities against aviation noise." Your writer then goes on to criticize America's scientists and engineers for being unable to overcome the noise produced by jet transports. He further goes on to make the claim that "if a more efficient in-flight suppressor . . . cannot be produced . . . it is because the powers-that-be are more willing to ignore the feeling of the thousands of airport-area residents across the country than to tackle the challenge at hand."

Let us examine these statements. Quieting a jet engine is a particularly simple matter. An extremely effective noise suppression technique consists of filling the tailpipe with reinforced concrete. I am sure your writer, unless he is an inveterate railroad commuter, would not approve of this solution because of the mechanical interference it produces with the performance of the aircraft.

Obviously then, the solution to the aircraft noise problem must be weighed not only in terms of its effect on the noise produced but in terms of its effect on aircraft performance. Dr. Bolt's testimony simply pointed out that with present techniques and with present knowledge the thrust penalty which an efficient suppression system provides, requires a concomitant increase in engine power which, in turn, increases the noise and the cost of aircraft operation. Thus, at the present time, a far more fruitful approach is the programing of operations to minimize the disturbance produced by the noise rather than the noise itself.

Your writer's ethical misstatement, and the somewhat childish idea it attempts to convey, concerns the financial motivations of the firm of Bolt Beranek and Newman, Inc. Not only is Dr. Bolt no longer an employe of his firm, a connection which he felt ethically impelled to sever in order to devote his attention to the National Science Foundation (an organization from whom Bolt Beranek and Newman, Inc., neither solicits nor accepts funds because of similar ethical considerations), but the ultimate misstatement of our having "reaped a financial bonanza through the simple device of making noise surveys . . ." reflects a lack of knowledge of the fact that less than 3% of this firm's income is connected with airport noise surveys.

We hope that this "Glide Slope Resident" will be educated and/or reassured by the above facts. Should he have further questions, and wish to reveal his name, we will be most happy to answer them.

Jordan J. Baruch
Vice President
Bolt Beranek and Newman, Inc.
50 Moulton Street
Cambridge 38, Mass.

Fluorine Rocket Fuel

There are today many diverse R & D programs in the aerospace field. I am convinced that many of them, including the oxygen-hydrogen rocket, nuclear rocket, Dyna-Soar, and the supersonic airliner should be greatly accelerated over their present slow, leisurely development rate.

However, I think that one of these programs, the fluorine-hydrogen rocket, should be canceled. While the specific impulse of this combination is slightly higher than for the hydrogen-oxygen case, the difference is not large. Fluorine is an extremely reactive substance, and lining the tankage and plumbing against its chemical activity would be difficult. The exhaust product, hydrogen fluoride, is a deadly poison gas, while water from a hydrogen-oxygen rocket is harmless. Furthermore, nuclear rockets should become available almost as soon as hydrogen-fluorine systems could be developed, and these have a still higher specific impulse. With both systems available, the better performance nuclear rockets would be preferred, and the fluorine powerplants would probably rarely be called upon.

Frederick Pilcher
Lawrence, Kan.

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.

Shared Authorship

The article "Scientists Study Space Pilot Automation" by Erwin J. Bulban, which appeared in your issue of June 27, has just been brought to my attention. The summarization of our work was quite precise and factual. I was, however, seriously disturbed by the failure to include mention of my co-author.

Manfred Clynes was a full co-author in every sense and he shares equal credit and responsibility for the ideas propounded as well as the matter of their presentation. I would deeply appreciate it if note of this could be made in a future issue of Aviation Week in order to set the record straight.

Nathan S. Kline, M.D.
Director of Research
State of New York
Department of Mental Hygiene
Rockland State Hospital
Orangeburg, N. Y.

Stratocruiser Statistics

As an avid reader of your magazine for over 10 years, I have only praise for it—regarding the consistently interesting and comprehensive presentation of usually very accurate factual information as well as the workmanship of the magazine itself (e.g., proofreading, layout, etc.).

Yet, is it possible that the average Northwest Airlines Stratocruiser passenger would have taken one of these great, big, comfortable planes for a trip of only 22 mi.? (Shortlines, AW Sept. 12, p. 52.)

Herbert Popper
Consulting Engineer
Electronics Laboratory
General Electric Co.
Syracuse, N. Y.

(Instead of 62 million passenger miles, the item should have read more than 62 million plane miles. In spite of the nice compliment above, this is an error which was not caught in the copyreading.—Ed.)

