

Aviation Week

Including Space Technology

75 Cents

A McGraw-Hill Publication

August 10, 1959

SPECIAL REPORTS:

- Lycoming T55
- MIT Guidance

Earth, Sun From GE
Thor Nose Cone



AEROJET
for
miss-distance
detection

FIRETRAC
firing error
trajectory recorder
and computer

Aerojet's FIRETRAC is a highly accurate system for measuring the relative trajectory, velocity, and miss-distance of a missile with respect to a target drone at which it is fired. This information permits rapid evaluation of missiles, guidance systems, fire control systems, and training operations. FIRETRAC configurations have been designed for the following drones: F6F, F9F, QF-80, KDA (Q-2), KDB, and QB-47. Installations for drones of other types can be provided as required. Designed and developed for the Navy's Bureau of Aeronautics, FIRETRAC is a product of Aerojet's Ordnance Engineering Division at Frederick, Md.

AEROJET-GENERAL CORP®

THE
GENERAL
TIRE

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY
(Plants at Azusa and near Sacramento, California; and Frederick, Maryland)
Engineers, scientists—investigate outstanding opportunities at Aerojet.

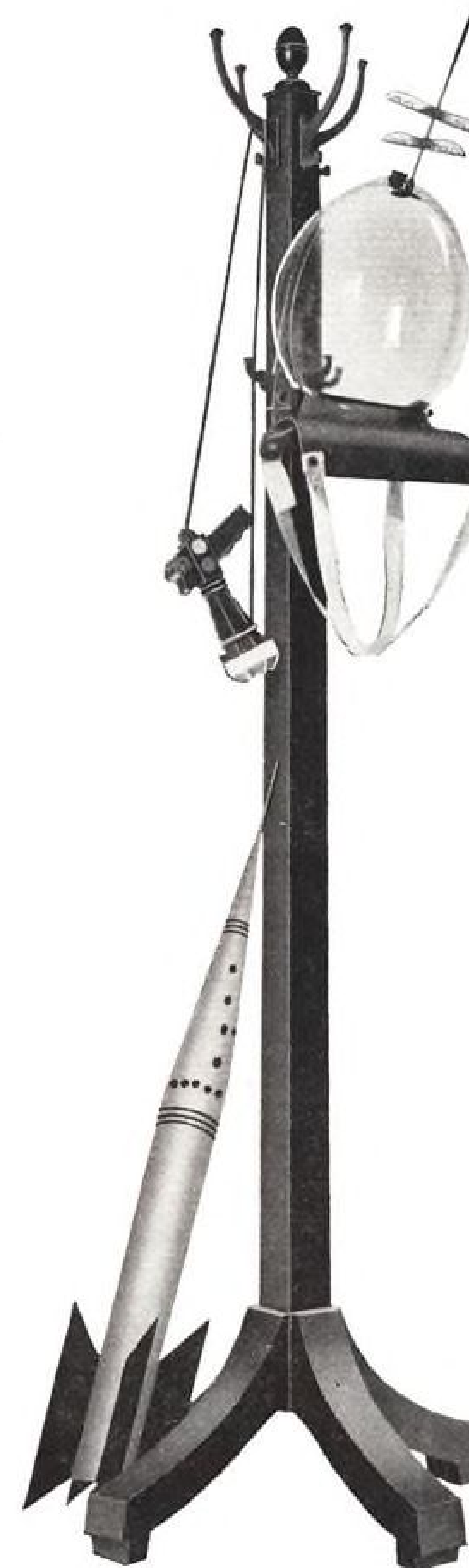
SOME DOWN-TO-EARTH THOUGHTS ABOUT THE SPACE AGE

Like all those who participate in the progress of aviation, we are awed by the prospect of the conquest of space. But before we rush headlong into the cosmic dust, let's hang up our space helmets for a moment for some sober reflection on what it will take to get there.

In the race toward tomorrow, look to the reliable as well as the swift. Our recent missile successes and "failures" clearly indicate that space conquest will depend not only on technological *breakthroughs*, but equally on the virtual elimination of mechanical *breakdowns*. Good hardware is even more important in the space age.

For over 16 years, Hydro-Aire has built a reputation on building better hardware for airborne vehicles. Today these products function reliably on virtually every type of aircraft. The same ingenuity and dependability that made these products possible is now the key to solving the problems of more hostile environments, more stringent operating conditions.

The men whose space vehicles will be equipped with these products, can don *their* space helmets with confidence.



Challenging positions are now open for qualified design engineers on Hydro-Aire's expanding staff. Submit inquiries to Mr. D. B. Nickerson, Chief Engineer, Hydro-Aire, 3000 Winona Avenue, Burbank, Calif.

Producing Controls for Every Basic Airborne System

HYDRO-AIRE
BURBANK, CALIFORNIA
Division of CRANE CO.
Anti-Skid Braking Systems • Fuel
System Controls • Pneumatic
Controls • Hydraulic Controls
Actuation Systems • Electronic
Devices

SARGENT

SERVO-SYSTEMS OF FORCE CONTROL



With 38 years acceptance Sargent builds precision linear and rotary hydraulic, pneumatic, mechanical and electronic systems of force control to meet successfully the increasingly high requirements of marine, aircraft, missile, petroleum and industrial use. From original idea to finished product — SARGENT.

SARGENT FACILITIES

Research
Design
Development
Testing
Qualifying

Manufacturing
including —
Machining & Grinding
Heat Treating, all types
Plating, all types
Inspection
Assembly

SARGENT BUILDS

Servo-Systems
Hydraulic Systems
Integrated Packages
Hydraulic Actuators
Hydraulic Valves

Hydraulic Pumps
Hydraulic Motors
Pneumatic Cylinders
Pneumatic Valves
Ball Screw Actuators
Gear Actuators
Gear Accessory Boxes
Electronic Systems

Standard of Excellence

"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.

— U.S. Supreme Court



Since 1920

ENGINEERING CORPORATION

MAIN OFFICE & PLANT, 2533 E. FIFTY-SIXTH ST.

HUNTINGTON PARK, CALIF.

AVIATION CALENDAR

Aug. 16-17—Annual Reunion, the Early Birds, Lakefront Airport, Cleveland, Ohio.
Aug. 17—First National Ultrasonic Symposium, Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif.
Aug. 18-21—Western Electronic Show & Convention, Institute of Radio Engineers, Cow Palace, San Francisco, Calif.
Aug. 23—Downtown Baton Rouge Exchange Club's Sky-O-Rama, Baton Rouge, La. Program includes the Blue Angels and military displays, both flying and static.
Aug. 24-26—Gas Dynamics Symposium, American Rocket Society, Northwestern University, Evanston, Ill.
Aug. 24-26—Institute of the Aeronautical Sciences' National Specialists Meeting, a symposium on anti-submarine warfare, (classified), San Diego, Calif.
Aug. 24-27—Fourth Symposium on Ballistic Missile and Space Technology, Los Angeles, Calif. Sponsors: USAF's Ballistic Missile Division; Space Technology Laboratories, Inc.
Aug. 27-28—International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England.
Aug. 31-Sept. 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex.
Aug. 31-Sept. 3—Conference on Stratospheric Meteorology, American Meteorological Society, Curtis Hotel, Minneapolis, Minn.
Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.
Sept. 1-2—Conference on physical chemistry in aerodynamic and space flight, University of Pennsylvania, Philadelphia, Pa. Sponsors: Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Dept.
Sept. 2-4—1959 Cryogenic Engineering Conference (Continued on page 6)

AVIATION WEEK Including Space Technology

August 10, 1959
Vol. 71, No. 6

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. Publication Offices, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary. Officers of the Publications Division: Nelson L. Douglass, President; Harry L. Waddell, Senior Vice President; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office. ©Copyright 1959 by McGraw-Hill Publishing Co., Inc. All rights reserved. Cable Address: "McGraw-Hill New York." Publications combined with AVIATION WEEK including SPACE TECHNOLOGY are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

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 Aviation Week, including Space Technology, 330 West 42nd Street, New York 36, N. Y.

AVIATION WEEK, August 10, 1959

Pressure Potentiometers for...

HIGH TEMPERATURES and CORROSIVE FLUIDS



Type P103
Pressure Potentiometer
shown ¾ size

New Trans-Sonics* Pressure Potentiometers, Type P103, measure pressures of corrosive fluids such as red fuming nitric acid (RFNA) and unsymmetrical dimethylhydrazine (UDMH) for telemetry and control applications at ambient temperatures up to 600F.

Corrosive fluids are contained by a welded Inconel-X bellows which actuates a dynamically balanced mechanism. This mechanism is hermetically sealed in a stainless steel case for protection against corrosion and other environmental hazards.

Accurate and reliable performance has been proven under the following conditions typical of missile environments: *Random Gaussian Vibration* 0.1g²/cps, 15 to 2,000 cps; *Acceleration* 75g; *Shock* 75g.

Flexibility of installation is assured by small size and light weight. Dimensions are 1 7/8" diameter by 1 7/8" long. Weight is only 6 ounces. Standard ranges are 0-100 and 0-150 psia . . . other ranges to special order. Write for Technical Bulletin P103 to Trans-Sonics, Inc., Dept. 7, Burlington, Mass.

*TRADEMARK

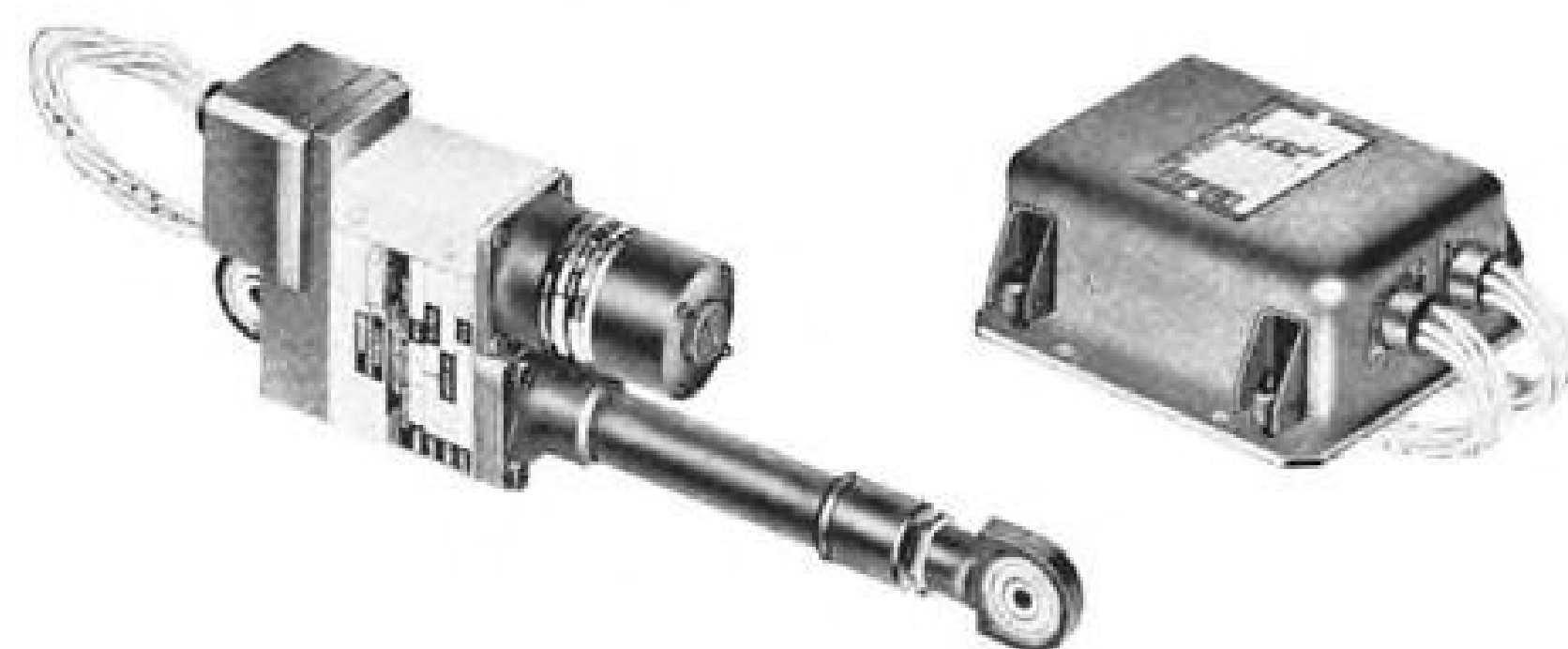
TRANS-SONICS

Precision Transducers

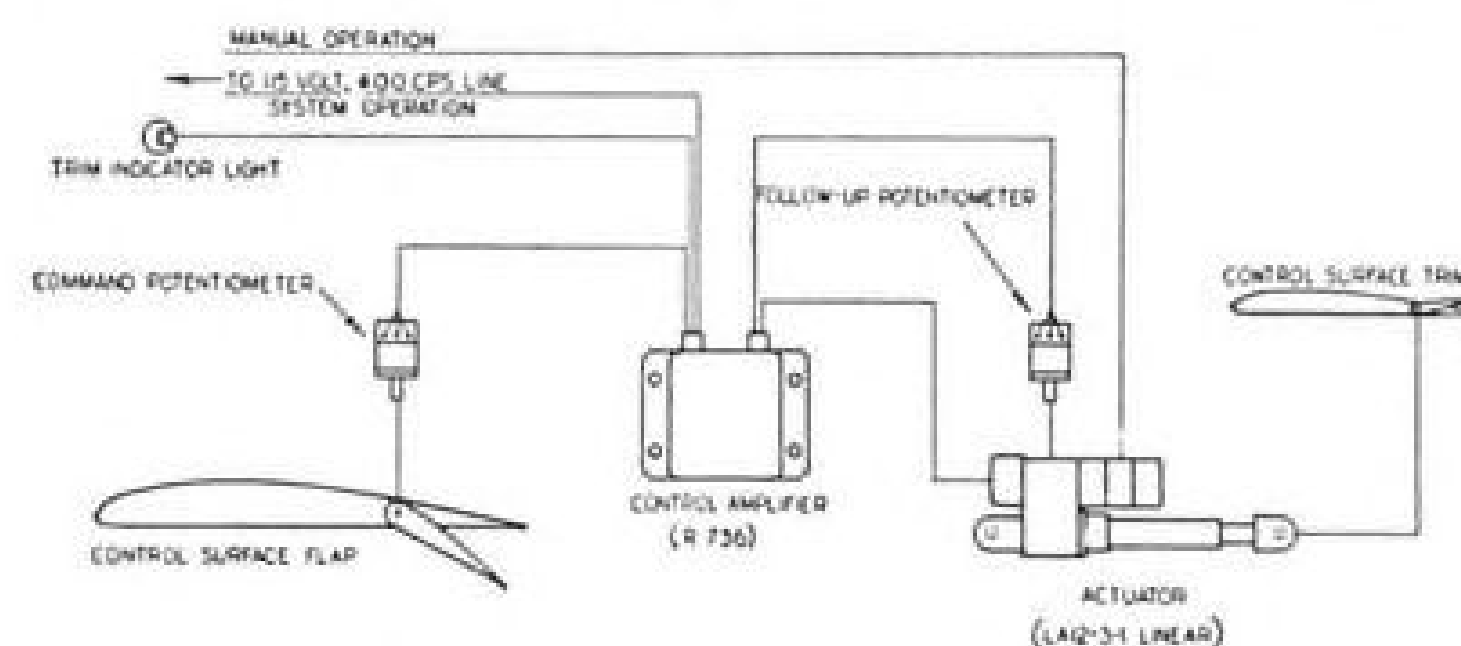
ISA SHOW
Booth No. 117

AIRBORNE

electromechanical system provides automatic trim control for T-38



Schematic diagram shows Airborne automatic horizontal stabilizer trim control system on Northrop T-38 Talon. Control is achieved by d-c signals from 1000-ohm potentiometer on flap and followup from similar potentiometer on actuator. System functions only when flaps are lowered, with signal light indicating completion of adjustment for flap position selected.



Automatic horizontal trim control on Northrop's T-38 Talon high-performance jet trainer is provided by an Airborne electromechanical system comprised of an electronic control amplifier and an Airborne modular-type linear actuator. The system functions when the flaps are in use. At other times, the actuator is manually controlled by the pilot.

Sealed relays especially selected for their reliability characteristics are used in the output stage of the amplifier to control the 115-v, 400-cycle supply required by the brake-equipped actuator. The step function thus provided assures positive release of the actuator brake.

Control is simply achieved by d-c command signals generated by a 1000-ohm potentiometer on the

wing flap and followup from a similar potentiometer on the actuator. Hysteresis of the control circuitry is deliberately broad to preclude hunting.

The entire system is designed for extreme compactness and light weight. The actuator is the smallest of Airborne's modular-design series, weighing only 1.4 lb., yet providing 75 lb. output. The control box measures only 1.6 x 4.2 x 3 in. and weighs just 1.2 lb.

Whatever your requirements in electromechanical control systems, it will pay you to check with Airborne. We have the engineering capabilities and production facilities to meet almost any need. Write, phone or wire any one of our offices.



Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY • Offices in Los Angeles and Dallas

AVIATION CALENDAR

(Continued from page 5)

- ference, University of California, Berkeley, Calif.
- Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.
- Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.
- Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences; Office of Naval Research; National Science Foundation.
- Sept. 14-15—Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Society of Automotive Engineers, Milwaukee Arena, Milwaukee, Wis.
- Sept. 14-16—14th Midwest Quality Control Conference, American Society for Quality Control, Sheraton Hotel, French Lick, Ind.
- Sept. 16-17—Western Regional Meeting on Frontiers of Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.
- Sept. 17-18—Conference on Effects of Nuclear Radiation on Semiconductors, Western Union Auditorium, New York, N. Y. Sponsor: Army Signal Corps.
- Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago, Amphitheater, Chicago, Ill.
- Sept. 21-22—Conference on Planning and Designing of Urban Helicopter Facilities, Institute of Aeronautical Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.
- Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.
- Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.
- Sept. 28-30—1959 National Symposium on Telemetry, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers' Professional Group on Space Electronics & Telemetry.
- Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.
- Oct. 5-7—Seventh Anglo-American Aeronautical Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.
- Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.
- Oct. 6-8—12th Annual Meeting, National Business Aircraft Assn., Hotel Leamington, Minneapolis, Minn.
- Oct. 6-9—International Symposium on High-Temperature Technology, Asilomar Conference Grounds, Monterey Peninsula, Calif. Sponsor: Stanford Research Institute.
- Oct. 8-10—Society of Experimental Test Pilots' Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif. Third Annual Awards Banquet, Oct. 10.
- Oct. 12-14—15th National Electronics Conference, Hotel Sherman, Chicago, Ill.
- Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.

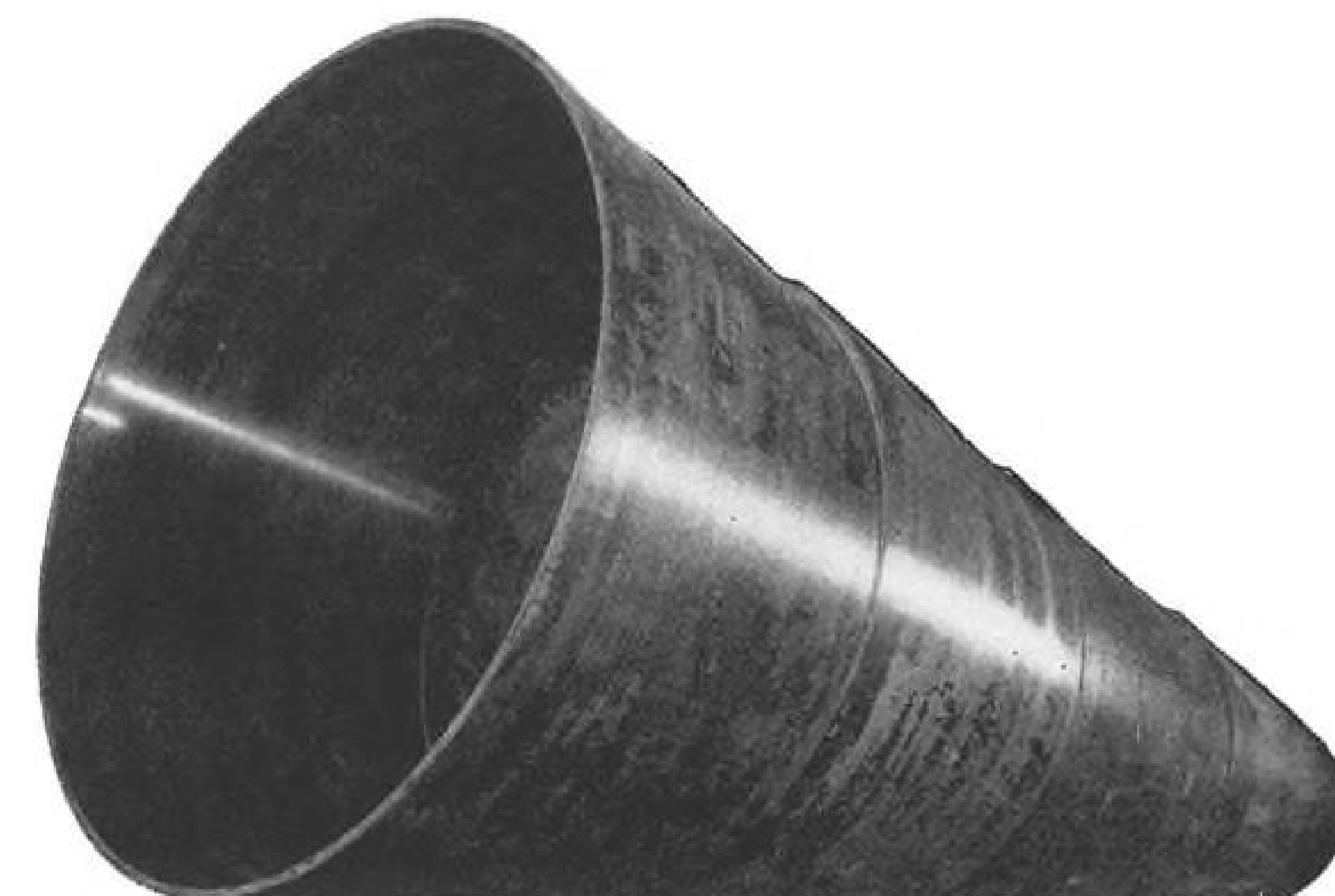
B.F. Goodrich

WHAT IS IT? Probably the biggest homogeneous void-free laminate ever built . . . a B. F. Goodrich ablation shield for an experimental re-entry vehicle designed and built by General Electric to be test flown on an Air Force Atlas ICBM. Fabricated by a special B. F. Goodrich winding technique, the shield contains about five miles of high-temperature resin tape. This fabricating technique, which is also being used being for many other specialized B. F. Goodrich products of various types and sizes, completely eliminates precision matched metal molds, cuts tooling costs by hundreds of thousands of dollars, and saves plenty of lead time. Autoclave curing replaces massive high pressure presses.

Throughout the construction of this re-entry vehicle shield, B. F. Goodrich maintains constant quality control of resin content and residual volatiles. Modern radiological facilities are used for final checking.

The fabrication and curing of such huge void-free parts illustrates the advances made by B. F. Goodrich in producing high-temperature, reinforced plastic products. So if you're up in the air and want down-to-earth answers on plastic laminate constructions, contact *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. AW-89, Akron, Ohio.*

B.F. Goodrich aviation products





SIZE 8 RESOLVER



SIZE 8 STEPPER MOTOR



SIZE 8 SERVO MOTOR



SIZE 8 MOTOR TACHOMETER

NOW! all four

SIZE 8 RESOLVER—The first winding-compensated Size 8 in the field* Maximum functional error 0.1% (accuracy). Null voltage does not exceed 1 millivolt per volt input. Available with BuOrd type shaft.

| | IR8N4-600 | IR8N4-601 | *IR8W4-602 |
|--------------------------------|------------|-------------|------------|
| Maximum Input Voltage | 26 | 26 | 26 |
| Effective Resistance (Ohms) | 1180 | 5787 | 840 |
| Input Impedance (Ohms) | 130 + j370 | 467 + j1580 | 220 + j370 |
| Total Null Volt. (MV/V Input) | 1 mv/v | 1 mv/v | 1 mv/v |
| Maximum Functional Error (%) | .1 | .1 | .1 |
| Transformation Ratio (Degrees) | | | |
| Rotor to Stator | .94 ± .02 | .47 ± .02 | .87 ± .02 |
| Rotor to Compensator | --- | --- | .99 ± .02 |

SIZE 8 STEPPER MOTOR—Stepping rate up to 120 pulses per second. Low rotor inertia enables unit to be high speed type.

FEATURES

1. High reliability, no mechanical detent.
2. Precision stainless steel ball bearings for long life with no radial play.
3. Low gear train shock resulting in longer gear life with less backlash.
4. No brushes to wear out.

| | |
|--------------------------------------|---------------|
| Stepping Rate (Pulses per second) | 80 |
| Torque (in.-oz.) at 90° | 0.9 in. oz. |
| Rotor Inertia (Gm. Cm ²) | .7 |
| Voltage | 26 volts |
| Current | .260 |
| Temperature Range (Degrees C) | -55° to +100° |

SIZE 8 SERVO MOTOR—Available with stall torque up to .42 in.-oz. Max. weight 1.5 ounces.

| | |
|---|---------------|
| No Load Speed (RPM) | 6500 |
| Stall Torque (in.-oz.) | 0.33 |
| Rotor Inertia (Gm Cm ²) | 0.75 |
| Acceleration at Stall (rad/sec ²) | 31,000 |
| Temperature Range (Degrees C) | -55° to +125° |

| | FIXED PHASE | CONTROL PHASE | |
|---------------------|-------------|---------------|----------|
| | | Series | Parallel |
| Voltage | 26 | 26 | 13 |
| Frequency (CPS) | 400 | 400 | 400 |
| Power Input (Watts) | 3.0 | 3.0 | 3.0 |

in hand... a family of precision-bred Size 8 servo components

SIZE 8 MOTOR TACHOMETER—Units have high (100°C) and low (-55°C) temperature range. Fixed Phase Voltage 26V.

MOTOR

| | |
|---|--------------|
| No Load Speed (RPM) | 9,000 |
| Stall Torque (in. oz.) | 0.25 |
| Rotor Inertia (Gm Cm ²) | 1.0 |
| Acceleration at Stall (Rad/Sec ²) | 17,500 |
| Temp. Range (Deg. C) | -55° to +85° |

TACHOMETER

| | |
|---------------------------------|------|
| Reference Voltage | 26 |
| Power Input (watts) | 3.0 |
| Output Voltage (volts/1000 RPM) | .3 |
| Null Voltage (volts) | .012 |

Unparalleled for accuracy, reliability and precision, American Electronics Instrument Division's versatile new family of Size 8 components is another instance in the continuing series of advanced products introduced to meet the most critical demands of the industry.

Distinguished by utmost reliability, each ultra-precision unit—Resolvers—Stepper Motors—Servo Motors—Motor Tachometers—meets the rigid requirements of MIL-E-5272 and MIL-E-5400.

Corrosion resistant frames encase a compact unit of such reliability that ultimate saving in weight and space is achieved without sacrifice of accuracy. Also available in stainless steel.

Write for brochure detailing full particulars on Size 8 Servo Components.



AMERICAN ELECTRONICS, INC.

INSTRUMENT DIVISION

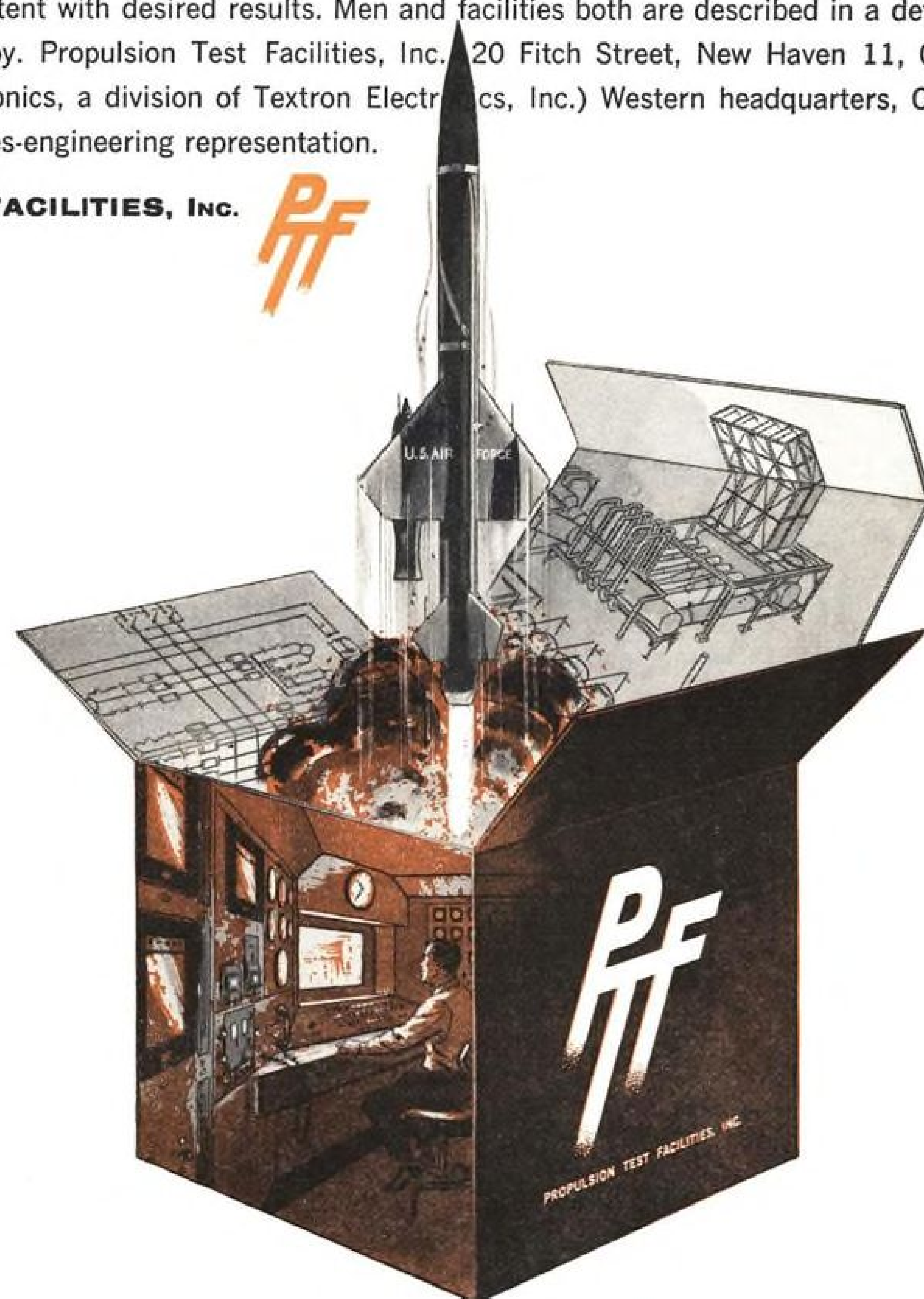
9503 W. JEFFERSON BLVD., CULVER CITY, CALIFORNIA - UPTON 0-5581
TWX: CULVER CITY CAL 7423

*A single source for
force simulative
test facilities*

CONCEPTION+DESIGN CONSTRUCTION+CHECK OUT

Propulsion Test Facilities offers a single source for the creation of multi-force, omni-environmental test facilities, such as engine test cells . . . complex space simulating cells . . . airframe and missile flutter and fatigue test equipment. More important, it provides the broad scope of test knowledge and practical experience required for such responsibility. The qualifications of the men available to you through PTF—men who themselves have been long time users of such equipment in the industry—guarantees maximum reliability and accuracy of test data, maximum convenience and safety for operating personnel, maximum economy consistent with desired results. Men and facilities both are described in a detailed brochure. Write for a copy. Propulsion Test Facilities, Inc., 20 Fitch Street, New Haven 11, Conn. (An affiliate of MB Electronics, a division of Textron Electronics, Inc.) Western headquarters, Culver City, Calif. World-wide sales-engineering representation.

PROPULSION TEST FACILITIES, INC.



CESSNA U-3A . . . FASTER, MORE ECONOMICAL MOBILITY FOR TOP LEADERS

Faster than many larger transports—and much more economical in initial cost, operation, and maintenance—Cessna's U-3A is now used extensively by the U. S. Air Force. Its exceptional performance and range provide high mobility for top leaders. And its easy adaptability as a light cargo carrier assures efficient, full-time service. Result: The Cessna U-3A makes substantial savings for the U. S. Air Force.





Douglas DC-8 jet transport of United Air Lines has windows measuring approximately 17" x 21", double-glazed and triple-glazed with PLEXIGLAS acrylic plastic. Outer panels are stretched PLEXIGLAS 55.

...aviation's standard transparent plastic

PLEXIGLAS is a trademark, Reg. U.S. Pat. Off. and in principal countries in the Western Hemisphere.

In Canada: Rohm & Haas Co. of Canada, Ltd.,
West Hill, Ontario



Chemicals for Industry
**ROHM & HAAS
COMPANY**
WASHINGTON SQUARE, PHILADELPHIA 5, PA.

"WHERE THERE'S PROGRESS, THERE'S PLEXIGLAS"

Johns-Manville announces new **MIN-KLAD** Insulation!

This one new product answers 4 basic thermal and mechanical requirements

low conductivity

high heat capacity plus erosion resistance

high strength

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone.

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is actually

lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient

temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

JOHNS-MANVILLE
PRODUCTS



MICRO SWITCH Precision Switches

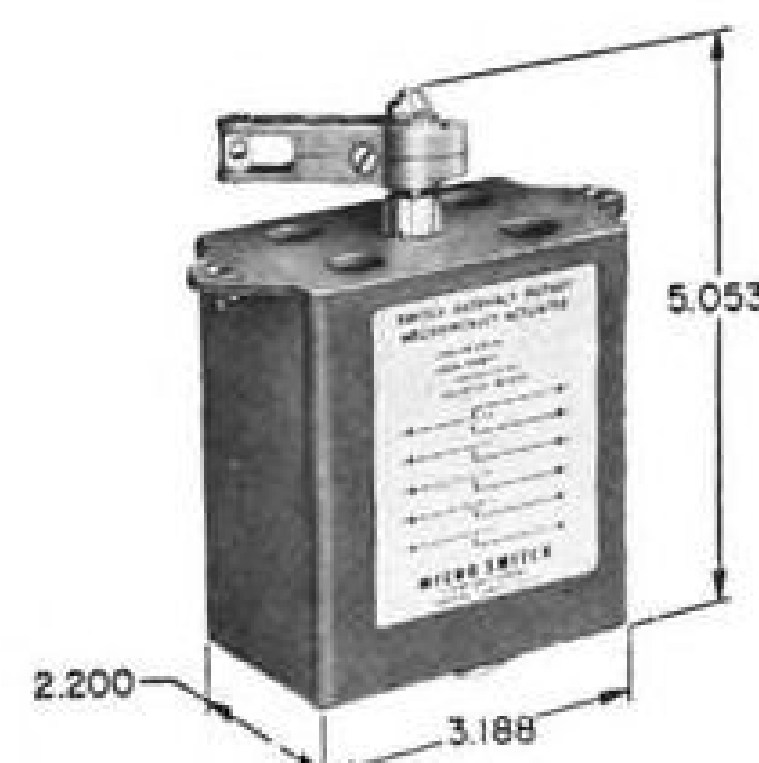
Assembling a 20-pole "2EK" series. Composed of 20 small, high-capacity V3 switches.



Multiple switch assemblies for aircraft applications



Series "2EK" 20-pole switch assembly



Series "1EK" 5-pole switch assembly

MICRO SWITCH not only offers aircraft designers precision switches of the utmost dependability . . . but provides them in compact assemblies to meet specific multiple circuit requirements.

The "EK" Series, two of which are shown here, is typical of this MICRO SWITCH skill in providing a complete package ready to install.

These "EK" assemblies, one a 20-pole and the other a 5-pole, have proved invaluable in aircraft armament applications. They are compactly wired to standard connectors. Circuits are plainly marked, and the assembly sealed in an environment-proof housing. Switch assemblies shown are operated by positive-drive, non-spring return rotary levers. These assemblies have close-tolerance on-off action. Height of the larger 20-pole switch is only 7.840" which permits mounting in small space.

MICRO SWITCH has developed a large number of switch assemblies to meet specific aircraft design problems. If one of those now available does not solve your multiple circuit problems, our engineers and technicians have the skill and experience to develop an assembly for your need. Save time. Save money. Consult MICRO SWITCH.

MICRO SWITCH . . . FREEPORT, ILLINOIS

A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario



Honeywell

MICRO SWITCH Precision Switches

GENERAL MOTORS HEXES HEAT ON THE VOODOO!



Harrison aircraft oil coolers—another quality product of General Motors research.

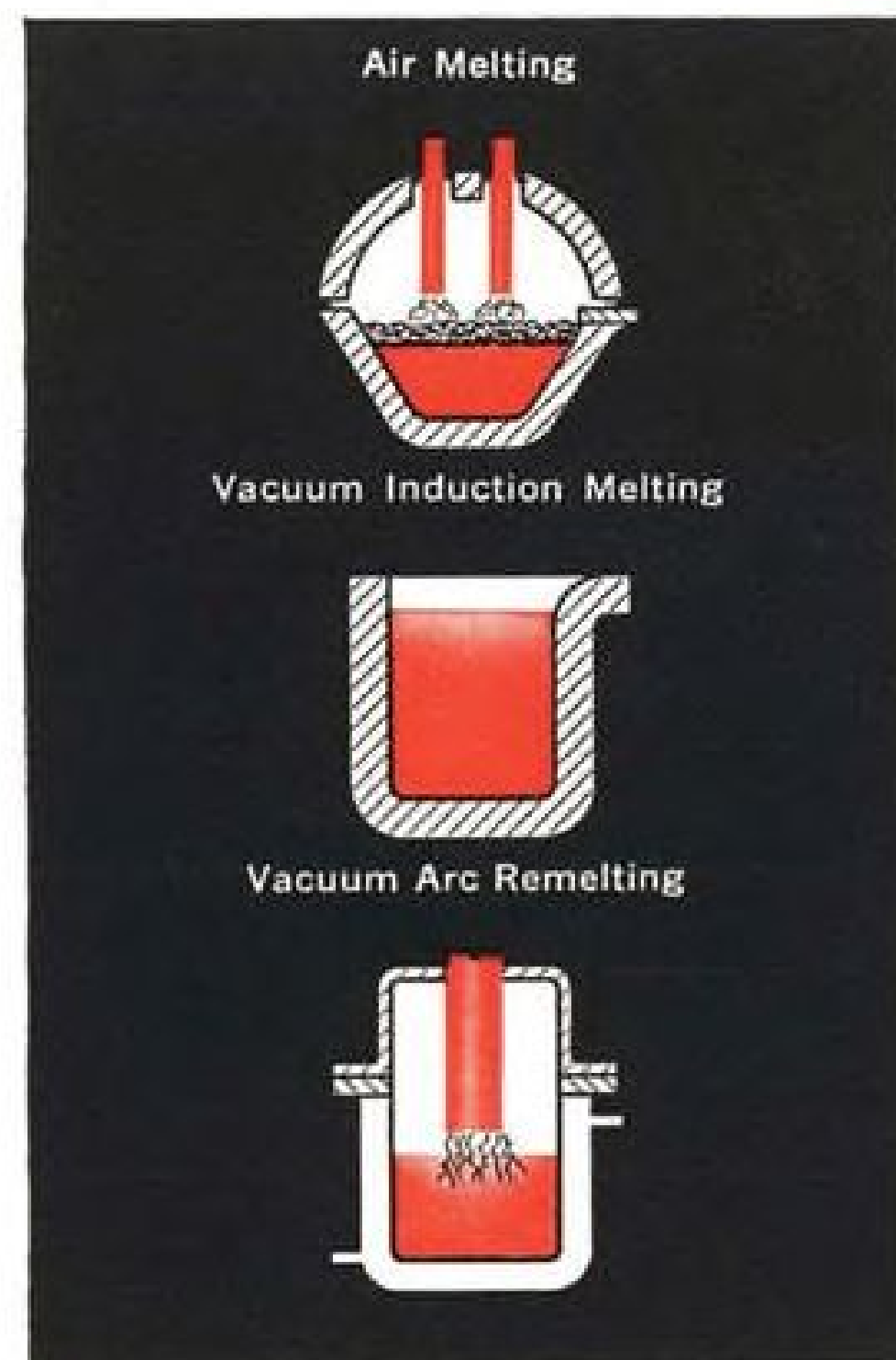
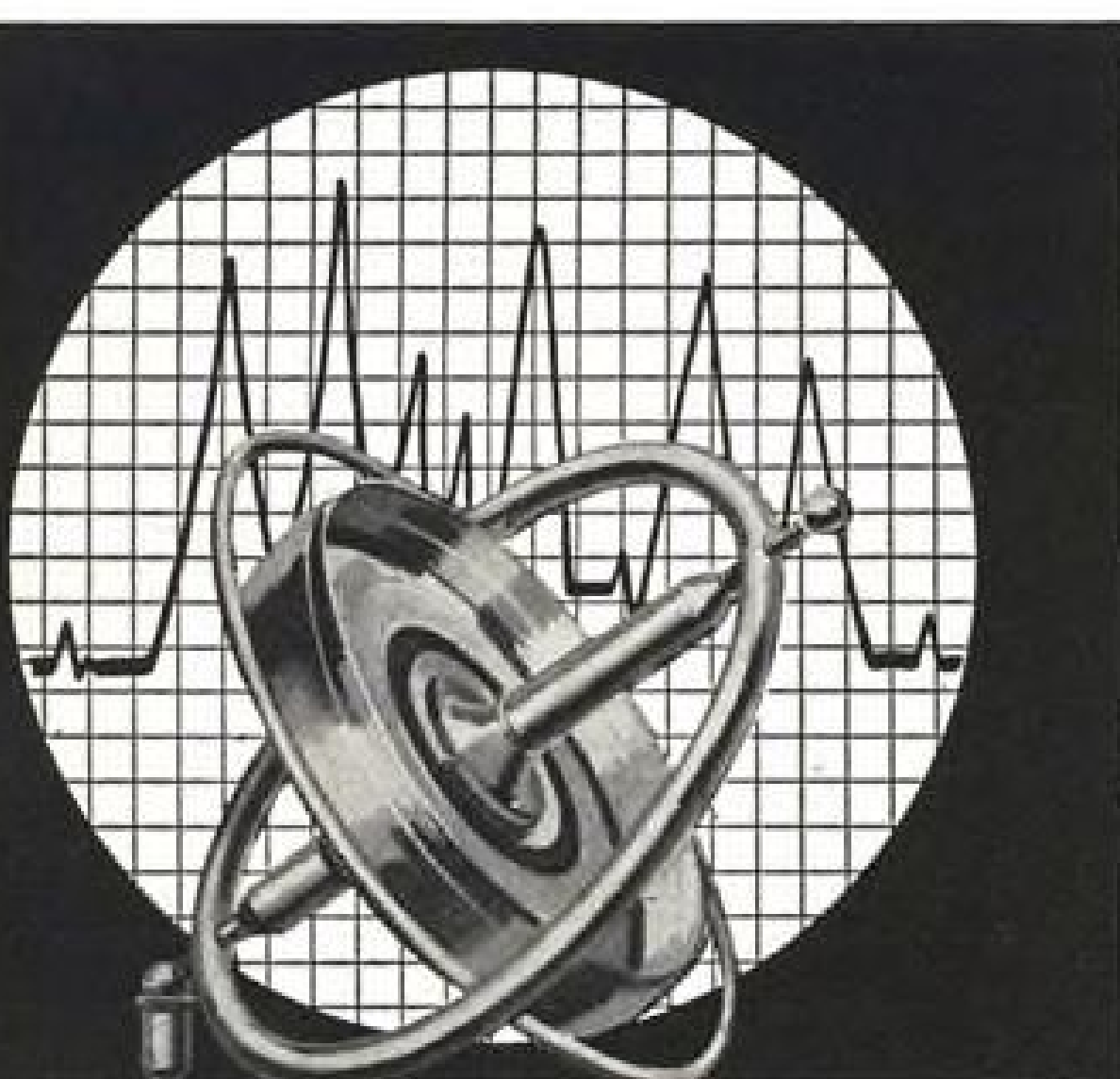
HARRISON OIL COOLERS CONTROL VITAL TEMPERATURES ON McDONNELL F-101B VOODOO—POWERFUL NEW INTERCEPTOR!

Like magic, the new Voodoo F-101B streaks to its target with an amazing combination of speed and long range. Such outstanding performance demands dependable operating temperatures *every second*. That's why rugged and reliable Harrison heat exchangers were selected to cool the engine oil on this supersonic all-weather interceptor of the Air Defense Command. Built and backed by General Motors, Harrison heat-transfer equipment provides dependable temperature control—in every type of industry, every line of defense. Harrison, with over 47 years in the heat-exchanger field, is your assurance of top quality in product and performance. If you have a cooling problem, look to Harrison for the answer.



AIRCRAFT, AUTOMOTIVE, MARINE AND INDUSTRIAL HEAT EXCHANGERS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK



a. Titanium slabs are heated prior to rolling into continuous sheet coils. Crucible's increased capacity for producing high purity metals, in all sizes and mill forms, is substantially reducing costs and delivery times.

b. Vacuum Melted Alloys are specified for gyroscope balls used in navigational and fire direction systems. The metals' improved properties facilitate miniaturization.

c. Titanium helium storage bottles for ICBM Atlas. Titanium, which must be vacuum melted, was selected because of its high strength weight ratio, cold-resistant properties and corrosion resistance.

d. Basic Melting Processes. Vacuum induction melting produces "purer" metals than conventional air melting because it eliminates all sources of contamination except the crucible. Vacuum arc remelting eliminates the crucible and permits production of ingots up to 18,000 lbs.



VACUUM MELTING CREATES

SUPER-DUTY METALS

Marked improvements in properties produced by High-Purity Metallurgy

Behind the development of space-age metals with entirely new characteristics is vacuum melting — a series of processes that produce "purer" metals with better properties.

Why Vacuum Melt? Vacuum melting protects molten metal from contact with air. It also provides closer control of composition, helps eliminate inclusions, and minimizes center porosity and segregation in ingots.

In the field of vacuum melting, Crucible's position is unique. As the leading producer of special purpose steels, Crucible's experience in high-quality steelmaking is unsurpassed. Through formerly affiliated companies, now fully integrated with it, Crucible led in the development and commercial production of vacuum-melted steels, iron, nickel, copper — and titanium. Therefore, Crucible's breadth of ex-

perience, together with its extensive facilities, places the company in the best position to provide the "super-quality" metals most suitable for any given application.

The three vacuum-melting processes — One of the Crucible processes is VIM — vacuum induction melting. It starts with very high-purity raw materials, produces extremely pure ingots. A second is VAR — vacuum arc remelting, or the consumable electrode process. This process, starting with air-melted electrodes, produces large ingots — up to 32" diameter x 18,000 lbs. It provides

metal with low-gas content and greatly improved uniformity of properties. The third process is VIR — vacuum arc remelting of vacuum induction melted electrodes—a double-melting technique. It permits manufacture of super-pure metals in the full range of ingot sizes.