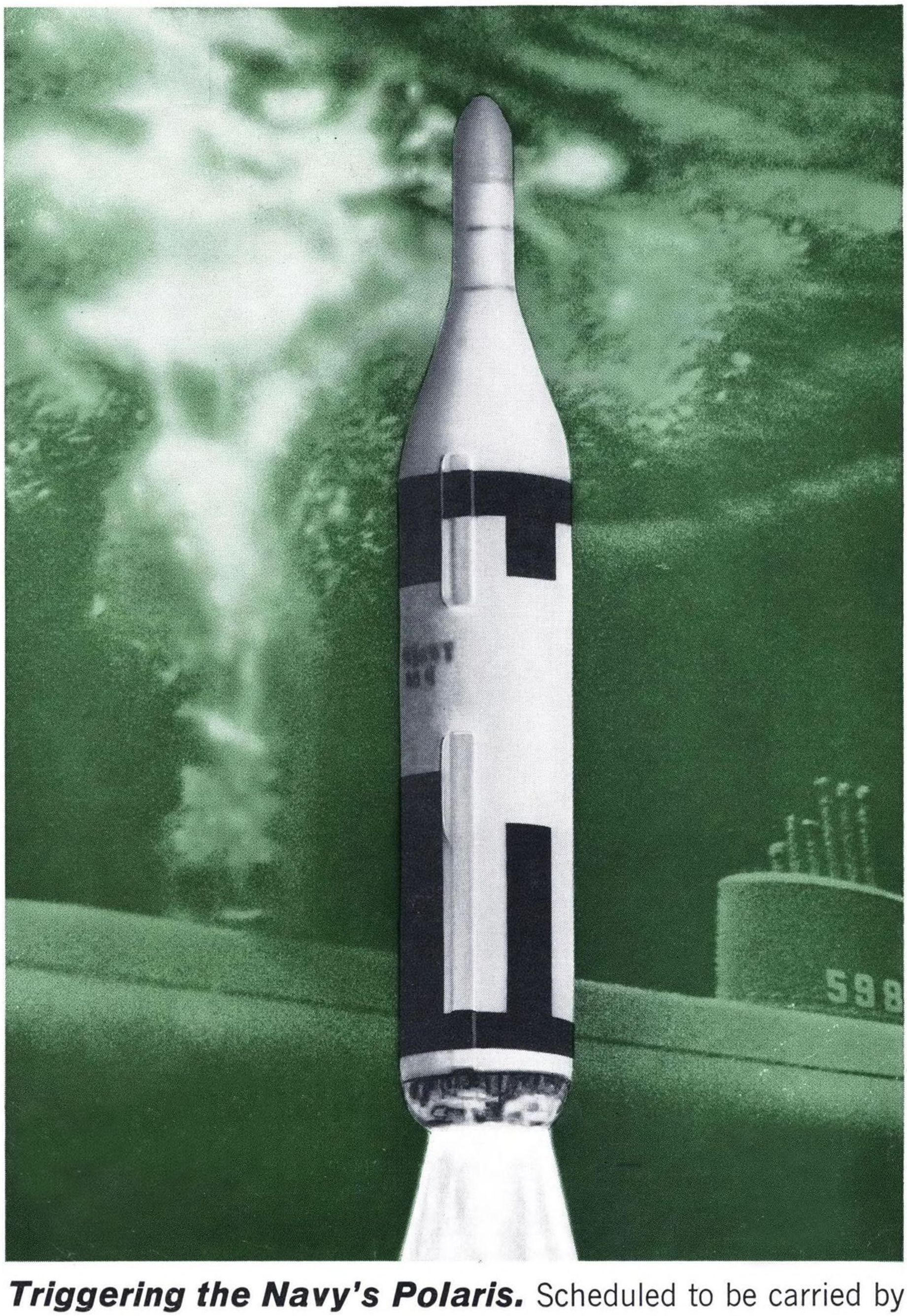
X-7 B-29 Retires

Starting on p. 58 of the Sept. 5 issue of Aviation Week, you have an article by Mr. William S. Reed concerning the X-7 missile research program carried on at Holloman Air Force Base, New Mexico, by the Lockheed Missiles and Space Division. This was quite an interesting and informative article, especially to this museum.

The B-29 aircraft, serial number 44-86402, which Lockheed used at Holloman for the major portion of this X-7 program has been donated to this museum by the Air Force and has been flight delivered here.

I thought it might be interesting for you to mention, as a follow up to the article by Mr. Reed, the final disposition of the aircraft at the expiration of the program. Congratulations on the top magazine in the field.

Howard G. White
President
The Aircraft Industries Museum, Inc.
Louisville, Ky.



UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

Triggering the Navy's Polaris. Scheduled to be carried by the Navy's latest nuclear-powered submarines, Polaris will extend American deterrent missile capability to every corner of the globe. Polaris is armed and fuzed by Avco.

Avco

AVCO CORPORATION, 750 THIRD AVENUE, NEW YORK 17, NEW YORK