Crucible's experience with all three processes, and its facilities for vacuum arc remelting its own specially air- or

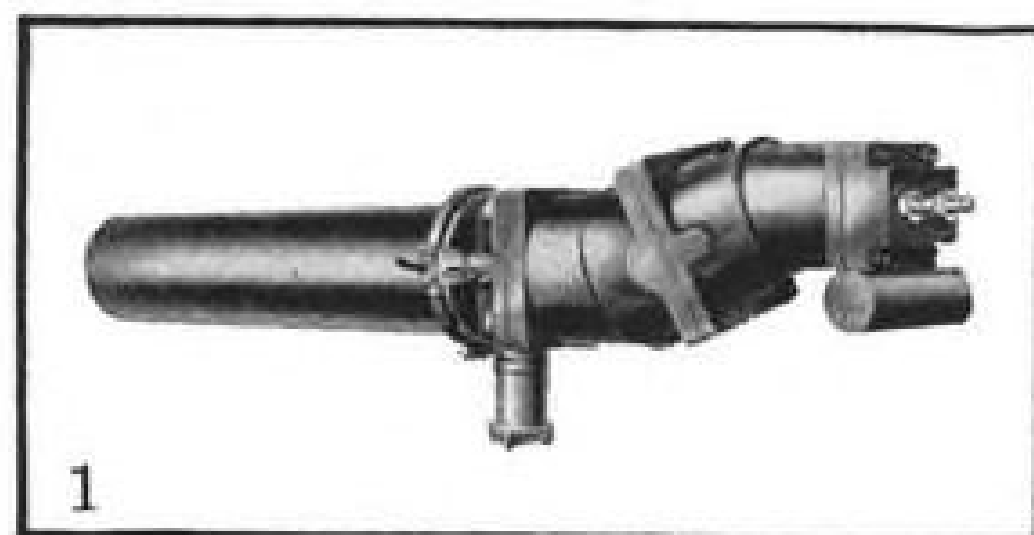
vacuum-melted electrodes, provides industry with a complete range of vacuum-melted metals at the lowest possible cost. Only at Crucible is there available this experience, flexibility and the facilities for vacuum-melting titanium, super-alloys, heat-resisting alloys, bearing steels, tool steels, stainless steels, electronic alloys and nuclear reactor materials.

If you'd like to know more about Crucible's work in High-Purity Metallurgy, read: "Quality Aspects and Properties of Vacuum Induction Melted and Vacuum Arc Remelted Steels and Super Alloys" and "Titanium for Aircraft and Spacecraft". Write: *Crucible Steel Company of America, Dept. AH-17, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE STEEL COMPANY OF AMERICA

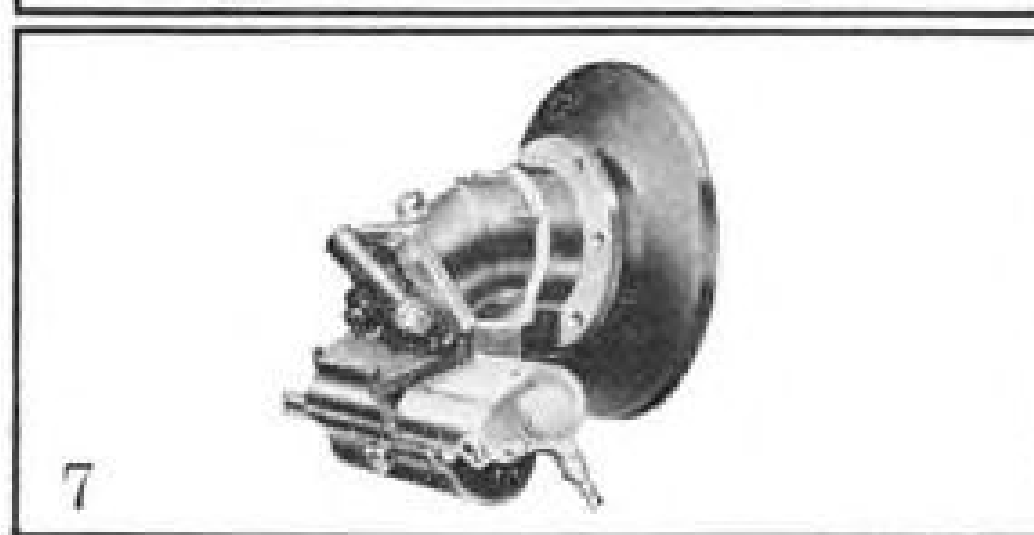
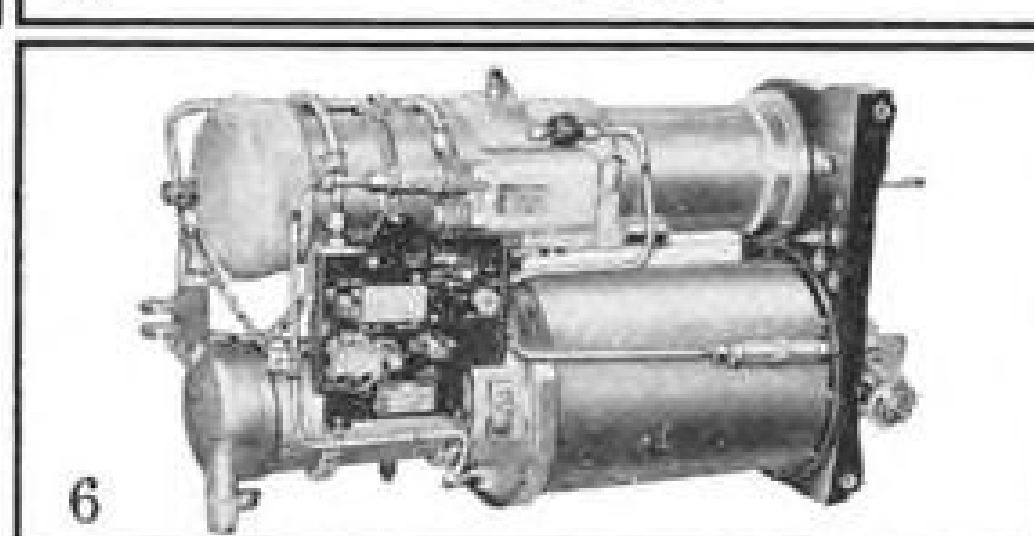
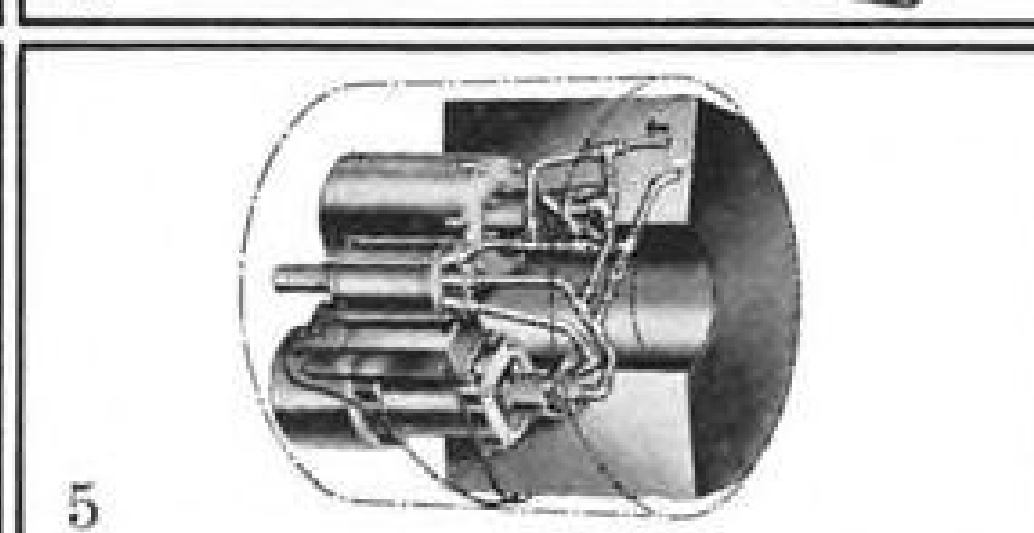
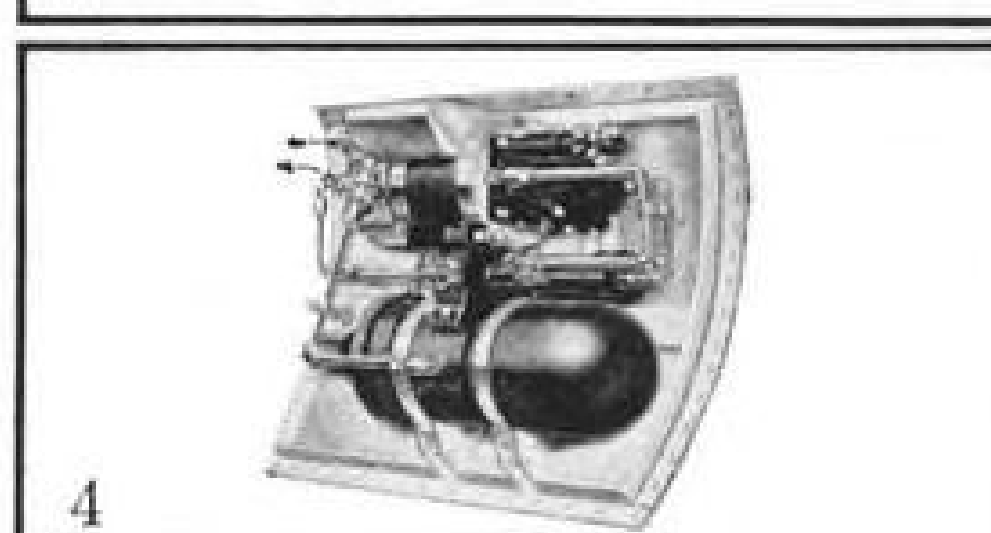
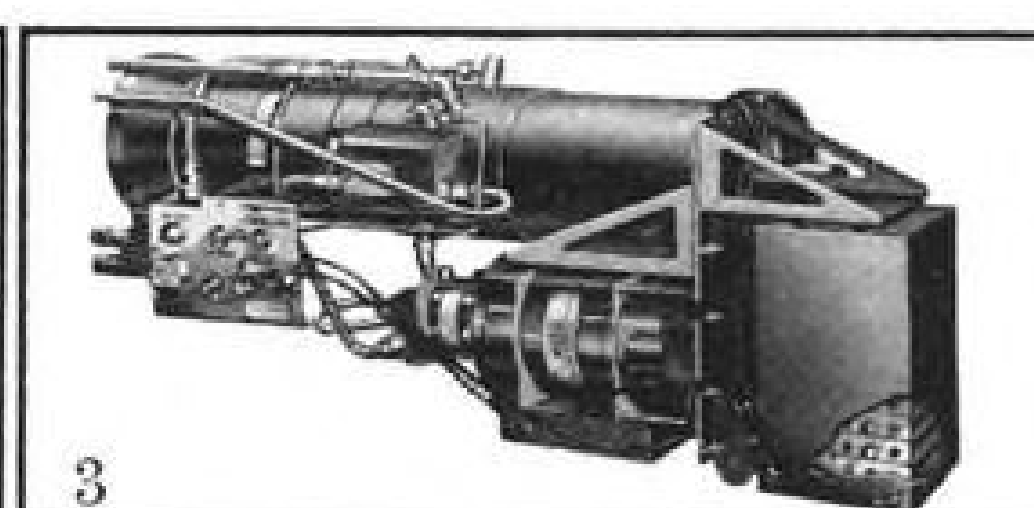
EFFICIENT, COMPATIBLE AUXILIARY POWER SYSTEMS...

designed and built by **VICKERS**



Typical Vickers designed
APS's include:

1. Hot Gas Systems
2. Close Frequency Systems
3. Battery Powered Systems
4. Door Mounted Systems
5. Blast Tube Configurations
6. Turbine Powered Systems
7. Flywheel Systems



Using proven components as building blocks, Vickers can shorten APS development time and speed delivery... all with the assurance of dependability. These advantages are passed on to you whether your specifications call for one or any combination of the following:

- TEMPERATURE TOLERANT SYSTEMS
- MAXIMUM EFFICIENCY
- CLOSE FREQUENCY CONTROL
- HIGH SPECIFIC POWER
- HIGH OR LOW DRIVE SPEEDS
- ACCURATE VOLTAGE REGULATION

For further information contact the nearest Vickers Sales and Service Office or write for Bulletin No. A-5236.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Aero Hydraulics Division — Engineering, Sales and Service Offices:

ADMINISTRATIVE and ENGINEERING CENTER | **TORRANCE, CALIFORNIA**
P. O. Box 302 • Detroit 32, Michigan | 3201 Lomita Blvd., P.O. Box 2003 • Torrance, Calif.

Aero Hydraulics Division District Sales and Service Offices:

Albertson, Long Island, N.Y., 882 Willis Ave. • Arlington, Texas, P. O. Box 213 • Seattle 4, Washington, 623 8th Ave. South • Washington 5, D.C., 624-7 Wyatt Bldg.

Additional Service facilities at: Miami Springs, Florida, 641 De Soto Drive

TELEGRAMS: Vickers WUX Detroit • TELETYPE: "ROY" 1149 • CABLE: Videt

OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

8239

Engineers and Builders of Fluid Power Equipment Since 1921

Aviation Week

Including Space Technology

August 10, 1959

Vol. 71, No. 6
Member ABP and ABC

EDITORIAL OFFICES: New York 36—330 W. 42nd St., Phone: LOnacre 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 7-5117 European Office—1 rue du Temple, Geneva, Switzerland, Phone: 32-35-63

PUBLISHERRobert W. Martin, Jr.
EDITOR.....Robert B. Hotz

MANAGING EDITOR.....William Gregory
EUROPEAN EDITOR.....David A. Anderton
WASHINGTON.....Cecil Brownlow
NEW YORK.....Harry Raven, Herbert J. Coleman
LOS ANGELES.....Irving Stone, Richard Sweeney,
Russell Hawkes, William S. Reed
DALLAS.....Erwin J. Bulban
ENGINEERING.....Robert I. Stanfield, J. S.
Butz, Jr., Michael Yaffee
AVIONICS.....Philip J. Klass, James A. Fusca
CONGRESS.....Katherine Johnson, Ford Eastman
SPACE TECHNOLOGY.....Evert Clark, Craig Lewis
TRANSPORT.....L. L. Doty, Glenn Garrison,
Robert H. Cook

EQUIPMENT.....Barry Tully
BUSINESS FLYING.....Erwin J. Bulban
ART EDITOR.....Lawrence J. Herb
ASST. ART EDITOR.....Richard X. MacMillan
SPECIAL PROJECTS.....John A. Nammack
EDITORIAL PRODUCTION.....Arnold Sherman
ASSISTANT EDITORS.....Elizabeth M. Hein,
Edith Walford
EDITORIAL ASSISTANTS.....Marjorie Nail,
Jerome Bailey, Marjorie Todd
LIBRARIAN.....Theresa V. Maggio

FOREIGN NEWS SERVICE

EDITOR.....John Wilhelm
LONDON.....John Tunstall
PARIS.....Robert E. Farrell
BONN.....Morrie Helitzer
MEXICO CITY.....Peter Weaver
TOKYO.....Sol Sanders

DOMESTIC NEWS BUREAUS

ATLANTA 3.....1301 Rhodes-Haverty Bldg.
CHICAGO 11.....520 No. Michigan Ave.
CLEVELAND 15.....1510 Hanna Bldg.
DETROIT 26.....856 Penobscot Bldg.
HOUSTON 25.....1303 Prudential Bldg.
SAN FRANCISCO 4.....68 Post St.

SALES

ADVERTISING SALES MANAGER
E. P. Blanchard, Jr.
ATLANTA.....R. H. Powell
BOSTON.....A. C. Boughton
CHICAGO and ST. LOUIS.....J. S. Costello,
D. C. Jackman
CLEVELAND.....H. P. Johnson
DALLAS.....R. T. Wood
DENVER.....John G. Patten
DETROIT.....R. R. Butera
LOS ANGELES.....C. F. McReynolds,
D. T. Brennan, C. A. Ransdell
NEW YORK.....M. J. Storz, J. M. Grinton,
J. D. Warth
PHILADELPHIA.....J. D. Willis, W. L. Blanchard
SAN FRANCISCO.....William Woolston
PROMOTION & RESEARCH MGR.....C. C. Gersna

RESEARCH & MARKETING
Mary Whitney Fenton, Jacqueline Gonnet

BUSINESS

BUSINESS MANAGER.....J. G. Johnson
CIRCULATION MANAGER.....T. J. Lucy
ASST. BUSINESS MANAGER.....W. V. Cockren
PRODUCTION MANAGER.....F. A. Dube

Defense Budget Cut Below 1959 Level..... 26

► Congress puts Fiscal 1960 budget at \$39 billion; total is \$19 million under President's request.

Ozark Pegs Growth to Federal Subsidy..... 38

► Midwestern airline, now starting turboprop service, sees basic role as non-competitive with trunklines.

Lycoming T55 Cleared for Airframe Use..... 87

► Free-power turbine performance exceeds major specification guarantees in 50 hr. USAF preliminary rating tests.

SPACE TECHNOLOGY

Hughes Space Approach..... 55
Rockets Probe Nuclear Blasts..... 29
Project Mercury Pressure Suit..... 30
Saturn Booster Recovery..... 31
Thor Nose Cone Photographs..... 32
GE System Stabilizes Nose Cone..... 33
Hot-Shot Tunnels Record Heat..... 66

MISSILE ENGINEERING

French Missile Combine..... 28
Nike Zeus Test Facilities..... 30
Nike, Hawk System Coordination..... 34
Lacrosse Fired in Army Exercise..... 35

AVIONICS

MIT Inertial Guidance Efforts..... 71
System Speeds Missile Check..... 81
Airport Traffic on TV..... 111

AERONAUTICAL ENGINEERING

T55 Cleared for Airframe Use..... 87
N-156F Makes First Flight..... 27
USAF Hydrocarbon Fuel Tests..... 27
Ramjet Produces Static Thrust..... 30
An-10 Military Version..... 31
Army Turbine VTOL System..... 35
Crash May Cancel Coleopter Project..... 37
Qantas 707-420 Carries Extra Pod..... 37
Folland Pushes Gnat Trainer..... 101

AIR TRANSPORT

Ozark Pegs Growth to Subsidy..... 38
France Gains West Coast Stop..... 39
Board Objects to Rate Proposal..... 40
Durfee Favors Routes Based on Traffic..... 40
FAA Fines PanAm on 707 Operation..... 41
Airlines Modifying Electra Wing..... 43
Sabena's Jet Age Supply Net..... 45
Douglas DC-8 Production Tempo..... 47
Shortlines..... 50
Airline Observer..... 50

MANAGEMENT

Defense Budget Cut Below 1959..... 26
Senate Restores NASA Funds..... 26
Pace on Industry Hiring..... 36
TWA Registers Profit..... 43
Who's Where..... 23
Industry Observer..... 23
Washington Roundup..... 25
News Digest..... 37

BUSINESS FLYING

Pilot Report on Broussard MH-1521.. 104
Calendar..... 5
Letters..... 134

EDITORIAL

Facing Soviet Facts..... 21

COVER: Sun is shown a few degrees above the horizon during the ascending portion of a 1,500 mi. flight by a Douglas-Air Force Thor intermediate range ballistic missile nose cone. The re-entry vehicle, designed by General Electric's Missile and Space Department, was the first to be stabilized around all three axes and to utilize all of the basic elements of an interplanetary flight control system. Two infrared sensors were used for yaw and pitch stabilization so that the nose cone would be stable to the horizon and held around local vertical. Roll stabilization was accomplished with a sun tracker. Camera lens gives the sun a sparkling appearance and reflections from lens elements produce small circles of light on the photo. For other pictures, see p. 32.

PICTURE CREDITS

Cover—General Electric; 29—Sandia Corp.; 30—B. F. Goodrich; 32, 57—General Electric; 34—Hughes Aircraft Co.; 35—Martin Co.; 36—Convair; 37—Boeing; 38—Ozark Airlines; 45—Sabena; 47—Douglas Aircraft Co., Trans-Canada; 55, 87, 93, 96, 97—Lycoming Division; 71—MIT; 81—Epsco; 83—Goodyear Aircraft; 101—Folland Aircraft, Ltd.; 104, 105—Max Holste; 111—National Aviation Experimental Center.

78,032 copies of this issue printed

AVIATION WEEK, August 10, 1959



America's first missile family...scions of space technology

Science and technology, especially as it relates to missile art, has advanced more rapidly in the last five years than in the preceding five centuries. Any review of the many milestones successfully attained since 1954 reveals an epic of hard work, inventiveness, accomplishment, and *single objective*. This single objective—the achievement of operational weapon capability at the earliest possible date—is being realized. ★ Atlas, Thor, Titan, Minuteman, and the follow-on advanced space probe experiments are all demonstrations of the basic soundness of the U.S. Air Force's concept of ballistic missile management. ★ Space Technology Laboratories is responsible for the over-all systems engineering and technical direction for these projects. The scope and magnitude of STL's activities provides scientists and engineers unique professional opportunities. ★ Important staff positions are now available for those with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.

Space Technology Laboratories, Inc.



P.O. BOX 95004, LOS ANGELES 45, CALIFORNIA

EDITORIAL

Facing Soviet Facts

(Frank Holeman of the New York Daily News is an able veteran of the Washington press corps who accompanied Vice President Nixon on his recent tour of the Soviet Union and Poland. In this dispatch to the Daily News, written on his return to the United States, Holeman presents a fresh and vivid picture of the impact of the 1959 vintage Soviet Union on an American citizen. Our own experience in the Soviet Union in 1956 and again two months ago confirms the accuracy of Holeman's observations. We are reprinting his dispatch below because it is a story every American should read and heed.—R. B. H.)

We waved good-bye to a lot of friendly people in Warsaw, Poland, this morning on the way to the airport with Vice President Nixon.

They laughed and clapped and some threw bunches of carnations and gladioli.

Here and there along the way, though, you'd see a man or a woman wave, smile, then suddenly turn sad. I saw one man wiping his eyes after we passed.

There was really something pathetic about the whole episode. In 12 hours with our big jet transport planes, we would be in a different world, the free world. The poor Poles would still be right there in the Communist world, which many obviously detest.

Two Week Lifetime

We learned a lot of new things about that Communist world in our two weeks with Nixon. It may not sound like a long time to you, but two weeks behind the Iron Curtain can be a lifetime.

The Russians gave us the most extensive tour of their country any big group of Westerners has ever had. Granted that we saw only the cities and factories they selected, we still saw more than anybody else.

Impressions differ, of course. Here are the very strong convictions I brought back:

1. We have badly underestimated Russia, particularly its vigorous economic growth.
2. Prime Minister Khrushchev is so cocky over Russia's recent achievements and potential expansion that he underestimates us, too. That's the real reason for his being invited to the U. S.
3. President Eisenhower was dead right when he said we can lose the struggle between free enterprise and a managed economy—and thus lose our freedom—unless all groups in the U. S. begin to exercise a lot of self-discipline.

4. Worse than that, we can lose the economic and political hold if we keep raising prices. We can become a second-class power while we're gaily paying each other higher prices and wages unrelated to the real cost of production. In a few years, the Communists will be flooding world markets at rock-bottom prices, or below.

5. As much as anything else, we need to re-awaken our deep national pride, which seems to sleep between wars. Many Russians have enthusiasm for their way of life, believe it or not. All over the country are signs, "Work for the Victory of Communism!" We need the same kind of enthusiasm, or more, for freedom.

6. Make no mistake about it, it would be better to die in an all-out atomic war than to live the way the Russians do, in a police state ruled by men instead of laws. Patrick Henry was right when he said: "Give me liberty or give me death."

Margin Is Narrowing

I know this sounds grim and gloomy, but the time has come to face the hard facts. The margin of superiority we have over the Russians is narrowing so fast we can't afford to scoff at them any longer. They are on our heels and closing fast.

The reason I feel compelled to say these disagreeable things is this: I have already seen false pride and underestimation of Communists kill American boys. I was in Korea the first day American troops went into action.

We underestimated the enemy then. I don't want the same thing to happen with Russia.

Idlewild Arrival

When we arrived at Idlewild Airport the night of July 22 to board our Boeing 707 jet plane, the big graceful swept-wing craft looked like the eighth wonder of the world. But 10 days later, when I flew back into Moscow in a Soviet Tu-104 jet, the American plane was just another jet on the runway. The Tu-104 carries 100 passengers in comfort at 500 miles an hour. We flew them from Moscow through Siberia and back. They land and take off on schedule. Four pretty hostesses served delicious food, fruit and vodka.

American airmen complain that the Tu-104 eats too much fuel, can't operate economically, and has to "hug the ground." I'm sure that's all true. But people who can build as good a plane as the Tu-104 are not going to stop there.

POWER FOR MISSILE & AIRCRAFT HYDRAULIC SYSTEMS

Eastern HIGH SPEED GEAR PUMPS

SHOWN
ACTUAL SIZE

Eastern Aviation Hydraulic Pumps set new standards for performance, yet are the smallest, most lightweight ever made.

By meeting customer requirements and government specifications with precise detail, Eastern Pumps give reliable long-term service.

Hundreds of models, close-coupled to electric motors with speeds to 24,000 RPM, can be furnished for your special systems. You gain the advantage of economical mass-produced components custom-engineered into whatever configuration is needed. Performance is from .015 to 1.5 GPM, 0 to 3000 PSIG, with theoretical displacements from .0021 to .0419 cubic inches per revolution. A variety of bearing combinations handle different types of fluid and operating pressures.

Missile and aircraft system engineers have discovered Eastern Pumps do the same job as units that use greater space and weigh far more. Applications have included circulating coolant in bomber guidance system, providing hydraulic power for ground control of jet, charging accumulator in an in-flight refueling system, furnishing an APU system with power to a missile, and countless others.

For your next project, contact Eastern for creative engineering help that really helps.

Write for NEW Aviation Bulletin 350 describing the above units and larger-capacity pumps.

EASTERN INDUSTRIES, INCORPORATED

100 Skiff Street • Hamden 14, Conn. West Coast Office: 1608 Centinela Avenue • Inglewood 3, California

WHO'S WHERE

In the Front Office

Dr. James R. Killian, Jr., a director, General Motors Corp. Dr. Killian, chairman of the corporation of Massachusetts Institute of Technology, recently resigned as President Eisenhower's special assistant for science and technology.

Charles L. Davis and Clyde A. Parton, divisional vice presidents, Military Products Group, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Mr. Davis continues as general manager of the Aeronautical Division, and Mr. Parton as general manager, Ordnance Division.

Frederick A. Fielder, vice president and general manager, Loewy-Hydropress Division, Baldwin-Lima-Hamilton Corp., New York, N. Y.

Rahland C. Zinn, vice president, Lockheed Aircraft Service, Inc., New York, N. Y.

Ted R. Thoren, vice president-engineering, Pesco Products Division, Borg-Warner Corp., Bedford, Ohio.

George C. Dannals, vice president-engineering, Dynatronics, Inc., Orlando, Fla.

Gerald J. Lynch, a vice president, Ford Motor Co. Mr. Lynch continues as general manager of the company's Aeronautic Division, Los Angeles, Calif.

William W. Wood, Jr., manager of Simulation Engineering, Link Aviation, Inc., Binghamton, N. Y., a subsidiary of General Precision Equipment Corp. Mr. Wood continues as vice president of manufacturing. Also: H. G. LeClerc, manager of manufacturing.

Nathaniel H. Goodrich, deputy general counsel, Federal Aviation Agency, Washington, D. C. The FAA also announced the following appointments in the Office of International Coordination: Raymond B. Maloy, chief; Capt. Donald E. MacIntosh (USN), deputy chief; Alfred Hand, assistant to the chief; Carroll D. Heath, executive assistant; Evan J. Lewis, chief, Technical Assistance Division; Claude H. Smith, (acting) chief, International Organizations Division.

William B. Becker, director of operations and engineering, Air Transport Assn., Washington, D. C.

David J. Green, vice president-advanced systems development, Tasker Instruments Corp., Hollywood, Calif.

James Forner, vice president-governmental relations TelAutograph Corp., Los Angeles, Calif.

James M. Dill, vice president and general manager, Ratigan Electronics, Inc., Glendale, Calif.

Lowell R. Dailey, deputy assistant director, Research Engineering, Department of Defense, Washington, D. C.

Changes

Thomas F. Huntington, executive assistant to the president, Trans World Airlines, Inc.

Roy Coats, administrative assistant to the president, The Kaynar Mfg. Co., Pico-Rivera, Calif.

Dr. Paul A. Libby, assistant director of the Aerodynamics Laboratory, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

INDUSTRY OBSERVER

► Bidders briefing session for Air Force's new airborne long-range interceptor (ALRI) program to convert RC-121D aircraft so that it's new AN/APS-95 radar can directly feed Lockheed target information into SAGE air defense system for guidance of long-range interceptors and Bomarc missiles will be held in Dayton on Aug. 13-14. Industry bids are due Sept. 14. Approximately eight to 12 aircraft and avionics companies are expected to bid for prime, including Lockheed, Litton Industries and General Electric. Work involves development of automatic data processing and communications equipment plus modification of RC-121D aircraft to accommodate new mission.

► Plan to establish a single military long-haul communications network through integration and expansion of separate service facilities has been approved by Secretary of Defense Neil McElroy. New Joint Communications Network will not include specialized communications such as Strategic Air Command and Air Defense Command control systems or those which form integral part of a weapon system. Joint Chiefs of Staff will be responsible for coordination and control of integrated system which will be developed on evolutionary basis during next 10 years. Operation of system will be parceled out to individual services following a study.

► National Aeronautics and Space Administration has begun development of a geodetic satellite with the award of a preliminary design contract for the high intensity flashing light system to Edgerton, Germeshausen and Grier, Inc., of Boston.

► Acquisition and tracking station for Advanced Research Projects Agency's WS-117L Polar-orbit reconnaissance satellite is scheduled to be located in Iowa, supplementing facilities at Vandenberg AFB, Calif., and the Pacific Missile Range.

► Basic requirements for location of operational sites for USAF's Minuteman solid-propellant intercontinental ballistic missile are being studied in relation to a wide variety of terrain characteristics. Parallel contracts have been awarded to ensure adequate analysis of launch area characteristics.

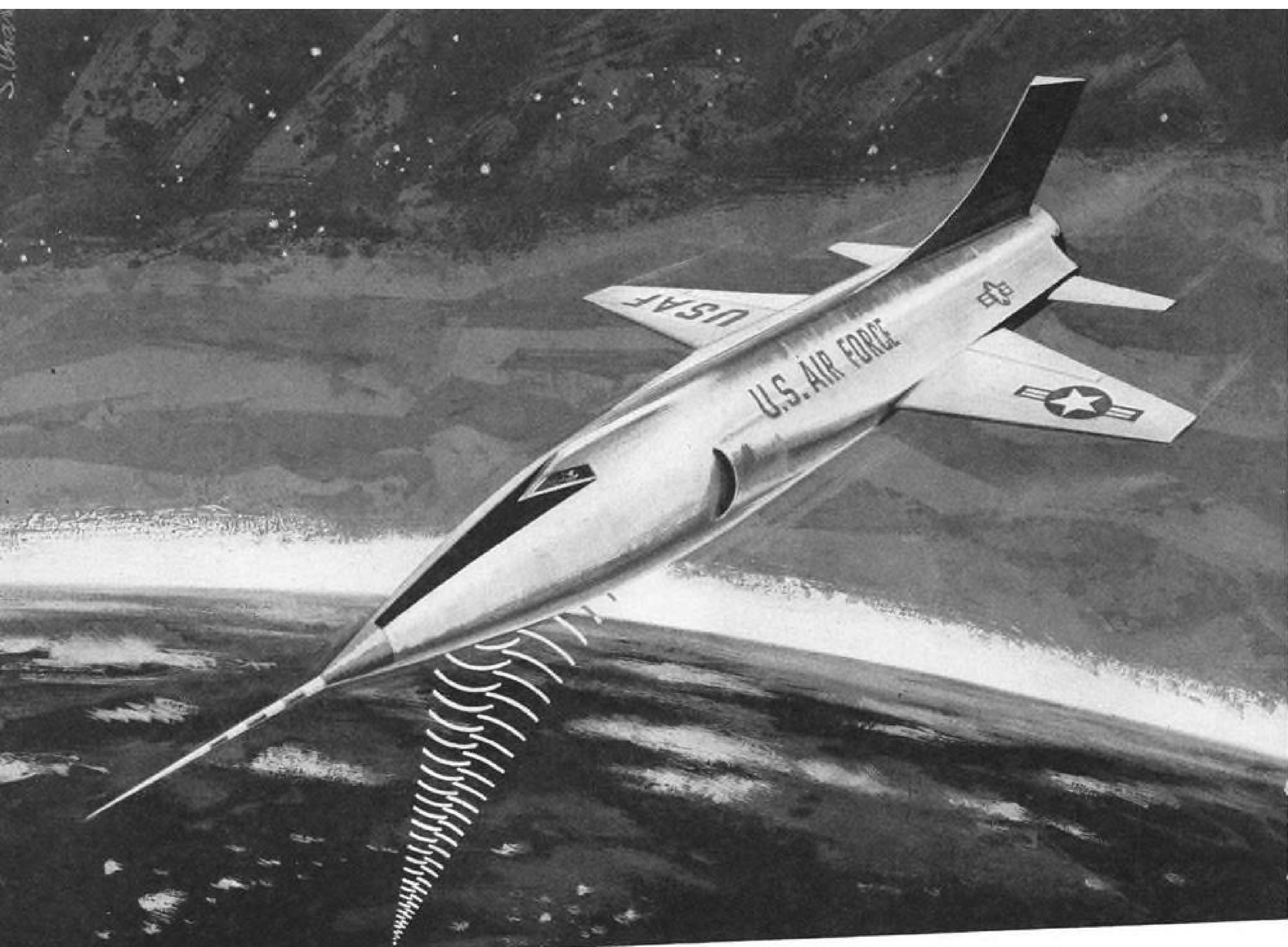
► Installation of radar and communications equipment at Ballistic Missile Early Warning System (BMEWS) site in Greenland is scheduled to begin within the next several months.

► Four helicopter manufacturers are in the running for a West German order for a flying crane. Only one is U.S.—Sikorsky Aircraft Division with its S-60. Other competitors are Westland Aircraft, Ltd. with the twin turbine Westminster, Sud Aviation with its triple turbine helicopter and Italy's Agusta with a triple turbine design using the General Electric T58 engine.

► National Research Corp. is studying methods of adapting tantalum and tantalum-tungsten alloys for use in nozzles and other hot parts of solid propellant rocket engines under a Navy Bureau of Ordnance contract. Company already has tested one tantalum-tungsten alloy that reportedly has three times the tensile strength of straight tantalum at 4,000F and can be easily fabricated.

► Ryan Aeronautical Co.'s XQ-2C version of the Firebee target drone has reached an altitude of 59,800 ft. in flight trials. During the trials, the drone demonstrated a speed capability of 560 kt. and the ability to fly at altitudes of above 50,000 ft. for approximately 77 min. Powerplant is the Continental J69-T-29. Drone is scheduled for delivery to the Air Force in January.

► Kaman Aircraft Corp. reduces chances of fatigue and cuts weight about 5% on its HU2K rotor blade by using a new technique for broaching the aluminum spar leading edge of the 22 ft. blade. Leading edge is an extruded aluminum section extending across a third of the 20 in. blade chord, and the trailing edge is glass fiber honeycomb material. Broaching technique gives the aluminum a smooth interior as well as exterior finish, thus combatting fatigue, and provides uniform blade thickness. Total blade and fitting weight is 168 lb.



.....RADAR SIGNALS FROM SPACE.....

When man first rides a rocket into the fringes of our atmosphere, tracking stations on the ground will know his position and trajectory from signals beamed to earth by a tiny radar transponder.

This Stavid-designed and Stavid-built beacon receives transmissions from tactical radar sets on the ground and develops coded pulses for identification and tracking. The system provides for the passage of data in both directions, and permits tracking at greater distances than ever before. This development represents new gains in miniaturization techniques achieved by Stavid engineers, who are steadily advancing the state-of-the-art in electronics systems engineering.

OTHER AIRBORNE PROJECTS INCLUDE:

- High-power Modulator-Transmitter for Radar Set AN/APQ-71
- Search and Bombing Radar OA-2003 (XN-1)/ASB
- All-Weather Radar Toss-Bombing System

STAVID Engineering, Inc. Plainfield, New Jersey

Imaginative Electronics...

Outstanding engineers and scientists are invited to inquire into opportunities on Stavid's advanced systems engineering teams.



Stavid Project Engineer, W. L. McCULLOH, has 10 years' experience in the development of airborne electronics, including: X and S-band Beacons, Radar Toss Bombing, Airborne DME and ranging and coding circuitry.

Washington Roundup

Hebert Sequel

House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D-La.) can be counted on to take steps to discourage financial support by defense contractors of some industry and service organizations engaged in public and congressional lobbying activities.

There will be strong pressure on the military services to disallow support—such as membership dues and assessments—to these organizations as costs on government contracts. The subcommittee also probably will urge the Ways and Means Committee to consider removal of their tax exempt status as non-profit organizations.

Hearings will continue until the adjournment of Congress, probably in a month. A report with recommendations for action will then be issued.

Line of Succession

Department of Defense has defined the line of succession in case of the death, disability or absence of the Secretary of Defense in a new directive. Deputy Secretary Thomas S. Gates is next in line behind Defense Secretary Neil McElroy, and Gates is followed by Army Secretary Wilber M. Brucker, Navy Secretary William B. Franke, Air Force Secretary James H. Douglas and Dr. Herbert F. York, director of defense research and engineering.

These top defense officials are followed in succession by the assistant defense secretaries and the general counsel in order of seniority, the under secretaries of the Army, Navy and Air Force, then the assistant service secretaries, all ranked by seniority.

Space Cadet Corps

Latest twist in the drive to meet the challenge of the space age is a Space Cadet Corps proposed by Rep. Victor L. Anfuso (D-N. Y.). Rep. Anfuso is promoting a bill that would create a corps of space cadets to "encourage and help the young people of the country to take an active part now and eventually to find careers in the space sciences and practical astronautics." Space Cadet Corps would be run from Washington by a corporation backed by representatives of education, aviation, astronautics and related fields. Rep. Anfuso thinks the nation's youth should be marshalled into the corps to encourage development of rocketry, provide education and practical experience in fields allied to the space effort, obtain scholarships and provide personnel for satellite and star watching.

Debate on Fare Debate

Civil Aeronautics Board decision to investigate the \$45 economy fares offered by National, Northeast and Eastern airlines between New York and Miami has raised the ire of two thrift minded Board members. Vice Chairman Chan Gurney and member G. Joseph Minetti took their colleagues to task last week for answering a National request to suspend its competitors' economy fares by ordering an investigation of the fares charged by all three carriers.

Pointing out that National uses high capacity aircraft on the flight, while its two competitors offer the service with a lower seating capacity, Gurney and Minetti said National had lived up to Board demands for high density

aircraft on low-fare service. Failure of the CAB to grant National's request to suspend the competing fares could be viewed as a rejection by CAB of its past views on economy fares and a breaking of faith with the only carrier which unqualifiedly complied with Board desires on low-fare proposals, the dissenting members said.

Renegotiation Board

A steady and attentive listener at Hebert subcommittee hearings on allegations of contractor influence on military procurement has been Thomas Coggeshall, chairman of the Renegotiation Board, which has the final say on defense profits unless the contractor challenges its determination in court.

Southwestern Service Case

Local air transportation needs of six southwestern states are now under study by the Civil Aeronautics Board. Under the Southwestern Area Local Service Case ordered last week by CAB, both local service and trunk-line carrier route authorities, along with community needs, will be studied in portions of the states of Arkansas, Louisiana, Oklahoma, New Mexico and Colorado and the entire state of Texas. Airlines participating in the case thus far include American, Braniff, Continental, Delta, Eastern, Trans World, Central, Frontier and Trans-Texas. The new case raises the total of local service area cases now before the Board to seven.

Successor to Keirn

Air Force has named Brig. Gen. Irving L. Branch to replace retiring Maj. Gen. Donald Keirn as Assistant Deputy Chief of Staff/Development for Nuclear Systems. Former deputy commander of Air Force Special Weapons Center at Kirtland AFB, Gen. Branch will take over as chief of the USAF nuclear aircraft program this month.

Branch's appointment fills Keirn's USAF job but leaves unfilled his corollary jobs as director of Defense Department and Atomic Energy Commission efforts in the Aircraft Nuclear Propulsion program. Program management has been a disputed issue in recent months, and a number of proposals for new management approaches have been discussed as a means of speeding progress on the ANP program.

Late last week, no decision was apparent as to whether the program will continue to be managed jointly along present lines or whether some new approach will be adopted.

Iberia Bid Blocked

Iberia Airlines of Spain lost its recent bid for a New York-Mexico City route primarily because the carrier wanted to operate a service not covered by the bilateral agreement between Spain and the U. S. The Civil Aeronautics Board rejected the Iberia application since the Spanish carrier wanted to use the New York-Mexico City route as the third leg of a triangular Madrid-New York-Mexico City route, closing the gap between its current Madrid-New York and Madrid-Mexico City routes. CAB said such a triangular route operation, with aircraft operating continuous flights around all three legs, was not contemplated in the Spanish bilateral.

—Washington staff

Defense Budget Cut Below 1959 Level

Congress puts Fiscal 1960 budget at \$39 billion; total is \$19 million under President's request.

By Katherine Johnsen

Washington—Congress completed action last week on a \$39.2 billion defense budget for Fiscal 1960, a figure \$660 million below Fiscal 1959 funds.

The final total is \$19 million less than the President requested in January, \$380 million more than the House originally voted and \$366 million less than the Senate originally voted. In some measure the differences reflect technical and military decisions made during the seven months that the budget has been before Congress, rather than basic policy differences between the House, Senate, and Administration. Several Administration requests for key programs were changed during the period.

The service allocations for Fiscal 1960 are Air Force \$17.5 billion; Navy \$11 billion; Army \$9.4 billion. Procurement allocations include:

- **USAF aircraft and missiles**, \$6.8 billion. Of this, \$4.3 billion is for aircraft, \$2.5 billion for missiles.
- **Navy aircraft and related materiel**, \$2 billion.
- **Army missiles and equipment**, \$1.4 billion.

Allocations for research, development, test and evaluation include:

- **USAF**, \$1.2 billion.
- **Navy**, \$1 billion.
- **Army**, \$1 billion.
- **Advanced Research Projects Agency**, \$455 million.

For the first time this year, test and evaluation funds were included in the research and development budgets rather than in the procurement budgets. About \$2 billion for development, test, and evaluation in the Fiscal 1960 budget is included in procurement allocations (AW June 1, p. 31).

Air Force's total Fiscal 1960 budget for research, development, test, evaluation and procurement of \$8 billion is approximately \$600 million above the Fiscal 1959 budget for these categories.

Final budget also gives Defense Secretary Neil McElroy extensive flex-

ibility in the use of missile funds. He is authorized to transfer funds from one missile project to another and has authority to transfer up to \$150 million from other defense categories to missiles. In addition, McElroy has a \$150 million emergency fund intended primarily for acceleration of missile programs when warranted.

These are the fund details:

- **Army Nike Zeus** missile defense system. Army was voted \$137 million to begin production of the anti-missile missile. Early in the year, Defense Secretary Neil McElroy repeatedly told congressional committees, he did not want funds in Fiscal 1960 to begin Nike Zeus production. Nevertheless, the House voted \$200 million for Zeus production and other Army modernization programs. During subsequent Senate testimony, however, McElroy supported \$137 million for Zeus. In addition, the final budget earmarks about \$300 million for Nike Zeus research and development.

- **Convair Atlas** intercontinental ballistic missile. Funds were provided to finance 17 squadrons. Originally, the Administration had asked for only nine. After the House voted an additional \$85 million as a down payment on eight

additional squadrons, Secretary McElroy supported the increase.

- **USAF Minuteman**. Solid-propellant intercontinental ballistic missile. Congress added \$77 million more than the Administration had requested to the budget in order to accelerate development of the USAF solid fuel ballistic missile system. After the House voted the additional amount, McElroy did not oppose it. He also pointed out to the Senate that this would make it possible to phase operational missiles into the inventory six to 12 months earlier than planned.

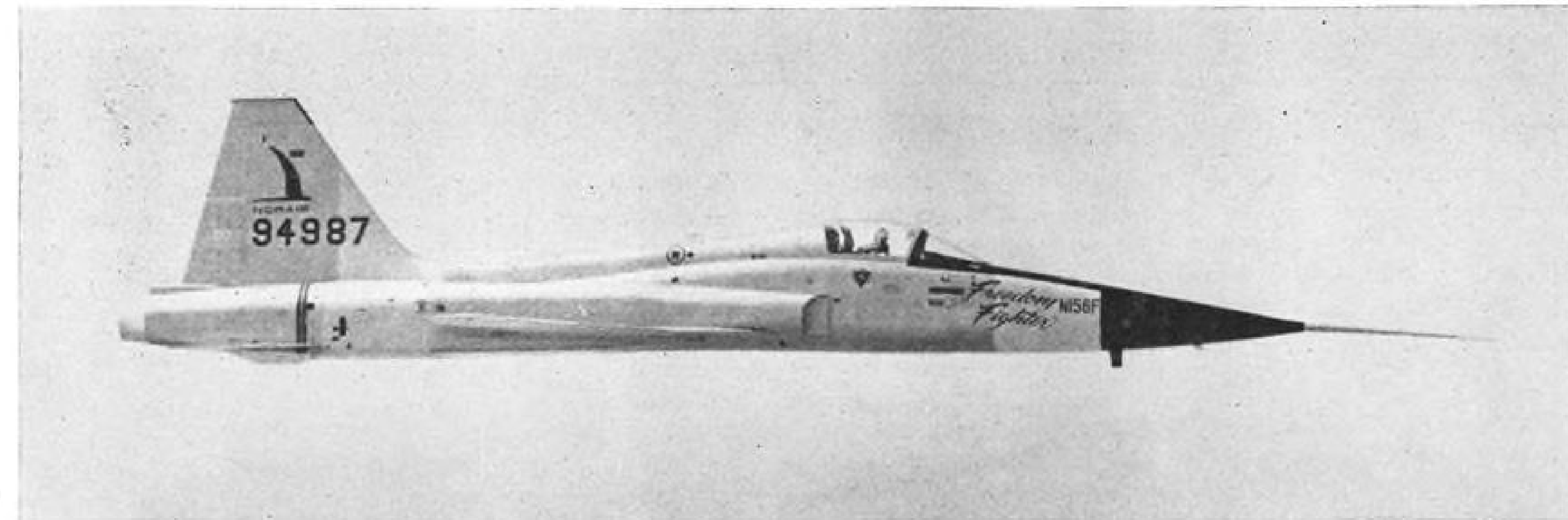
- **Air defense missiles**. Congress cut funds sharply below Administration proposals for both the USAF Boeing Bomarc area defense missile and the Army-Douglas Nike Hercules point defense system. Defense Department's "master plan" for air defense submitted by Secretary McElroy after much congressional prodding (AW May 11, p. 26) called for a reduction of \$33 million in the original Fiscal 1960 Bomarc program and \$77 million in the Nike Hercules program. Congress went farther and made a total cut of \$83 million in Bomarc and "no less than \$100 million" in Nike. This still left about \$365 million earmarked for Bomarc and an undesignated small amount for Nike Hercules.

- **Navy aircraft carrier**. A total of \$35 million is provided to start long-lead procurement for a second nuclear-powered carrier. The Administration had proposed \$260 million for a conventional powered carrier. The House killed this project. The Senate voted \$380 million to launch construction of a nuclear ship.

- **Martin Mace** tactical surface-to-surface missile. USAF is authorized to transfer procurement funds from other projects for this missile, provided Defense Secretary McElroy first certifies to the two appropriations committees that the missile is "essential." Previously, the House had flatly rejected the \$127.5 million requested.

- **USAF aircraft**. Request for \$53 million for the purchase of 10 cargo jets for Military Transport Service was eliminated. The \$24 million requested for 15 jet utility trainers and \$23 million for jet navigation trainers, originally rejected by the House as "administrative types and not essential," was approved in the final action.

- **MATS**. Congress restricted \$85 million of MATS Fiscal 1960 funds for procurement of commercial air transportation. The House originally had proposed \$80 million for this, the amount set aside in Fiscal 1959. The Senate had proposed \$100 million.



Northrop N-156F Fighter Makes First Flight

Northrop N-156F twin-jet fighter makes its first flight over Edwards AFB (AW Aug. 3, p. 34). Norair Division of Northrop Corp. is developing the aircraft under Department of Defense contract for use by NATO nations. Powerplants are General Electric J85-1 prototype engines rated at about 2,500 lb. thrust each. Production J85-5 turbojets are expected to be delivered to Northrop in September.

USAF to Test Mach 3-5 Fuel in F-104

By Michael Yaffee

Air Force next month will begin flight evaluation of one, and possibly two, new hydrocarbon fuels in a Lockheed F-104 jet fighter at Edwards AFB, Calif., as the next step in its search for high-temperature, high-performance fuels for future air-breathing aircraft engines that will fly at Mach 3-5 speeds.

In these tests Air Force researchers will be searching primarily for high thermal stability. Future fuels will have to operate at 600-800F without forming filter-clogging sludges. And, for the first time, the researchers will be watching Btu./gal. more closely than Btu./lb. with volume rapidly becoming a more critical factor than weight in advanced aircraft design. (The space-limited F-104, for example, has no room for fuel tanks in its ultra-thin wings.)

Fuel Contracts

Air Materiel Command has already contracted to purchase 100,000-gal. evaluation quantities of the fuel from Esso Standard Oil Co. and Ashland Oil & Refining Co. Scheduled for September delivery, the two fuels now are being prepared to specifications set forth by the Fuel and Oil Branch of Wright Air Development Center's Propulsion Laboratory. Evaluation of the fuels will be carried out by WADC, with the assistance of General Electric and Monsanto Chemical Co.

At present, the Ashland fuel comes closer to meeting the Air Force requirement in regard to the desired chemical and physical characteristics and is the favored fuel. It is the one slated to undergo the F-104 flight evaluation at Edwards AFB and possibly a Northrop Snark missile flight test at the Atlantic Missile Test Range. It is a blend of two pure chemical compounds, a mono-

cyclic aromatic (possibly benzene) and a polycyclic aromatic (believed to be naphthalene) which, in this case, is being obtained from coal tar. If the fuel ever reaches full scale production, Ashland plans to use a petroleum starting material in place of the coal tar.

The two aromatics are hydrogenated to form saturated cyclic compounds. Once the two aromatics are obtained, all processing is carried out on standard refinery equipment. Unlike processed petroleum fractions, which usually consist of a number of different compounds, the end product here is relatively pure, consisting of only the saturated versions of the two starting materials, with well defined characteristics. Cost of the final fuel is \$225,000 for the first 100,000 gal. with Ashland offering AMC a second increment at a somewhat lower price.

The Esso fuel will be evaluated by WADC and results of these tests will determine whether or not it merits actual flight testing. The fuel itself is similar to Esso's Stock G, a relatively high boiling virgin distillate which is extensively treated by means other than hydrogenation to concentrate the naphthenes and remove the unsaturated (aromatic) compounds. Because it is made by processing a crude petroleum fraction rather than coal tar and because the methods of treatment used are less costly than hydrogenation, the Esso fuel is less expensive and will cost AMC only \$100,000 for the 100,000 gal. quantity.

On the other hand, the Esso fuel is relatively viscous at low temperatures (144 centistokes at -40F against 12 centistokes for the Ashland fuel); but Esso believes this can be improved by distillation or other processing. Its chemical and physical characteristics are generally less well defined and it is

believed to have a somewhat lower heating value.

Primarily, WADC researchers are looking for high thermal stability. To whatever extent possible, aircraft fuels must serve as heat sinks, taking as much heat as possible from the airframe, engine components, and lubricating oil. The fuel should not coke or form sludges that will clog filters and fuel lines at high temperatures.

Fuel Stability

Current JP fuels, mixtures of chain and cyclic hydrocarbons, are thermally stable up to approximately Mach 2 when operating temperatures start running as high as 300-400F. The Air Force, thinking in terms of Mach 3-5 turbojet and ramjet powered aircraft, wants fuels that will be thermally stable at 600-800F. It is now generally be-

Tu-104B Record Claimed

Moscow—Soviets have claimed that the Tu-104B jet transport established five world records Aug. 1 when an aircraft carrying a 15-ton load flew 1,000 km. (621.4 mi.) at a mean speed of 1015.8 km. (631 mph.).

The speed set records for planes with five and 10 ton payloads, according to the Russians. Jet transport flew the Moscow-Orsha-Moscow route in 59 min. On the same day, Lt. Col. V. P. Smirnov reportedly set another altitude record in twin jet RV aircraft which attained a height of 20,000 km. (66,256 ft.) with payload of two tons. The same pilot and same plane on July 13th climbed to an 20,300 km. (66,584 ft.) with a one-ton load to claim another record (AW Aug. 3, p. 32).

Senate Restores NASA Funds

Washington—Senate last week restored a \$68.2 million House cut made in National Aeronautics and Space Administration's Fiscal 1960 budget following a strong plea by NASA Administrator Keith Glennan (AW July 20, p. 26). Glennan had told the Senate Appropriations Committee that "to sustain these cuts or to compromise them will hamstring the U. S. space program."

The \$462 million budget voted NASA by the House and the \$530 million voted by the Senate were placed before a joint House-Senate committee for decision. The House cuts were: \$3 million for salaries; \$35 million for research and development; \$30 million for construction and equipment.

"These cuts could well have crippled our nation's space program," Sen. Lyndon Johnson (D.-Tex.), majority leader, told the Senate. "We certainly should not hobble ourselves in the space race at the very time that our vice president must publicly acknowledge that the Soviets are ahead of us in the thrust of their rockets."

French Missile Combine

Paris—U. S. aircraft industry is expected to participate in the capitalization and work of the new French agency for development of long range ballistic missiles. The new combine, called Societe pour les Etudes et Realisation des Engins Ballistiques, (AW April 7, 1958, p. 62) has headquarters at Courbevoie, near Paris, in a building given by Sud Aviation, one of the member firms.

The other member French aircraft or engine firms include Nord Aviation, Generale Aeronautique Marcel Dassault, Societe Matra, Sncma and SEPR. Government agencies include ONERA, French equivalent of the U. S. National Aeronautics and Space Administration, and French Defense Department's Service des Poudres, responsible under French law for all solid propellant development work.

Technical director of SEREB (initials used to designate the group) is Fernand Vinsonneau, former technical director for Sud's Military Division and before that for Ouest Aviation, one of Sud's predecessor companies.

American observers have been impressed with the speed and direction of the French effort and regard it as one of the most promising technical developments to take place in Europe since World War II.

Some French sources, queried by Aviation Week, express skepticism about the organization and believe that, like many of France's postwar projects, this one also will eventually run out of money, and therefore out of projects.

A way has been opened for American participation in the French project under a scheme similar to that by which Pratt & Whitney Aircraft acquired an interest in Sncma, the French nationalized aircraft factory (AW May 4, p. 30). Currently, discussions are taking place at high technical levels between American firms interested in solid-propellant missile work, and the French combine. Governments must approve any agreements.

lieved that saturated cyclic hydrocarbons are more thermally stable than chain hydrocarbons and this is the reason for the Air Force's evaluation of the naphthenic fuels being prepared by Ashland and Esso. Also, this type of fuel currently appears to offer the best currently attainable compromise of thermal stability, good low temperature properties, low vapor pressure, high hydrogen percentage, and high density.

In laboratory tests to date, both the Esso and Ashland fuels have shown good thermal stability characteristics at the upper temperature limit (450-500F) of the present Fuel Coker Test, forming insignificant amounts of coke or varnish and generally meeting target stability values of preheater demerits (maximum of 3) and filter pressure drop (maximum of 1) tentatively set by WADC for its fuel of the future.

As in current fuels, heating values or energy content is an important consideration. But this time, the Air Force will be looking more closely at volume energy values than at weight energy values owing to the increasing importance of the former in present and future space-limited aircraft. Through experience, the Air Force also has learned that the relationship of range to Btu./lb. is directly proportional. Now they want to establish the relationship of range to Btu./gal.; i.e., how much farther will an aircraft be able to go for a given increase in Btu. gal.

For these reasons, along with other objectives that can't be pinpointed in laboratory tests, the Air Force plans to evaluate the fuel in actual flights of

an F-104. It would, of course, simplify logistic problems if one fuel could be used in both aircraft and missile weapon systems. Where the fuel of the future is used, it is intended to serve as a total fuel, that is, it will be used in the turbojet and ramjet afterburner of an engine. General Electric's J93 engine for the North American B-70 and F-108 Mach 3 aircraft is slated to use a hydrocarbon fuel in the turbojet portion and a special chemical (borane) fuel in the after-burner.

On a weight basis, the energy content of the new naphthenic fuels compares closely to present JP fuels at approximately 18,500 Btu./lb. On a volume basis, however, the new fuels register roughly 135,000 Btu./gal., compared with 119,885 Btu./gal. for JP-4 and 125,300 Btu./gal. for JP-6. While the Air Force is placing increased emphasis on the Btu./gal. value it would still like to reach a Btu./lb. value of 19,000. Another object of the upcoming flight tests will be to help WADC researchers decide if they should compromise Btu./lb. or Btu./gal. and how far this should go.

The fuels from Ashland and Esso are not the only ones undergoing or scheduled for evaluation by WADC. Almost all major petroleum companies and many chemical firms have submitted samples—some on request from WADC—ranging from gallon to drum quantities. The market potential for this new fuel is an enticing one. According to an Air Force estimate, the demand for an advanced fuel for supersonic engines could reach 100

million gal./year in five to 10 years. Commercial transports, provided that they go supersonic, probably would take 150 million gal./year. Air Force, apparently, is willing to pay more than the current jet fuel price, roughly 13 cents/gal. to get the performance it wants.

Officially, the present WADC fuel program began two years ago. It got going in earnest a little over a year ago. At this time, WADC contracted with Monsanto Chemical to survey the literature on pure chemical fuels (as opposed to those derived from petroleum cuts), recommend the 50 best chemical fuels and to evaluate these fuels in regard to thermal stability, energy value, etc.

Monsanto now has completed its survey and recommendations and is starting on the evaluation, in which it also will compare chemical candidates with the more promising petroleum fuels. General Electric has tentatively agreed to act as an adjunct to WADC in running ground engine tests that the Air Force requires before a new fuel can be used in an actual flight test. Company will check out the Ashland fuel on a General Electric J79 engine similar to the one used in the F-104.

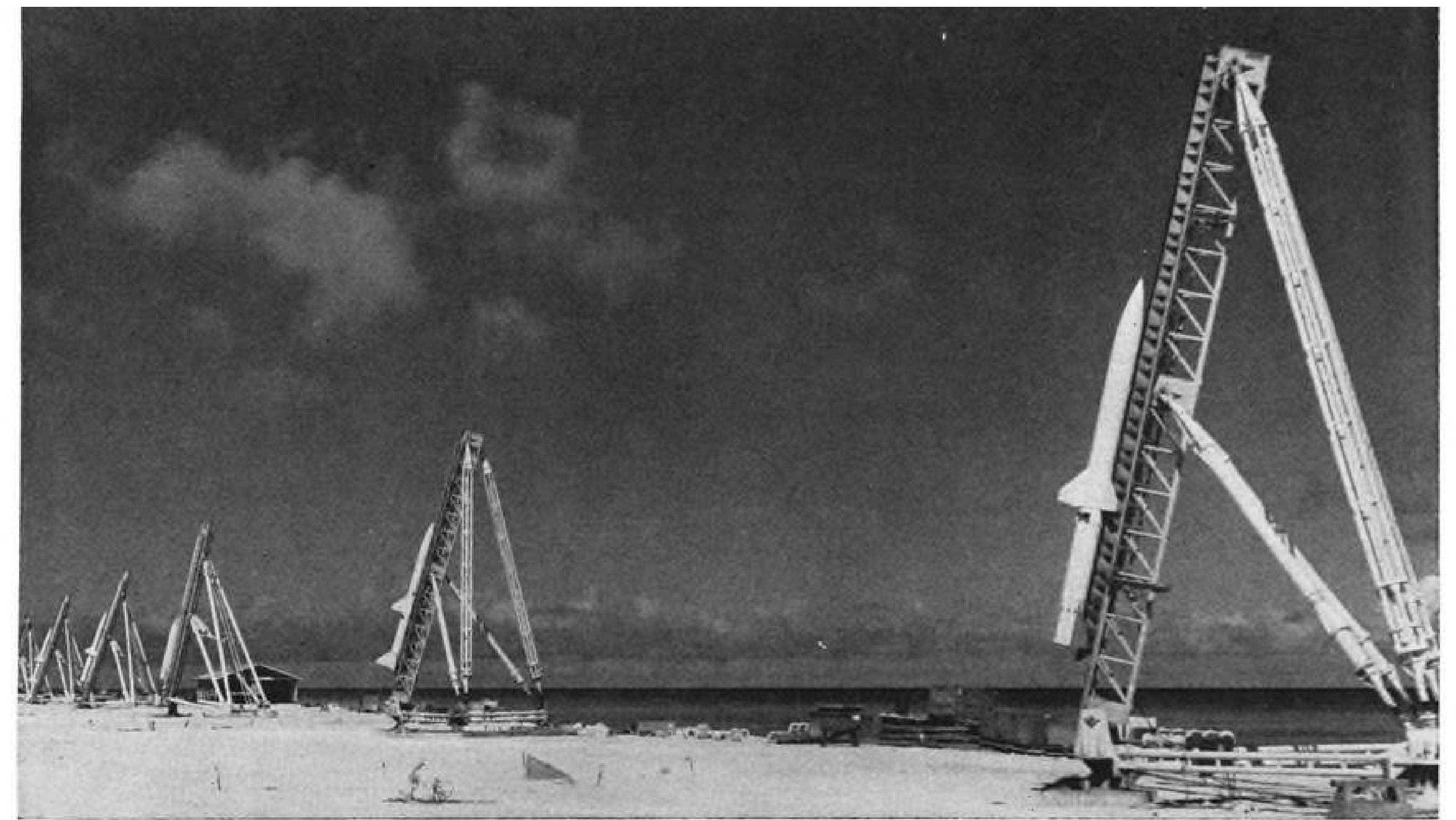
One-half of the Department of Defense effort to obtain better aircraft and missile fuels, the present WADC program is devoted to improving available hydrocarbon fuels rather than to developing new high energy chemical compounds. Originally, it was felt that these improved hydrocarbons would prove capable of meeting the performance requirements of rockets as well as of airbreathing aircraft engine (AW Mar. 23, p. 30). Now, however, some Air Force researchers are convinced that liquid-fueled rockets, with the possible exception of such elements as large recoverable boosters, are headed toward non-hydrocarbon systems.

Avco Is Developing New Titan Nose Cone

Washington—Avco Corp.'s Research and Development Division is designing an advanced version nose cone for the Martin Titan intercontinental ballistic missile under a \$73,360,000 Air Force contract announced last week.

Object of the contract is to obtain an ablating nose cone with a slender shape that will be capable of maintaining faster speed during re-entry into the atmosphere than that possible with the present blunt nose cones.

The faster re-entry will increase the accuracy of the Titan warhead by reducing the dispersion caused by wind and flight forces during a slower re-entry.



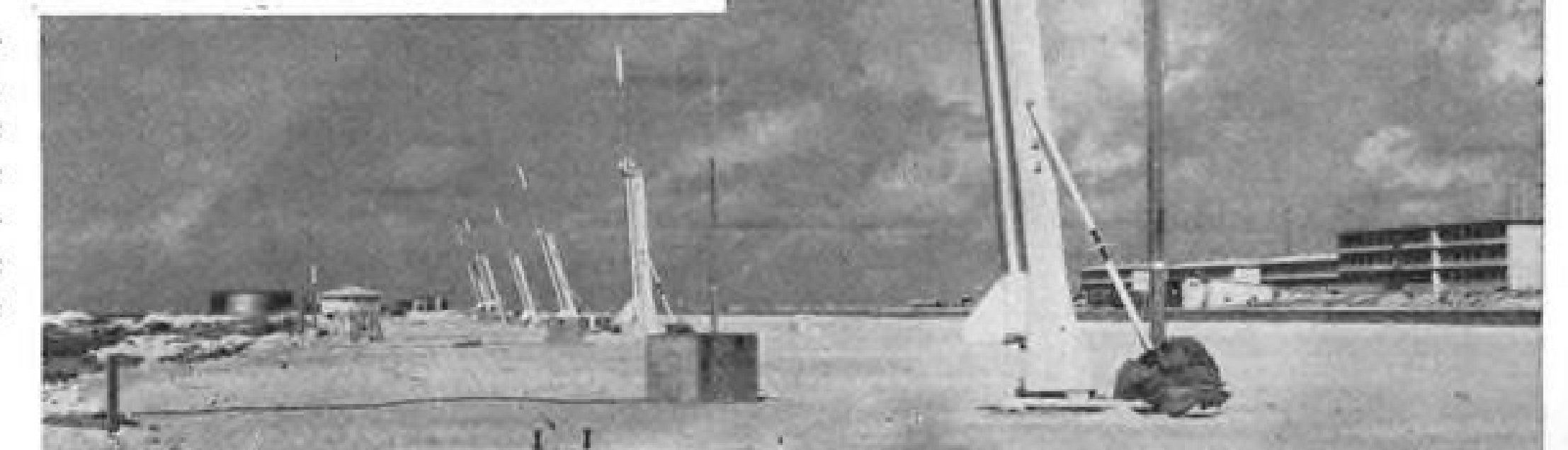
Sandia Corp. two-stage research rockets were fired into fireballs of two nuclear explosions during Atomic Energy Commission's Hardtack I operation last summer from Johnston Island. Rockets, two modified Lacrosse engines, measured nuclear radiation, blast, thermal radiation and electromagnetic effects.

Rockets Probe Nuclear Blasts

Sandia chaff rocket (left) gets prelaunch checkout. Data from Hardtack firings determined that ionizing radiation from the nuclear detonations was sufficient to absorb some radio waves and to scatter others.



Smaller Sandia rockets (right) with an Allgany Ballistic Laboratory Deacon first stage, Grand Central Arrow second stage, were used in studies of effects of high-altitude nuclear blasts on radio and radar transmissions. Total of 65 were fired, some fitted with chaff-ejecting heads to measure wind velocity.



Perturbation Cycle Ramjet Model Produces Static Thrust in Test

Los Angeles—Perturbation cycle ramjet which produces static thrust currently is operating in scale model size at Marquardt Co., Roy E. Marquardt, company president, said here last week.

Lack of static thrust has been a major drawback in these powerplants. Company said a perturbation cycle ramjet is a combination ramjet-rocket engine in which the rocket engine disturbs the incremental cycle of the ramjet.

The engine envisioned, Marquardt said, is capable of producing thrusts "of a magnitude now considered adequate." Being developed under an Air Force contract, the engine could be used in a concept which has ramjet engines

as booster powerplants for space vehicles, instead of large rocket engine first stages. Marquardt said the company also holds an Air Force contract dealing with use of ramjet boosters for rocket vehicles.

In addition, Marquardt said, the perturbation cycle engine may have applications to Mach 3 transports.

The company currently is developing ramjet power around the new boron based fuels, Marquardt said, adding that hydrogen also has been used as a fuel in tests. He explained that its low density and large volume required for a given total impulse are current problems. Use of boron fuels

Zeus Test Facilities

Washington—Construction will start within the near future on test facilities on Kwajalein Atoll and Johnston Island for flight testing of the Army-Douglas Nike Zeus anti-missile missile system.

Pacific range facilities will permit the Army to fire Nike Zeus test vehicles from Kwajalein to intercept ICBM nose cones launched along the Pacific Missile Range from Vandenberg AFB, Calif., and special targets fired from Johnston Island, which is within IRBM range of Kwajalein.

Army also is planning to extend the White Sands Missile Range beyond its present northern boundary for initial development and test work on the Nike Zeus system. Plans to build test facilities for the Army missile at Atlantic Missile Range have been dropped.

looks very promising, according to Marquardt, since ramjets have no moving parts in the engine proper and would not suffer the coking and other corrosion and contamination problems of turbojets using boron fuels.

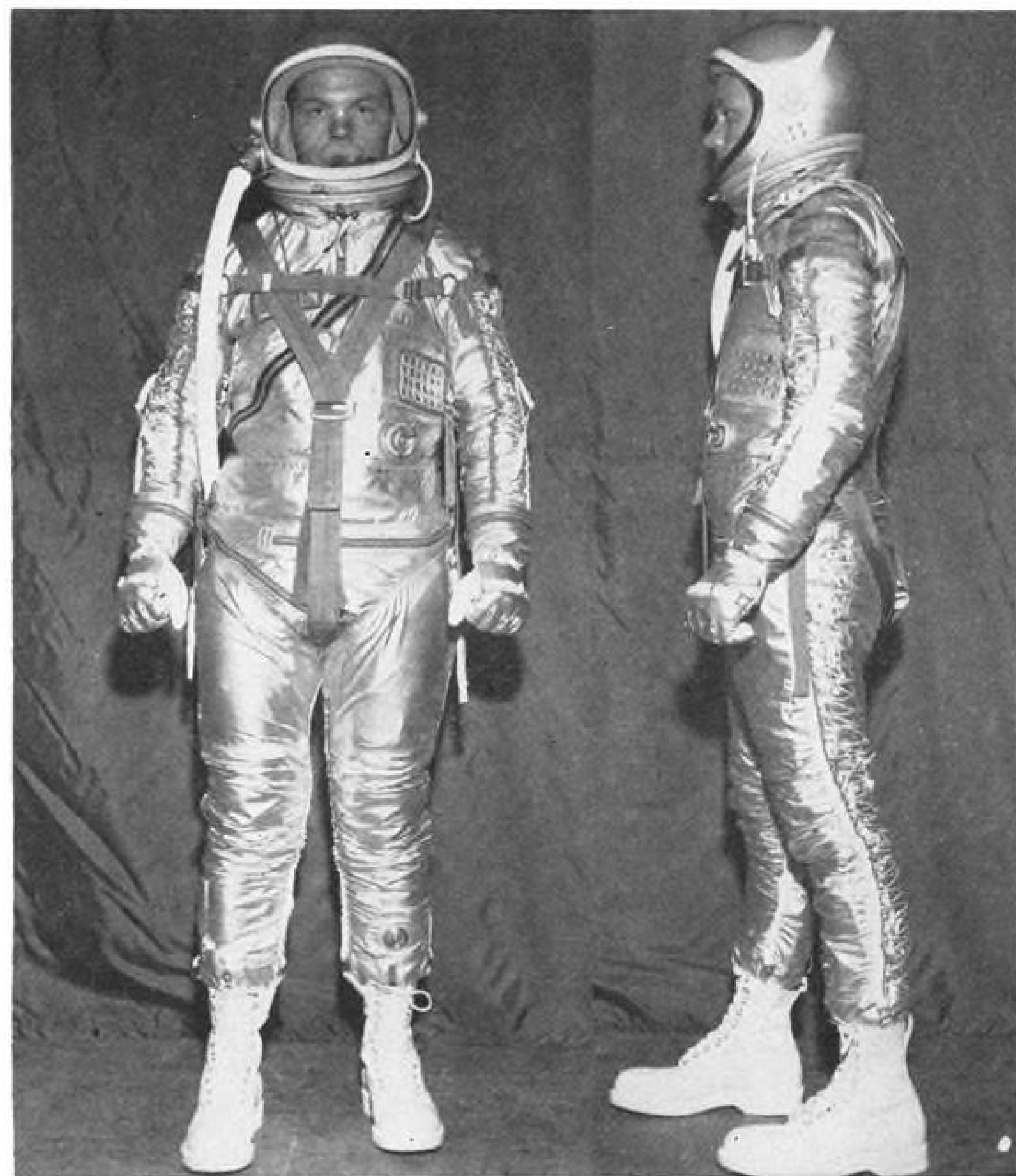
Marquardt also said that design improvements to Boeing Bomarc powerplants could upgrade its capabilities to anti-missile missile applications.

Speaking at a San Fernando Valley luncheon honoring the 15th anniversary of his company, Marquardt also announced the company's financial picture for the first 28 weeks of 1959. Sales totaled \$34,051,091, earnings after taxes were \$860,647 and earnings per share were 65 cents. These were in contrast with sales of \$25,321,270, earnings after taxes of \$573,135, and earnings per share of 44 cents, for last year.

Marquardt also announced the company will form a new Nuclear Systems Division to handle Project Pluto, the nuclear-powered ramjet, and other possible future nuclear systems. Formerly, Pluto work was accomplished in Marquardt's Astro Division. Alan Grubber will head the new division.

Directors also approved plant expansions at Van Nuys and Pomona, where Marquardt acquired Associated Missile Products, former American Machine & Foundry subsidiary which designs and deals in missile ground support systems and equipment. Expansion expenditures are \$1.25 million at Van Nuys and \$11 million at Pomona.

Marquardt also said the company's new test facility near Saugus, Calif., has been operating at Mach 8 capabilities, and could be expanded to Mach 17. The facility will continue to be used, Marquardt said, as a research facility, when the Ogden, Utah, plant test facilities are used for production testing, and the Van Nuys test facilities are outgrown.



Project Mercury Pressure Suit

Full pressure flight suit, selected by the National Aeronautics and Space Administration for the Project Mercury man-in-space flights, is a modification of the B. F. Goodrich-developed Navy Mk. 4 flight suit (AW June 22, p. 311). Mercury suit differs from the Navy's in its silvered coating for heat and radiation protection, its one-piece construction, and its Air Force type ventilated inner garment. Flight suits will be unpressurized during Mercury flights, becoming pressurized only upon failure of capsule pressurization. Goodrich will supply 20 suits under \$75,000 contract.

Space Technology

Saturn Booster Recovery System Detailed

Los Angeles—Methods of recovering and re-using Army's 1½-million-lb. thrust Saturn space vehicle boosters, and Saturn-boosted lunar vehicle designs, were detailed here by Dr. Wernher von Braun of Army Ballistic Missile Agency before the western regional meeting of the American Astronautical Society.

Recoverable booster of the three-stage, 162-ft.-long Saturn system will be powered by eight Rocketdyne Thor-Jupiter liquid propellant rockets. Inner ring of four thrust chambers would remain fixed. All four thrust chambers in the outer ring would be gimbaled to make possible attitude control. Fuel and liquid oxygen will be stored in a bundle of nine tanks. A large central liquid oxygen tank will be surrounded by a ring of eight smaller fuel and liquid oxygen tanks.

Von Braun said, "As a matter of probability, we cannot really hope to recover the first Saturn booster in a re-usable condition but we would like to get it back for post-flight inspection and to cannibalize it for re-usable parts." Cook Research Institute of Chicago is doing development work on Saturn's recovery gear.

First mission assigned to Saturn is the establishment of the so-called 24-hr. communications satellite at an altitude of 22,500 mi. over a point on the equator. Fifteen degree per hour angular velocity of a satellite at this altitude equals the angular velocity of the earth's rotation; therefore, if the orbit were from west to east the satellite would appear to remain fixed over the same point on the earth.

Kaiser Steel Co. already has begun construction of a Saturn launching structure at Cape Canaveral, Fla., and should finish around January.

First phase of the Saturn booster recovery will use a cluster of parachutes opened at or near booster apogee. Chutes will be small and strong to withstand the heavy air load imposed by high speeds of re-entry. This means that rate of descent will necessarily be

too high to permit recovery of the booster intact, unless some additional deceleration is supplied. Eight small retrorockets will supply the necessary reverse thrust when triggered by contact of a dangling probe with the surface of the sea. A retrorocket will be located between each pair of fuel and liquid oxygen tanks in the outer ring on the periphery of the cluster. Probe would fire the retrorockets at a height of 50 to 100 ft.

An unexpected stumbling block is the task of picking up the big booster after it has been returned to the ground intact. The idea receiving most attention is a plan to modify Navy LSTs as pickup ships. Water ballast tanks would be installed in the bow to make it possible to force the bow ramp beneath the surface of the water. The floating booster then would be winched up the slipway, the ramp raised and the ballast pumped overboard.

Von Braun said ABMA has devised a new, simple pyrotechnic starting technique for Saturn which is needed to give simultaneous ignition to the clustered chambers. Saturn propulsion system has a growth potential from 1.5 million lb. thrust to 2 million lb. thrust. As part of the idea that a booster should not be a one-shot item, Saturn has been given the reliability features usually associated with multi-engined aircraft. Fuel system includes continuous cross feed between the clustered tanks in both the fuel system and the oxidizer system to ensure that no single stoppage can force a tank to remain unused.

Saturn will be able to carry out its mission even after the complete loss of one engine.

A total Saturn vehicle would consist of the clustered booster, a Martin Titan first stage, in this case used as the second stage of Saturn, with a Convair Centaur as third stage. Von Braun mentioned two versions of Saturn which could be used for manned lunar flights. One version would be a six-stage vehicle standing 438 ft. high on the pad. Stages one and two would have diameters of 460 in.; stage three would have a diameter of 360 in.; stage four 256 in.; and stages five and six 120 in.

Thrust at liftoff would be 12 million lb. First three stages would be used to place top three stages into a lunar orbit. Stage four would provide energy for soft landing, and would serve as the launching structure for the return trip. The final two stages would remain for the return to earth and re-entry.

Von Braun favors another idea which would use a five stage vehicle with a

total length of 304 ft. and a maximum diameter of 256 in. Heart of this plan is orbital fueling of the lunar vehicle. The five stage descendant of Saturn would place an unfueled lunar vehicle in an earth orbit. Five Saturn-boosted tankers would then have to rendezvous with the lunar vehicle and fuel it.

Von Braun said he can see no useful purpose for projected space suits except possibly for lunar explorations. He pointed out that in space there is really no need for legs and hands, therefore, there is no need for complicated suits retaining these features. Von Braun supported the idea of a one or two-man space bottle with low thrust rocket propulsion and tool-equipped manipulators useful for construction and maintenance in space.

An-10 Military Version

Moscow—Military version of the Antonov An-10 turboprop transport now in passenger service with Aeroflot (AW Aug. 3, p. 40) is being developed for transportation of troops, light artillery and tanks. This was disclosed by Soviet Premier Nikita Khrushchev during an inspection of a TWA Boeing 707-131 and USAF VC-137 jet transport at Vnukovo Airport.

Khrushchev said he had just returned from Kiev where he saw a demonstration of the military version of the An-10.

"I will tell you a secret," he said. "That plane can be used for airborne troops. I yesterday saw a self-propelled gun loaded on the plane which landed on a dirt strip and was unloaded very quickly. It can also take a light tank. It is a very good plane."

He claimed that the An-10 can fly faster than the Il-18 turboprop transport, but Soviet technical sources do not support this claim, listing a 350 mph. cruise for the An-10 as compared with 410 mph. for the Il-18.

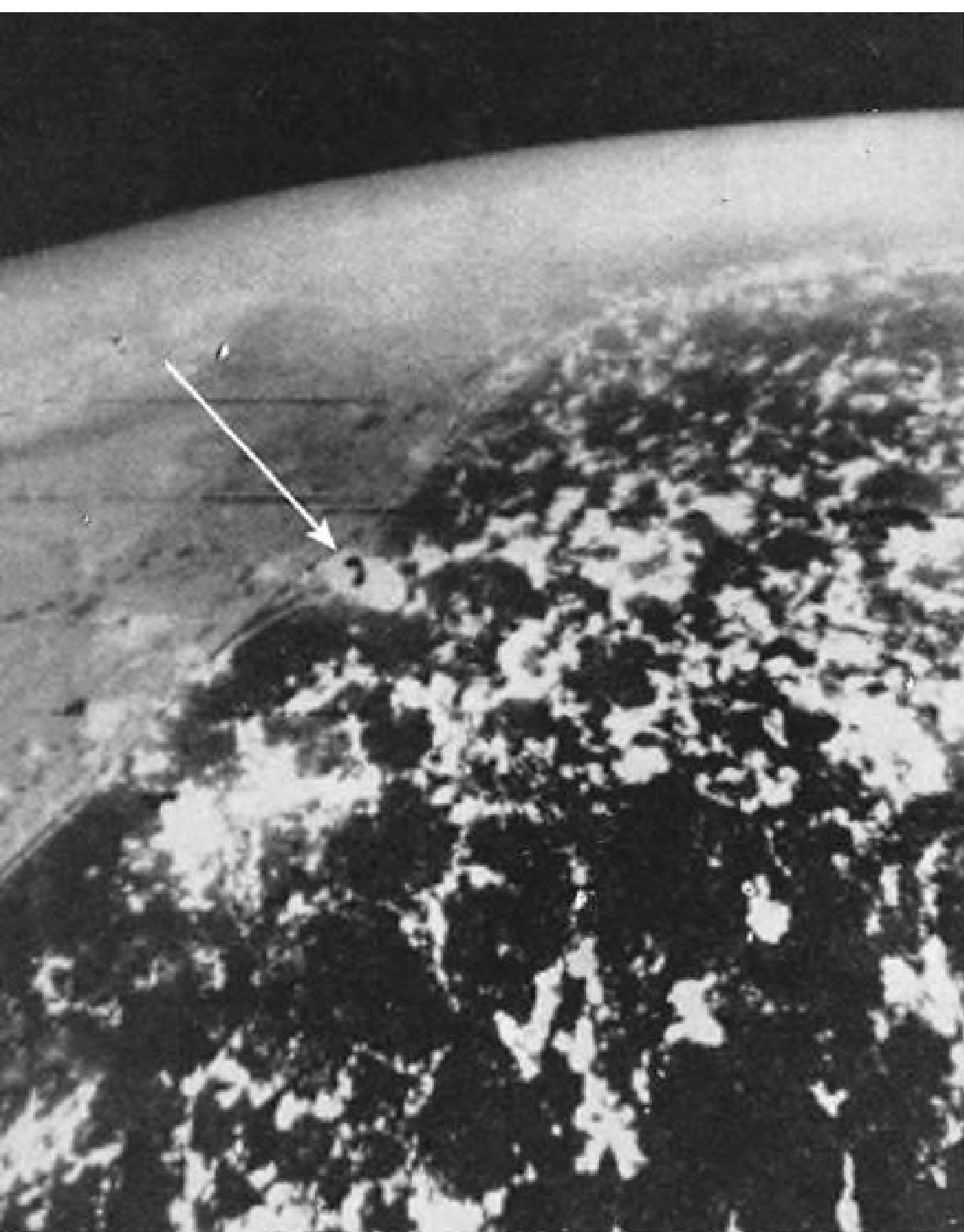
Khrushchev visited the Boeing 707 and VC-137 accompanied by Soviet aircraft designer Andrei N. Tupolev and other aviation officials. He jokingly urged Tupolev to "take plenty of pictures" of the interior of the plane.

"Andre Nikolaievich must try to steal something from you," he said. "All aircraft builders steal from each other. There is nothing unusual about that."

"Some have more opportunity than others," retorted Col. Charles Taylor, USAF escort officer and former air attaché in Moscow. Tupolev is credited with copying the Tu-4 Soviet four-engine bomber and the Tu-70 transport from USAF B-29s that landed in the USSR during World War II and were interned.

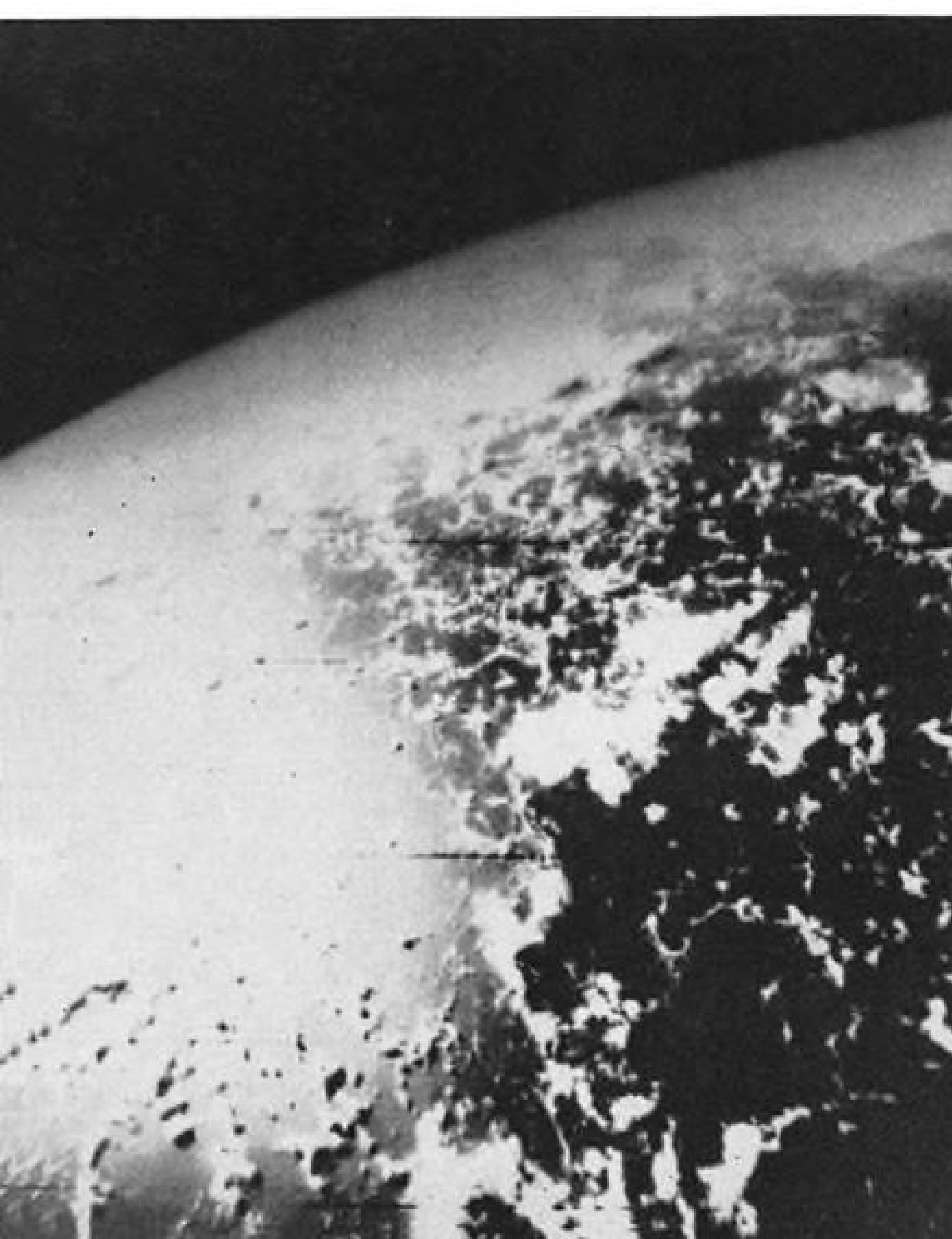
Satellite Weather Radar

Washington — National Aeronautics and Space Administration will request industry proposals this week for light-weight, long-lived weather radar suitable for use in a meteorological satellite. Radar is intended to give meteorologists a three-dimensional picture of precipitation around the globe (AW June 22, p. 144). Approximately 15 companies will be invited to submit proposals for a feasibility study and construction of experimental equipment.



GE-Thor Nose Cone Photographs Atlantic Missile Range

Cape Canaveral, Fla., is slightly obscured behind main body of an Air Force-Douglas Thor intermediate range ballistic missile (arrow, upper left) in a photo made from its General Electric nose cone after separation at a relative speed of about 4 mph. At top right, photo was made of Grand Bahama Island group (upper center) as cone gained altitude. Photos are marked improvement over first nose cone separation film (AW May 25, p. 26). Near apogee (bottom, left) earth curvature is evident and cone is stabilized on all three axes, using sun tracker, infrared sensors and small computer. View is downrange toward British West Indies; Antigua Island is at upper right. In photo at bottom right, cone is over cloud bank that covered about 120,000 sq. mi. of ocean.



Space Technology

GE System Stabilizes Thor Nose Cone

By J. S. Butz, Jr.

Philadelphia—First reorientation of nose cone that began its re-entry backward and the first flight checkout of a three-axis stabilization system suitable for use in an interplanetary vehicle were accomplished during a recent firing of a Douglas-Thor intermediate range ballistic missile from the Air Force Missile Test Range, Cape Canaveral, Fla. Nose cone package and instrumentation were provided by the General Electric Missile and Space Vehicle Department here in Philadelphia.

A 16 mm. camera placed in the nose cone to aid in the evaluation of the stabilization system also brought back the most complete U. S. films to date of a ballistic missile flight and the clearest obtained from an altitude of 300 mi. (see pictures).

It has become standard practice over the past year for the Air Force to increase the usefulness of the large ballistic missiles fired in weapon development programs by simultaneously using them to test equipment for space vehicles and to conduct scientific experiments above the atmosphere.

The 1,500-mi. Thor flight on July 24 provided a good example of this "piggy-back" policy combining the testing of tactical weapon systems with basic work needed for the future.

Primary Objective

Primary objective of the July 24 flight was to demonstrate that the attitude control system on a General Electric Mark 2 heat sink type re-entry vehicle could turn it over in case the vehicle made a backward re-entry, so that the heat shield would be facing forward. This vehicle is one of the standard series developed for the Thor and Atlas missiles.

The possibility of a backward re-entry is quite high under normal conditions for heat sink nose cones. Most of them resemble truncated ice cream cones, and this general nose cone shape will fly either forward or backward. They are unstable, however, and wobble, preventing the establishment of stable, laminar flow conditions over the heat shield.

Therefore, these nose cones must have attitude control systems using six gas jets to make certain that the heat shield is facing forward and stabilized to ensure that a successful re-entry can be made. On the July 24 flight, the stabilization system was specifically programmed to initiate a backward re-entry and, once this had been established, the system was released to perform its

design function of stabilizing the nose cone in the forward attitude.

The gas jet control system on this flight was of the type specified for a tactical nose cone, but the sensors and computers of the stabilization system were more elaborate and advanced than any needed for an earth-confined ballistic weapon. Two axis stabilization is all that is required for an IRBM or ICBM warhead and this can be accomplished with a number of well proved and reliable devices.

The stabilization system used on this test is advanced enough to be used in the navigation and control of a space vehicle on an interplanetary mission. This nose cone flight was the first known instance of a vehicle in space being fully stabilized around three axes. This is a prime requisite for interplanetary navigation.

The miniaturized infrared sensors, sun trackers and digital computers which were the heart of this system were produced by GE's Missile and Space Vehicle Department, contractors for the complete re-entry vehicle, after a development program which depended upon design data obtained from previous "piggy-back" flights, used to make scientific measurements above the atmosphere.

The three-axis stabilization system that flew in the Thor consisted of two infrared sensors to lock onto the horizon and provide references in the pitch and yaw planes. After these sensors were actuated and the nose cone fixed around local vertical, a sun tracker was used to stabilize in the roll plane and prevent the vehicle from spinning.

The value of this type of system for use in interplanetary travel is that it can operate in a celestial as well as an earth or planetary coordinate system and can transfer between the two as required, depending upon the nearness of a planet.

The complete system includes a digital computer between the sensors and the gas jet control units to convert the observations of the reference planes into command for the controls. A 2.5 lb. computer performed this function on the Thor flight. The infrared sensors weighed about 2 lb. and the sun tracker approximately 6 lb.

Other more advanced units developed in this GE program include an infrared sensor digital computer package which gives commands directly to the control system, that weighs less than 2 lb. Similar packages exist or are in development for very small sun tracker and star tracker units. Depending upon the mission, these three types of sensor-computers may be combined to provide

stabilization and control about three axes to less than .2 deg.

The design of the infrared sensors was based upon infrared measurements made above the atmosphere during two ballistic missile flights almost a year ago, one during the day and one at night. These measurements showed exactly the difference in infrared radiation of the earth and its atmosphere and the quality of the interface between the two. Two types of infrared horizon sensors were designed as a result of this work, one which looks at 90 deg. of the horizon and one that looks at all 360 deg. Each of them is able to locate and stay locked on the interface between the earth and the atmosphere to an accuracy of .1 to .2 deg. The device with the larger scanning field is useful at great distances from the earth.

Sun Tracker Design

The sun tracker is basically a simple instrument. It consists of a box with a slit in it and a long strip of sensitized material an inch or so behind the slit and perpendicular to it. There is a break in the sensitized strip so that if the slit is facing the sun directly, none of the light falls on the strip. If the tracker is not aimed directly at the sun, the light shines in the slit at an angle and causes a current to flow through the sensitized strip. This signal is sent to a computer which actuates the vehicle control system so that the tracker is again orientated directly at the sun and the light falls on the null point on the sensitized strip. The difficult part of the design of such an instrument is to get the exact geometry of the slit, the sensitized strip, the orientation of the device, etc., for a given mission.

In-flight monitoring of the stabilization and control systems in the Mark 2 and other types of heat sink nose cones has been highly successful using telemetry. A back-up data recovery system was designed originally into these re-entry vehicles in the event telemetry did not prove completely satisfactory.

This system recorded all pertinent performance data on tape inside a small capsule which was ejected from the nose cone after re-entry had been completed. This capsule has a flotation system and several devices to aid in its location and recovery on the earth's surface.

It was never intended to recover the complete heat sink nose cone because a detailed inspection of its surface is not necessary as in the case of ablation type nose cones. The successful recovery of several of the data capsules ejected after re-entry by the heat sink vehicles has contributed to growing knowledge of re-entry and recovery techniques.

Defense System Coordinates Nike, Hawk

Washington—Mobile air defense system designed to coordinate the efforts of up to eight anti-aircraft missile batteries and developed by Hughes Aircraft Co. for Army use was demonstrated here last week during the annual meeting of the Assn. of the U.S. Army. System can handle either Nike or Hawk batteries or an integrated mix of the two missiles.

The new "vest pocket" air defense system, known as the AN/MSQ-18, is now in limited use with Army units in Europe. A number of MSQ-18s suitably interconnected to integrate the control of a larger number of Nike and Hawk batteries over a widely dispersed area and designated Missile Monitor is undergoing evaluation by the Army Air Defense Board at Ft. Bliss, Tex.

The MSQ-18 provides a central point for displaying all aerial targets in a local area together with push-button

controls which enable an Army commander to instantly assign targets to each of several Nike/Hawk batteries as well as to monitor their progress in tracking and shooting down the targets. The system greatly accelerates the assignment of targets and improves battery integration over the manual-voice communication techniques formerly used.

The "operations central" mounted in a two and one-half ton Army truck, serves as the nerve center for the system. The operations central also can be installed in a small hut that can be transported by helicopter. Inside the operations central are two radar consoles which display aerial targets detected by a central surveillance radar or by other remote air defense radars.

To assign any target, or group of targets, to a specific Nike/Hawk battery, the battalion commander moves

a ball-shaped control to position a small cursor around the target blip on the radar scope, pushes a button to indicate the type of weapon warhead to be used, then pushes another button corresponding to the battery being assigned the target.

This instantly transmits a message to the desired battery, causing a similar cursor to appear on its tracking radar scope to show the target or targets assigned for its action. When the battery radar begins to track the assigned target, its aiming point is automatically transmitted back to operations central and displayed on the master radar console. This enables the commander to determine whether the battery is tracking the correct target. Battery operator also reports back when his radar is on target and when the target is within range of the missile and on the effectiveness of engagement, using push buttons. All such information is displayed for the battalion commander.

In addition to the mobile operations central, MSQ-18 consists of a truck-mounted coder-decoder unit located at each battery site, which converts messages from operations central into appropriate displays and converts battery operator inputs into suitable messages for transmission back to operations central. The messages, which are handled in digital form, can be transmitted by radio or land lines. When used with Missile Monitor, where individual missile batteries are widely dispersed, the coder-decoder equipment also corrects data on target location for difference in location between central air defense radar and the particular missile battery.

The MSQ-18 is being produced by Hughes Aircraft's Ground Systems Group, Fullerton, Calif., under a \$30 million contract awarded in 1958.

First system was delivered to the Army late in 1957 for evaluation at Ft. Bliss and was officially accepted in March, 1958.

Lt. Gen. Arthur G. Trudeau, Army chief of research and development, told the AUSA meeting that communications and electronics have enabled the Army to make necessary increases in its command and control capabilities, but he warned industry of a need for more standardization. Trudeau noted that contractors are tending to build up their own electronics capability, and that this trend is resulting in a fractionalization of industry. One result, he said, is the appearance of similar but non-standard items in various missile systems, complicating maintenance and logistics problems.

Along with an urgent need for standardization, Trudeau stressed a require-

ment for development of more efficient machine tools. He said the need for advanced machine tools to make the production process more efficient is a major challenge to industry.

Trudeau has ordered preparation of a classified brochure aimed at giving industry a complete briefing on the current status of the Army research and development program and on its long-range plans. Purpose is to give qualified contractors ideas and goals they can use to help the Army advance its research programs. The Army chief of ordnance already has a similar document defining its qualitative development requirements for industry.

GE Will Develop Army Turbine VTOL System

Washington — A turbine-powered ducted fan propulsion system for VTOL aircraft will be developed for the Army by the General Electric Flight Propulsion Division.

GE will develop a propulsion system which uses bypassed turbine engine air to drive a turbine wheel attached to the rim of a ducted fan for lifting a VTOL vehicle, then uses conventional turbine thrust for forward flight.

Army contract calls for fabrication, test and analysis of a prototype system.

GE system will use a valve to divert the airstream from a turbine engine into an annular duct around the lift fan. Lift fan will have turbine buckets attached outside its rim, and the airstream will be turned downward through this tip turbine, driving the lift fan and providing a certain amount of direct thrust.

Powerplant will be one of the group developed at the GE Small Aircraft Engine Department which includes the T64, T58 and J85.

In VTOL operation, the lift fan would be used for vertical lift, with the thrust vector controlled by exit vanes. As the VTOL aircraft moved into forward flight, the diverter valve would be closed, shutting down the fan and converting the turbine engine to use for forward thrust.

GE says the system is designed to obtain good operating efficiency from the turbine engine in cruising flight and to use the lift fan to augment turbine power in vertical takeoff and landing procedures.

System can use either one or two engines. Fan could be fitted in the fuselage between two powerplants, or dual fans could be used on the wing on either side of a powerplant installation. GE said a VTOL transport powered with four of these units could carry a 4,000 lb. payload 600 naut. mi. at speeds ranging up to 320 kt.



Lacrosse Fired in Army Exercise

Army-Martin Lacrosse surface-to-surface guided missile is about to be fired (above) during Army exercise. Below, an angular tracker (foreground) is adjusted to pick up signals from Lacrosse as it is propelled toward a target. Power supply unit is at right, below, and a computer and a range and direction finder are at left, below. The Lacrosse weapon system also employs a target ranging set to determine exact range and direction of a target. The operator of the target ranging set lines up his equipment by sighting through a built-in binocular system. Lacrosse, produced by Martin Co. in Orlando, Fla., is capable of delivering a nuclear, shaped-charge, or conventional warhead. System can be airlifted.



AIR BATTLES can be monitored and targets assigned to missile batteries from controls at tactical display screen of Hughes Aircraft Co.'s air defense system's command center. System is being produced under a \$30 million Army contract.

Pace Defines Views on Industry Hiring

Washington—Frank Pace, board chairman of General Dynamics Corp., told the House Armed Services Investigating Subcommittee last week that "the light of publicity" is "the surest protection" against any attempts by defense contractors to influence the spending of public funds on obsolete or unnecessary weapons for private profit.

In this connection, Pace said, the subcommittee's current investigation into allegations of a U.S. "munitions lobby" would be "of major benefit."

Pace stressed that the possibility of a contractor influencing the use of procurement funds is small but said that opportunities for improprieties do exist and "should not be ignored." He recommended:

- That no prohibition be placed against engineers and technical personnel going directly from military service into defense industry employment. Subcommittee members concurred on this.
- That there be a two-year cooling off period before officers having "direct contact with industry" while in the service could be employed by defense industries. Pace readily admitted that his inside knowledge of government operations gained during four years' service as director of the Bureau of the Budget and as Secretary of the Army played a role in his employment in 1953 as executive vice president of General Dynamics.
- That the retirement pay of military officers should be suspended while they serve in civilian government positions.

Pace added that the "worst situation" would exist "if industry and government were afraid to talk to each other." He said that situations always will arise in military procurement in which "the integrity of men is the determining factor."

Association Testimony

Pace was the leadoff industry witness to appear before the subcommittee last week following two days of hearings into the activities of major service organizations—the Air Force Assn., Assn. of the U. S. Army and the Navy League. Statements on the financial status of the three organizations included:

- Air Force Assn.'s total 1958 income was more than \$1.2 million. Army Assn.'s was \$582,617; the Navy League's \$179,247.
- 1958 advertising income of AFA's magazine, "Air Force and Space Digest" was \$526,807. The 1958 advertising income of Army Assn.'s "Army" magazine was \$143,402; Navy League's "Navy" stood at \$32,000.

Rep. Hebert said that the subcommittee is interested in determining the

"type and extent of the operations of associations that have axes to grind in influencing public opinion and the Congress." The subcommittee has sent questionnaires to 30 defense organizations, including Aerospace Industries Assn. (AW Aug. 3, p. 31).

AFA President Peter Schenk told the subcommittee that AFA retains its objectivity in evaluating the weapons systems which it promotes and that "we are not the civilian arm of the Air Force. Nor are we the Assn. of the U. S. Air Force."

Both Army Assn. executive vice president, retired Lt. Gen. Walter L. Weible, and Navy League President Frank Gard Jameson proclaimed their pro-service outlook. Gen. Weible said that "Army" obtains its information from Army public information personnel. Jameson said, "If we are not for the Navy, we have not reason for existing."

Rep. Porter Hardy (D.-Va.) disputed AFA's "protestations of objectivity by an organization that is so obviously a protagonist. . . . You protest too loudly."

Schenk cited AFA's advocacy of a single service as an example of its objectivity, since "many in the Air Force did not agree with it." Hardy replied that members of the subcommittee who have handled defense organization since the original unification act over a decade ago are "very well aware" that the



Convair Red-Eye Missile

Red-eye surface-to-air guided missile system will be developed by Convair (Pomona) Division of General Dynamics Corp. under \$6 million contract awarded by Army Rocket and Guided Missile Agency, Army Ordnance Missile Command. Missile contains propellant, high-explosive warhead and electronic guidance system. Weapon will be used by Army and Marine Corps against strafing aircraft. Launcher is 4 ft. long, 3 in. in diameter and weighs 20 lb. When capped at both ends, launcher tube serves as shipping container.

only service in favor of a single service is USAF. Rep. Leon Gavin (R.-Pa.) added that AFA "wouldn't select an Army or Navy command for the single service by any stretch of the imagination."

Army Assn. and Navy League declared that they avoid downgrading the weapon systems of other services in "educating" the public on the importance of the weapons of their own services. "We studiously and conscientiously avoid adverse criticism of others," Gen. Weible said. In the fight between Army's point defense Nike Hercules system and the USAF-Boeing Bomarc area defense system, Weible said, "we never said anything against Bomarc" in pointing out the capabilities of Nike.

Schenk volunteered that AFA takes sides in such battles. In intermediate range ballistic missiles, he said, AFA "argued openly" for USAF's Thor and called for elimination of the competing Army Jupiter and, in the Nike Hercules-Bomarc controversy, proposed elimination of Army's Nike.

Hebert proposed that military unification is made difficult by associations "supported by contractors" which aim to "mould public and defense opinion to line up with one service."

Employment Stand

AFA urged that all bars against employment by defense industries of retired military personnel be removed. Army Assn. and Navy League opposed any further restrictions than the present two-year ban prohibiting retired officers from selling to their former service.

"Waiting periods before a retired military man can do business with the Department of Defense only cloud the issue," Schenk told the subcommittee. "Cooling off periods only decrease a man's knowledge of a given situation; they do not strengthen his integrity. . . . The competence and integrity in the case of general officers has been certificated by the U. S. Senate. . . . We cannot believe that these military leaders hang up their integrity in the closet along with their uniforms." Hebert replied that a military man "is still a human being and not an angel."

Under questioning, Schenk said he saw no objection to "the same man changing sides at the negotiation table from one day to the next."

Schenk called for "strengthening the partnership that has developed between industry and the Department of Defense." He said that frequently industry's contribution is the "key factor" in determining military requirements. "Indeed, there are highly-placed mili-

tary men who sincerely feel that industry currently is setting the pace in the research and development of new weapon systems," he added.

Details disclosed in the associations' questionnaires included:

- AFA listed its 1958 entertainment cost at \$2,968 expended in selling advertising for its magazine and industrial exhibit space at its Airpower Panorama staged in connection with AFA's annual convention in Dallas. Army Assn. reported \$2,381 for entertainment; Navy League nothing.
- AFA's 1958 national convention involved a net loss of over \$67,000. Income of \$102,000 was more than offset by costs of \$169,000.
- AFA's Airpower Panorama resulted in a profit of \$44,000. Income totaled \$108,000; expenses \$64,000.
- Army Assn. reported a 1958 income of \$71,000 from registration functions and exhibits at symposiums and meetings.
- 1958 salary expenses were: AFA, \$295,000; Army Assn., \$150,000; Navy League, \$43,000.

Crash May Cancel Coleopter Project

Paris—Sneema may drop its Coleopter VTOL project as a result of the aircraft's near-total destruction when it crashed and burned during a recent test flight.

Test pilot Auguste Morel escaped with slight injuries following ejection from an altitude of less than 225 ft. The annular-wing aircraft, which first flew April 17, burst into flames when it hit the ground.

Coleopter airframe was built by Nord Aviation for Sneema. Powerplant was a specially rigged Atar turbojet. The fact that only one prototype of the Coleopter exists probably means Sneema will be forced to shelve the project which has been under development for over three years. French government has been reluctant to finance the project all along.

First reports indicated the accident followed initial attempts by Morel to convert from vertical to horizontal flight. Officials at the flight test center at Melun-Villaroche, where the accident happened, denied this was the case. They said Morel lost control of the Coleopter when, having completed several inclination maneuvers, which previously had been successful, he tried to stabilize the aircraft for its vertical descent. Sensing a lack of control, Morel declared an emergency and ejected.

Coleopter was equipped with a low-altitude type ejection seat developed by Sud Aviation. Ejecting at 225 ft., Morel's chute broke open at an altitude of about 12 ft.



Qantas Carries Extra Pod on Boeing 707-420 Jet

Spare Rolls-Royce Conway turbojet engine is hung in an extra pod below the wing of a Qantas Empire Airways Boeing 707-420 Intercontinental jet transport. Called Pod-Pak, the unit's fairings are streamlined at both ends; normal pod cowlings enclose the sides. Strut is suspended from the front wing spar by two fittings and to the landing gear support rib by four bolts; no structural changes are involved in the 707-420's wing. Use of the pod eliminates the need for a large stock of engines at any point other than major airports along the airline's route. Pod can be carried during normal operations.

News Digest

James L. Anast's resignation as president and director of Lear, Inc. less than four months after he stepped into the top position was announced last week by the company's board of directors. Anast, who took over the presidency in a top management shakeup (AW April 13, p. 35), will be succeeded by Albert G. Handschumacher. Handschumacher, a vice president of Rheem Manufacturing Co. until his appointment to the Lear presidency, is a former senior vice president of Lear.

Lockheed Aircraft Corp. reported sales increased in the first half to \$607,903,000, or 31% above the \$465,735,000 recorded in the first half of 1958 but that earnings dropped 9%—from \$9,743,000 or \$1.65 a share to \$8,840,000 or \$1.37 a share. Transition from the Constellation to the Electra turbo-prop transport program was blamed for the drop in net. Backlog as of June 28 was \$1,032,281,000, a decline compared with \$1,214,972,000 a year ago but an increase over the \$956,534,000 reported three months ago. Missiles and Space Division sales reached \$230 million; civilian airplane and other sales totaled \$123 million.

Radio Corp. of America will develop cable-microwave networks to link Minuteman ICBM silos and launch-control centers (AW Aug. 3, p. 93) under a contract awarded by Boeing Airplane Co., Minuteman Assembly and test contractor. Radiation, Inc. has received an additional \$1,900,000 contract for the ground portion of Minuteman PCM/FM telemetry equipment from Boeing. Radiation, Inc. recently received a \$4 million contract for airborne telemetry equipment for Minuteman (AW July 20, p. 32).

Consolidated Systems Corp. received a \$98,600 contract from NASA's Goddard Space Flight Center for development of miniature mass spectrometers to be placed in a 35-in.-diameter satellite to be orbited in 1961 and to measure and analyze elements of the uppermost region of the atmosphere, the exosphere.

Republic Aviation Corp. reports sales of \$109,812,737 and net income of \$1,577,807 for the first half of this year, compared with sales of \$86,374,821 and net income of \$1,528,967 for the same period last year. Earnings for the six months this year were \$1.07 a share, compared with \$1.04 a share for the same period last year. Backlog as of June 30 was \$532 million.

AIR TRANSPORT

Ozark Pegs Growth to Federal Subsidy

Midwestern airline, now starting turboprop service, sees basic role as non-competitive with trunklines.

By Glenn Garrison

St. Louis—Ozark Air Lines has keyed its current route expansion and re-equipment programs to the principle that local service carriers must rely on federal subsidy for future growth.

The midwestern airline, which last week received the second of three Fairchild F-27 turboprop transports and has recently seen its route mileage grow 46%, wants to remain a local service carrier. Ozark thus belongs to the school of thought expressed by some financial sources in the controversial local service financing question (AW June 8, p. 37).

Ozark management sees the carrier's basic role in the transportation picture as interdependent and not competitive with the trunk carriers. And because Ozark's part of the job is to serve small and intermediate points where traffic and revenues are relatively light, the airline does not believe it can or necessarily should be self supporting.

Ozark, one of the largest local service airlines, expanded its operations last March from 18,597 to 26,930 scheduled airline miles a day in activating new routes awarded in the Seven States Area Investigation Case of the Civil Aeronautics Board. Its fleet of 20 high performance and four standard Douglas

DC-3s now serves 52 cities in 10 midwestern states and traffic runs about 50,000 passengers a month.

The carrier financed its F-27 purchase through the CAB Guaranteed Loan Program, raising \$2,118,996 for the aircraft and spares. It also has issued 132,944 additional shares of common stock to broaden its equity base and to provide \$551,530 for ground support equipment, development and working capital.

In linking the smaller points with the big cities of the Midwest, Ozark competes with the trunklines at only a few points and 70% of its traffic is connecting.

"We're a feederline, period," Joseph H. FitzGerald, executive vice president and general manager, told AVIATION WEEK. FitzGerald, formerly director of CAB's Bureau of Air Operations, is heading the airline while President Laddie Hamilton is on leave of absence.

The small and intermediate cities, FitzGerald points out, must be served, and among them the middle-sized, prosperous cities require a high frequency of flights. Yet there is not sufficient traffic to justify frequent trunkline schedules, and Ozark fills the gap.

"We're not the two-round-trips-a-day boys over these routes," FitzGerald said. He foresees some improvement of Ozark's routes as the trunklines get larger, faster airplanes and move out of the medium sized cities, but not enough improvement to alter the basic character of Ozark's system.

This basic character is not self supporting. To be self supporting, Ozark would have to change its pattern of service, get nonstop and long-haul routes in the high density markets. And because the trunklines would not relinquish these markets, Ozark would have to compete with them, and it is not designed to do this.

Local service carriers vary greatly not only in their route patterns but in their "aspirations," in FitzGerald's view. Ozark is perhaps more a feederline than any of the other local service carriers, he said, and it never expects to become a regional carrier.

Regarding a possible commuter-type, no-reservation service proposed by Allegheny Airline President Leslie O. Barnes (AW April 6, p. 38), FitzGerald believes it is a good approach for Allegheny but not for Ozark. Reason: because Ozark's business is so preponderantly one of connecting with the trunk carriers, reservations are necessary to protect the passenger's over-all trip.

A major problem faced by CAB and the feeder industry, in FitzGerald's view, is the expanding need for government support because of the expanding total of points served. While the subsidy need per plane mile has declined because of increased efficiency of operation, the total need nevertheless is greater. The Ozark official believes CAB will devise a new mail rate formula providing the business incentive to keep costs at a minimum and yet to expand service.

In this connection, Ozark has effected a reduction in maintenance costs of its DC-3s from over \$34 to under \$32 per flight hour, including increased wage

costs of about \$1 per flight hour.

Ozark expects to prove out its initial F-27 program within about a year of start of service, FitzGerald said. Three aircraft were ordered for this first phase as the minimum number practicable. If the program proves successful, five aircraft would be optimum for the present stage of Ozark's development, according to FitzGerald. The turboprop is not considered a replacement for the airline's DC-3s but as part of an integrated fleet.

Added capacity rather than frequency is needed on some segments, while on others there is presently little prospect of filling additional capacity. Ozark's DC-3s have 21- and 27-seat configurations. The F-27s will seat 40 and will require at least eight more passengers per mile than the DC-3s to achieve the same economic results. The F-27s also can compete with trunkline equipment over the few Ozark route segments that are competitive.

The new aircraft is expected to be particularly useful at Chicago where 25% of Ozark's traffic is developed and where frequencies are limited by terminal conditions. Another problem at Chicago with the DC-3s is the bad weather limitations that restrict advance bookings to 21 passengers during the winter. If weather turns out to be suitable, the full 27 seats can be filled. Ozark's July schedules called for 25 weekday departures from this city.

Ozark's turboprops will go in service between city pairs that in 1958 generated 48.8% of the airline's total traffic. Only two cities not in this high-density category of Ozark's routes will be served by the F-27.

During the first year of operation, the carrier expects to get a 6 hr. 43 min. average daily utilization from its F-27s, compared with 5 hr. 27 min. from its DC-3s in that period.

Financial effect of the new equipment as estimated by Ozark indicates subsidy needs of \$4,367,000 for the year ending Aug. 8, 1960, as compared with \$2,741,000 for the year ended Feb. 28, 1959, and \$2,023,000 for the six months ending Aug. 31, 1959. For the year ending Aug. 31, 1961, subsidy need will be \$4,135,000 and for the year ending Aug. 31, 1962, the need will be \$3,859,000, in Ozark's estimate.

Ozark selected the F-27 as the aircraft best suited to its particular needs, noting again the variation in needs among the local service carriers with different operational as well as traffic situations. Ozark's own routes lie over a low, flat area and the highest point in its system is 1,300 ft. Its average stage length is about 86 mi. Under the given conditions, Ozark's studies showed that the most efficient piston types had higher seat mile costs than the turboprop in addition to the ob-

solescence of the piston aircraft.

Considerable shopping around for a loan for its F-27 program was reported by Ozark to CAB in its application for a loan guaranty, as follows:

"Ozark Air Lines has handled its major financing with the Bank of St. Louis since the beginning of its operations; however, in approaching the financial requirements of the F-27 program involving approximately \$2½ million it became apparent that it would be impossible to handle the complete financing with the Bank of St. Louis due to its loan limitations of \$1 million. . . . It appeared Ozark could obtain its necessary financing from either local area or New York banks, provided a government guarantee on the loan could be obtained. Thus, it became a question of determining which would be the better source of capital. The decision was made to handle the financing on a local basis and necessary negotiations were held with the City National Bank and Trust Company and the Mercantile Trust Company. . . . In addition to banks, Ozark explored the possibility of buying two F-27 aircraft from Wohl and

Associates, New York City. These negotiations were broken off because of the inability to obtain financing for longer than a five year period.

"Discussions were also held with Crutenden, Podesta and Co., an underwriting firm in Chicago, regarding the terms and possibility of issuing debenture bonds coupled with a guaranteed loan in the amount of our financial requirements rather than by handling it through long term bank loans. Because of the uncertainty of the market for such bonds, this idea was discarded.

"In its attempts to secure loans on a non-guaranteed loan basis, Ozark believes that it explored the market thoroughly, both directly and by review of the experience of other local service carriers that have negotiated equipment loans. Except for the five-year proposal made by Wohl and Associates which would have involved the additional costs of a lease-option program, no other non-guaranteed loan was available. Ozark was specifically advised by the banks that they would not consider a loan for as long as a 10-year period without a government guarantee."

France Gains West Coast Stop

Washington—France last week gained access to the U. S. West Coast in a compromise agreement reached at the conclusion of bilateral negotiations in Paris. The agreement marked the end of an impasse that began over one year ago when the French renounced their air transport pact with the U. S. (AW July 28, 1958, p. 30).

The new proposed bilateral, which must still be formally ratified by the two nations, does not, however, give France the principal goal it had sought—a New York-West Coast route (AW Nov. 17, p. 38). Here's what it does provide for France:

- Polar route from France to Los Angeles or San Francisco.
- Traffic rights from Paris to Anchorage on a Paris-Tokyo route already in effect.
- Addition of Baltimore to a New York-Washington route.
- Route from New Caledonia or Tahiti to Honolulu and beyond to either Los Angeles or San Francisco.

U. S. carriers in turn were granted the rights to serve both Marseilles and Nice on Far Eastern routes. Under the old pact, U. S. airlines had authority to serve only one of these points. In addition, American carriers received duplicate operating authority over the New Caledonia and Tahiti route granted the French.

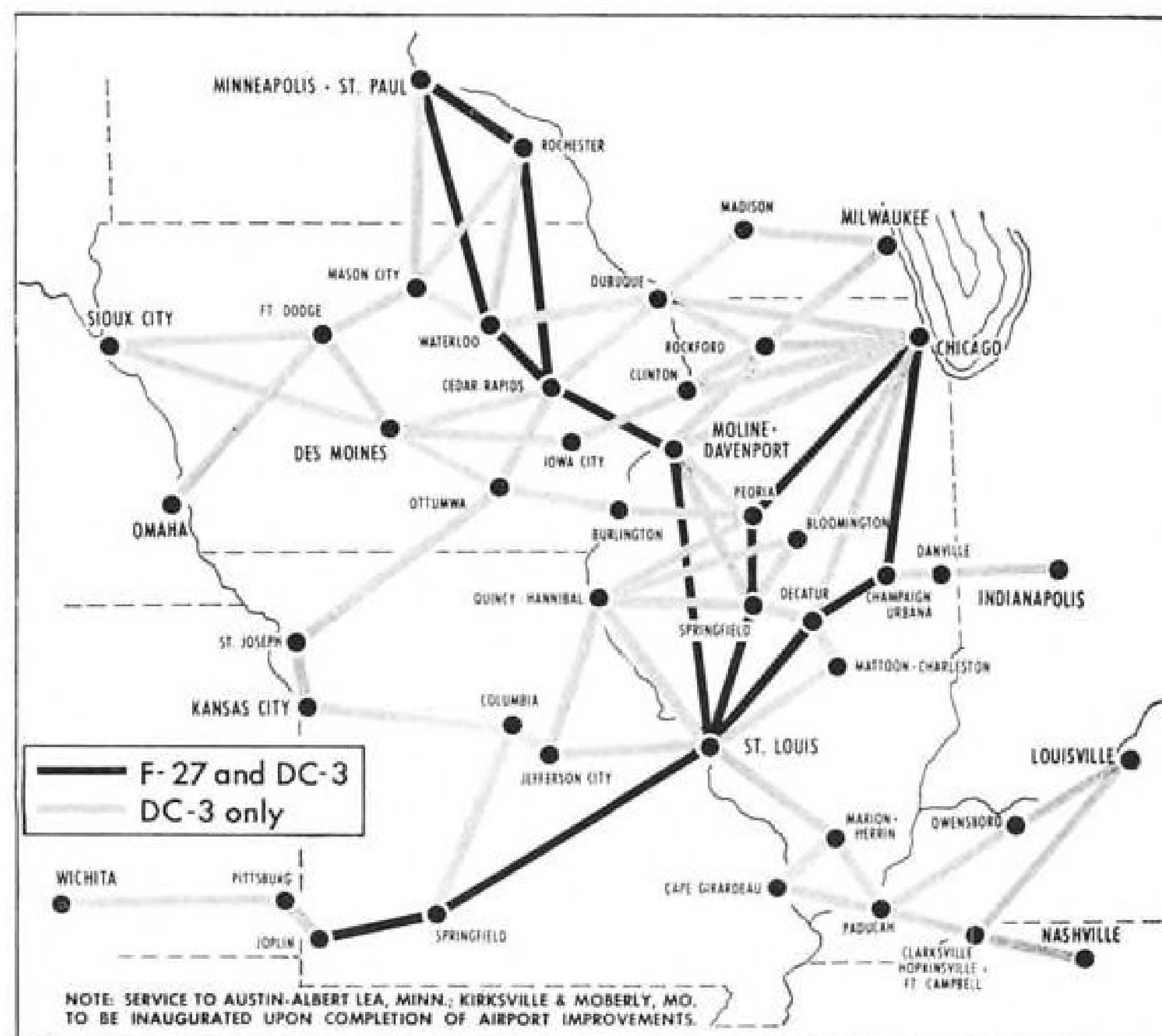
State Department officials here say the significance of the agreement lies in the fact that major portions of the bilateral to which France had objected remain in the new agreement.

France denounced the 13-year-old pact last year after failure to convince the U. S. that the French should have "double truck" rights, or duplication of any routes granted U. S. carriers. Major concern of the French was a desire to cut back on both the number of American carriers serving France and closer control of traffic capacity.

French delegates also pointed out that, while the U. S. has three carriers—Seaboard & Western, Pan American, and Trans World Airlines—serving France, only Air France entered this country. U. S. original stand was that France should not have any more routes than it already had.

In New York, Trans World Airlines said it was "pleased that the French and U. S. governments have reached agreement on the bilateral." Pan American World Airways had no comment.

Basis of France's renunciation of the treaty—which formally expired in June—and its demands for new routes was the fear that the large increase in seating capacity from the introduction of U. S. jet transports would seriously cripple Air France in the New York-Paris market.



INTEGRATION of Fairchild F-27 turboprop transports into Ozark Air Lines' route pattern is detailed above. F-27s will serve city pairs that generate 48.8% of its total traffic.

Board Registers Objections To Local Airline Rate Proposal

Washington—Local service airlines are restudying a Civil Aeronautics Board proposal for revised class rate formula for subsidy payments following CAB objections that modifications in the plan suggested by the carriers could result in subsidy payments higher than those planned by the Board (AW May 11, p. 40).

Changes in the proposal recommended by United Research, Inc., a private research firm employed by the Assn. of Local Transport Airlines and the Air Transport Assn., would constitute a significantly new subsidy formula if adopted, according to Board economists.

Designed to replace the complex mail rate proceedings now in effect, the Board's original plan calls for monthly subsidy payments based on a per-route-mile rate dependent upon frequency of flights and assumed passenger loads and would allow carriers a reasonable profit as part of the subsidy payments.

United Research extended the Board's basic plan to include the addition of a station subsidy and an allowance of 10% of operating revenues to be deducted from the combined sums of station and mileage subsidies. United Research also recommended that subsidy payments be applied to 12 daily round-trip flights as compared with the six suggested by the CAB plan.

Emphasizing the magnitude that the subsidy payments could theoretically reach if the full United plan was adopted, the Board estimated that increases in flight frequencies by the local service carriers to obtain maximum subsidy would cause the annual bill to "leap" to \$89.5 million based upon 1958 route structures. The many new routes authorized since then, the Board said, would bring the total to almost \$120 million. Subsidy payments under the present formula totaled \$36.7 million for the 13 local service airlines in Fiscal 1959.

Calling attention to its limiting of subsidy payments to the first six daily round trips for each route segment, CAB said that this number exceeds the maximum now being operated by most local service carriers.

Commercial revenues, CAB said, should cover an increasing share of the costs of operating a route segment as flight frequencies are increased. It said, for example, that this revenue should cover 46 cents of each dollar's expense on a two round-trip segment; 60 cents a three round-trip segment. For subsidy purposes, the Board added, public service requirements will be adequately

served by a maximum of six round trips a day per segment.

Local service concern over the Board's use of Douglas DC-3 operating costs as a base for compiling operational cost for new equipment, such as the Convair 340 and Fairchild F-27, also was noted by the Board.

CAB said studies it conducted showed that "in spite of the various problems" of integrating and operating new planes, their cost per seat mile during integration did not generally exceed that of the DC-3 and that, in the case of the F-27, was substantially the same.

Increased utilization and proved efficiency with the new aircraft in the future should provide the airlines with a "cushion" in the form of reduced unit costs, the Board said. It added that the growth of subsidy payments, now being experienced and attributed to the larger equipment, is more properly a result of the lag of utilization of capacity offered.

CAB also rejected a United recommendation that machinery of the program be reviewed quarterly instead of annually. The Board said it regarded this suggestion as "clearly unworkable" since it would involve such a volume of material that a full-time staff would be needed to recompute all the factors within the formula.

Durfee Favors Routes Based on Traffic Flow

Washington—Civil Aeronautics Board Chairman James R. Durfee believes local service airlines should be granted route awards based upon traffic flow area as a means of attaining greater management independence. Awards are now largely based upon distinct geographical areas served by the airlines.

Speaking at a recent regional meeting of the Air Line Transport Assn., in Fairbanks, Alaska, Durfee also termed CAB's proposed class rate subsidy formula as a "new look" intended to rationalize the distribution of subsidy payments and stabilize the financial health of the carriers. Adoption of the new formula, he said, would eliminate the "second guessing" of airline management by the Board and restore the confidence of the taxpayers in local service operations. Absence of a rational scheme, he added, could result in a loss of this confidence on the part of both taxpayers and Congress so that they "will begin to question as they did this year, the rising subsidy bill."

Terming the Board's present route

award procedure as a "cumbersome process" which "causes far too great an amount of delays, complaints and dissatisfaction," Durfee told ALTA members that Board aid to local service airline growth may best be accomplished through CAB attention to three general tasks. They are:

- CAB must lay down boundaries for local service operations in order to limit duplication that increases costs and wastes subsidy. Durfee said he favors a route standards program by which an area would be permanently marked out for a carrier by traffic flow. The carrier should be given a monopoly, "for the time being," Durfee said, with the freedom to provide all needed local service, decide which cities can support this service within the allotted subsidy, determine routings and schedules and other similar management decisions. He added that, while CAB would still have to hold route hearings to adjust boundaries between carriers and redefine the relative tasks of local and trunk airlines, the plan would still offer the best chance for management control and initiative under subsidy regulations.

- Adoption by the carriers of the Board's proposed class rate formula for subsidy is the only means by which the local service airlines can accomplish a more independent route program, Durfee said. He emphasized the importance of CAB's duty to get the maximum amount of local service transportation from each subsidy dollar while seeing that it is spent to improve the general air transportation system.

- Many "hard and fast" rules imposed on local service carriers should be lifted to provide greater management incentive. Durfee said Board policy in placing special local service restrictions on top of linear route descriptions on the airlines has assured a minimum number of stops for a certificated community but also has "hobbled" management to the extent that the carriers have often been denied the necessary flexibility to provide the kind of service actually needed by the communities.

"I would far prefer to see the Board checking the exercise of a less restricted management discretion than prescribing these hard and fast rules," Durfee said. He added:

"The alternative to this kind of scheme, however, is a continuation of a scheme that has government looking over your shoulder at every move you make, requiring prior approval of every step you take and second guessing you on every decision . . . and doing this with an organization that cannot hope to grow large enough, fast enough to meet the problems you face with it. What we want is to keep management out of the Washington hearing rooms . . . there aren't any passengers to be sold there."

FAA Fines PanAm on Operation of 707

New York—Pan American World Airways has paid a \$500 fine to Federal Aviation Agency for an operating violation in connection with the Boeing 707-120 which was involved in an emergency landing at New York International Airport on July 11. The fine, however, relates to a Dec. 24, 1958, operation with the aircraft and not to the flight that turned back to Idlewild after losing two main landing gear wheels on takeoff.

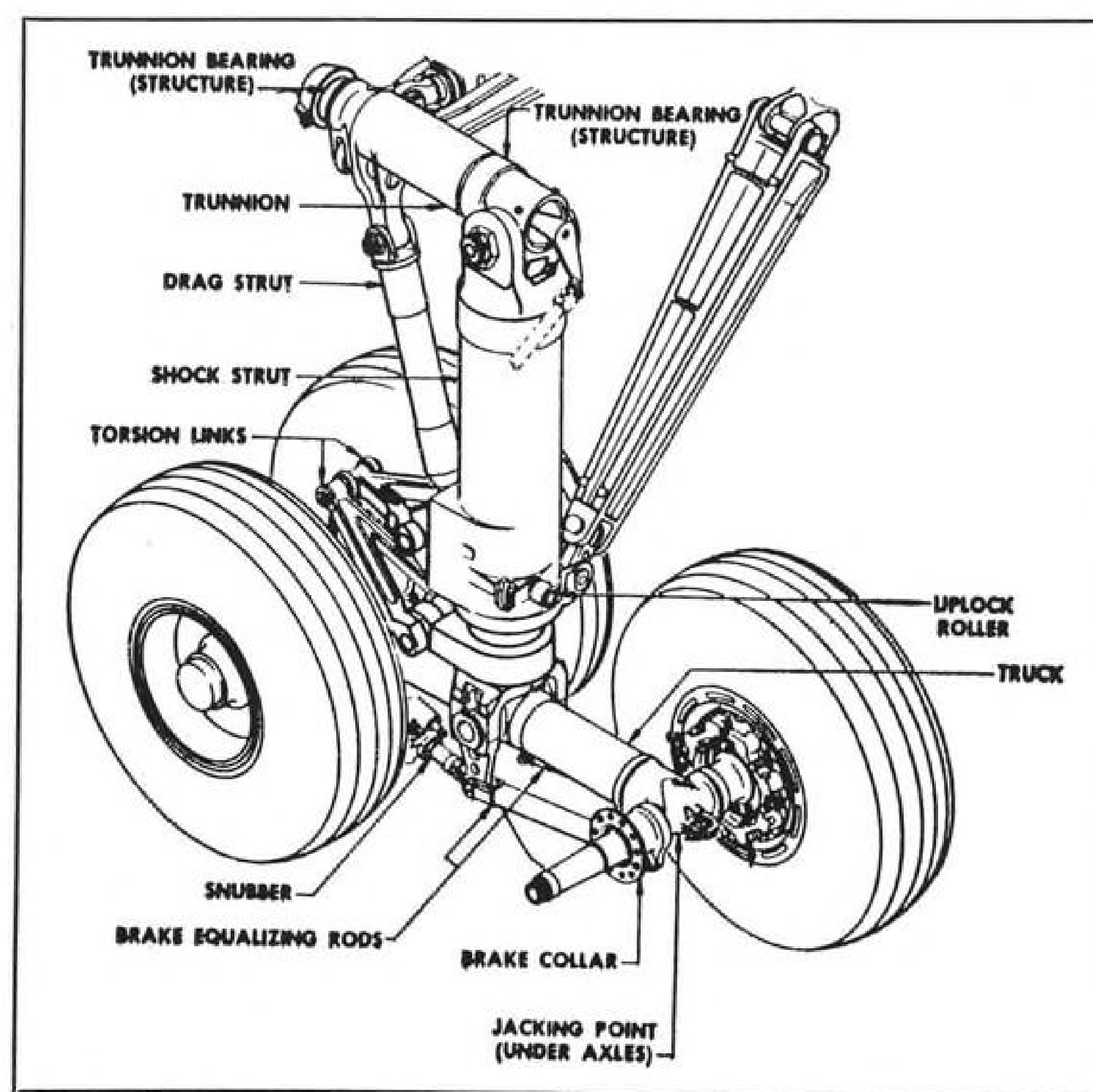
A second violation charge, now being processed by FAA's legal department, covers operation of the plane on July 10 without a snubber assembly. The first charge concerned operation without a snubber and operation without a fusion plug in the wheel. Pan American says the wheel was delivered without the fusion plug. The airline and FAA differ as to the essential nature of the snubber for safe flight. Pan American's manual, however, has recently been changed to require an operative snubber.

The snubber, a landing gear part designed to dampen the oscillation of the gear truck after takeoff, is the subject of one of three minor gear modifications. Boeing has decided on after tests following the Idlewild emergency (AW Aug. 3, p. 35). Excessive oscillation of the truck beam, resulting in contact with another part of the landing gear, is believed to have weakened the beam and led to its failure in the July 11 takeoff.

Pan American's position, as expressed at a recent CAB hearing in New York, by R. M. Adams, maintenance manager of the airline's Atlantic Division, is that the snubber performed a desirable function but was not considered an essential safety item. On about July 1, Adams testified, this item among others was discussed with FAA and it was decided to change the carrier's maintenance manual to require an operative snubber at all times. But, Adams said, there was no indication that this was an emergency item and the revision was not published until July 15. An Airworthiness Directive requiring inspection of truck beams was issued July 24.

Robert Crothers, FAA maintenance adviser of the International District Office, testified that the item had been discussed with the airline for some time. Pan American's manual was not acceptable to FAA in this respect, Crothers said, and Pan American "after a time agreed partially with our conclusions" and ultimately accepted them.

Pan American's technical theory regarding the gear oscillation, as expressed by Adams at the hearing, is primarily concerned with the automatic braking of the wheels during the retraction



GEAR of 707 is detailed above. Leveling cylinder is hidden by truck beam.

cycle. Balance of rotational forces of the two pairs of wheels on each main gear is the primary design feature which prevents excessive pitching of the truck, Adams said.

The snubber, while it performs a desirable function, "was not an essential safety item," he said. PanAm felt that if sufficient pitching forces were set up by uneven braking, the snubber would not be able to arrest them and prevent damage to the beam.

Boeing's modifications to the jet's gear assembly were covered in a service bulletin issued last week and retrofit parts will be issued. They apply to all models of the 707. Boeing said its tests showed that unequal stopping of the front and rear pairs of wheels after takeoff could cause excessive up and down pitching of the truck beam.

Pan American Capt. Edward Sommers described in detail his landing of the 707-120 with two wheels missing on his left main gear. His takeoff appeared normal, Sommers said, and he was airborne at about 161 kt. Gear-up was ordered as soon as a definite climb was established, but he was advised by the first officer that the gear-down warning lights had not gone off. Shortly after that came the tower advice that part of his gear had been lost. Som-

mers cruised at 2,500 to 3,000 ft. with gear down, flaps down 20 deg., always VFR and always in sight of the airport. He decided to land at Idlewild because it was "home base" and "I was sure that Idlewild could do the best job." He considered foaming of the runway an added precaution but said he frankly had never seen the foam and didn't know whether it really would have helped or not. There was a lag of about 25 min. between completion of preparations and clearance to land, and his fuel was getting low. He had 10,000 lb. when he landed, enough for a go-around. He crossed the threshold at about 133 kt., a little more than would have been normal because of the cross wind and because he wanted to make a soft landing. Initial part of the landing seemed normal as far as the directional factor was concerned. He raised the spoilers, did not initially use brakes but applied all four thrust reversers. As the weight came down on the gear, the left strut dug in and the aircraft tried to turn left. He used the right brake to bring the plane back. He evidently overbraked it slightly, because it started to the right. He cut the right reversers and it returned to center. By then the landing roll was over.

Another First in the West by Western



Western *electra* JETS... sparked by AC Jet Igniters

Western Airlines pioneers another first in modern flying between major cities of the West with its new *electra*/JET service. And the Electra's Allison engines are sparked by AC Jet Igniters—quality-made by the manufacturer with a long list of pioneering firsts in the field of aircraft spark plugs.

Efficient DC-6B Service... sparked by AC Aircraft Spark Plugs

For its DC-6B fleet Western wants reliability, too... high performance spark plugs with low premature removal and fewer maintenance delays. That's why, after extensive test evaluations, Western is now equipping its fleet with AC Aircraft Spark Plugs. Why not test them yourself?

DISTRIBUTED BY:

Airwork Corporation • General Aircraft Supply Corporation
Pacific Airmotive Corporation • Southwest Airmotive Company
Standard Aero Engine Ltd. • Van Dusen Aircraft Supplies, Inc.



General Foreman Al Jespersen watches Aviation Mechanic Frank Neal "bomb-test" the AC 271 Spark Plug. Frank prefers the combination of AC 271 and 275 spark plugs to power Western's P & W R2800-CB Engines "... they are easier to clean, provide greater scavenging area which keeps plugs burning cleaner, longer."

Aircraft
Care
starts with



AIRCRAFT SPARK PLUGS

AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS

Airlines Modifying Electra Wing To Cure Skin Cracking Problem

By Robert H. Cook

Washington—Wing structures of the Lockheed Electra turboprop transport are being modified by American and Eastern Air Lines as a result of nine cases of wing skin cracks reported to the manufacturer in the last three months.

Seven of the skin breaks occurred on Eastern aircraft, one on a Western Air Lines transport and the third on a Lockheed test plane.

From 2 in. to 10 in. in length and running spanwise, the cracks appeared in the front edge of the top wing plank, which is four planks back from the leading edge, and in all cases originated directly over the large rib carrying the landing gear loads. This rib is located outboard of the No. 2 and 3 engine nacelles.

Cracks were discovered in both right and left wings, according to Federal Aviation Agency spokesmen.

Early suspicions that cracks may have been a byproduct of the Electra's vibration problem (AW May 4, p. 47) were unfounded, the FAA spokesmen said, on the basis of Lockheed stress testing and analysis. These tests indicated that the skin damage resulted from excessive wing skin tension caused by vertical loads on the landing gear which were transmitted to the wing skin.

Tests also showed that the damage was not caused by wing loadings from excessive bending and twisting in flight.

Although two of the aircraft, the Lockheed test plane and Western aircraft, were involved in hard landings which exceeded the Electra's design requirements, Lockheed says that the tests indicate that the problem of wing skin cracks is a matter of design needing correction rather than an airline operational problem.

Lockheed Tests

Lockheed factory modification to correct this problem has been to install an aluminum plate one-quarter inch thick, four inches wide and 42 in. long as a chordwise reinforcing strap over the rib cap from the middle of plank No. 2 to the middle of plank No. 6. The plate acts as a bridge to lift wing risers from both sides, preventing the skin from sagging and reducing local bending stresses to a minimum. On the aircraft which have experienced wing cracks, additional doublers are now being installed.

To substantiate their belief that the damage was caused by stress transferred from the main gear, Lockheed

engineers conducted tests of flight, landing and taxi loads with stress gages placed on the wings of the company's test plane.

Analysis of the results showed that vertical deflection of the landing gear support rib under landing and taxi loads caused the wing box to arch in a chordwise direction. Weight of the nacelle inboard of this rib tended to hold the wing surface down to prevent the arching and resulted in a spanwise bowing of the surface.

At the spanwise splices of the wing skin planks, the risers were lifted by the rib skin clips from only one side, allowing the skin to sag and resulting in high stresses at the point of failure.

American Modifications

American Airlines experienced no trouble with the wing skin crack problem but has made the modification recommended by Lockheed. Completed fix per plane requires approximately 30 hr. with the aircraft going to New York for the repairs.

American also has completed engine tilt modifications to seven of its 16 Electras.

Its remaining 18 Electras on order will be delivered with the modification done by Lockheed.

Tilt modification at Eastern, which is more than one third complete, requires eight days per plane and is done in the company's Miami maintenance shops.

All 33 Eastern Electras requiring this fix are expected to be modified by the end of October. Seven others will be modified by Lockheed before they are delivered.

Air-India Supported For New York Route

Washington—Air-India International won a Civil Aeronautics Board examiner's recommendation last week for a foreign air carrier permit which would extend the airline's route system from London to New York.

Examiner John A. Cannon based his recommendation on grounds that Air-India's application is both in the public interest and in accord with a bilateral agreement signed between the U.S. and India in 1956.

Air-India presently operates a fleet of 10 Lockheed Super Constellations and has ordered three Boeing 707-437 jet aircraft for delivery early next year. Initial service to New York from London is planned for March, with three

round trips a week for the Boeing 707 and two round trip cargo flights utilizing the Super Constellations, the examiner noted.

The airline told the CAB examiner that it expects to achieve a load factor of at least 60% on the new service, since the 1958 load factor on the India-United Kingdom routing was 62%.

TWA Registers Profit In Half-Year Report

Washington—Trans World Airlines reports net income before taxes of \$3,972,000 for the first six months of 1959 as compared with losses of \$11,923,000 for the same 1958 period.

In another six-month report, KLM Royal Dutch Airlines said it recorded a net loss of \$573,000 in the first half of 1959 as compared with a loss of \$576,000 for same period last year.

TWA had revenues of \$159,306,000 for the six month period this year. After reserving \$2,408,000 for income taxes the airline had a net income of \$1,564,000 or 23 cents per share on 6,674,000 shares of common stock.

TWA attributed revenue gains to operations with the Boeing 707 aircraft, which have been flying with about a 94% load factor and a system-wide on-time departure record of better than 70%. The carrier also cited tighter management control over expenses.

KLM had total operating revenues of \$63,574,000, operating expenses of \$68,208,000 and an operating loss of \$4,634,000 in the six-month period. Income of \$1,083,000 from sale of aircraft and \$3,538,000 released from provisions for taxes on profits, combined with a loss of \$380,000 termed miscellaneous, produced the \$573,000 net loss figure. The airline's net loss is equal to minus 40 cents per share.

Other airline financial reports:

- **Western Air Lines** reported first half earnings of \$1,894,874 or \$1.87 a share on total revenues of \$27,932,161. Comparing these with the first half in 1957 rather than 1958, which was drastically affected by a pilot strike, total revenues showed a 42% increase from the \$19,642,761 in that period. Earnings for the first half of 1957 were \$1,473,310 or \$1.65 a share, but this included 56 cents a share gained from sale of property compared with only 6 cents a share from similar sources this year.

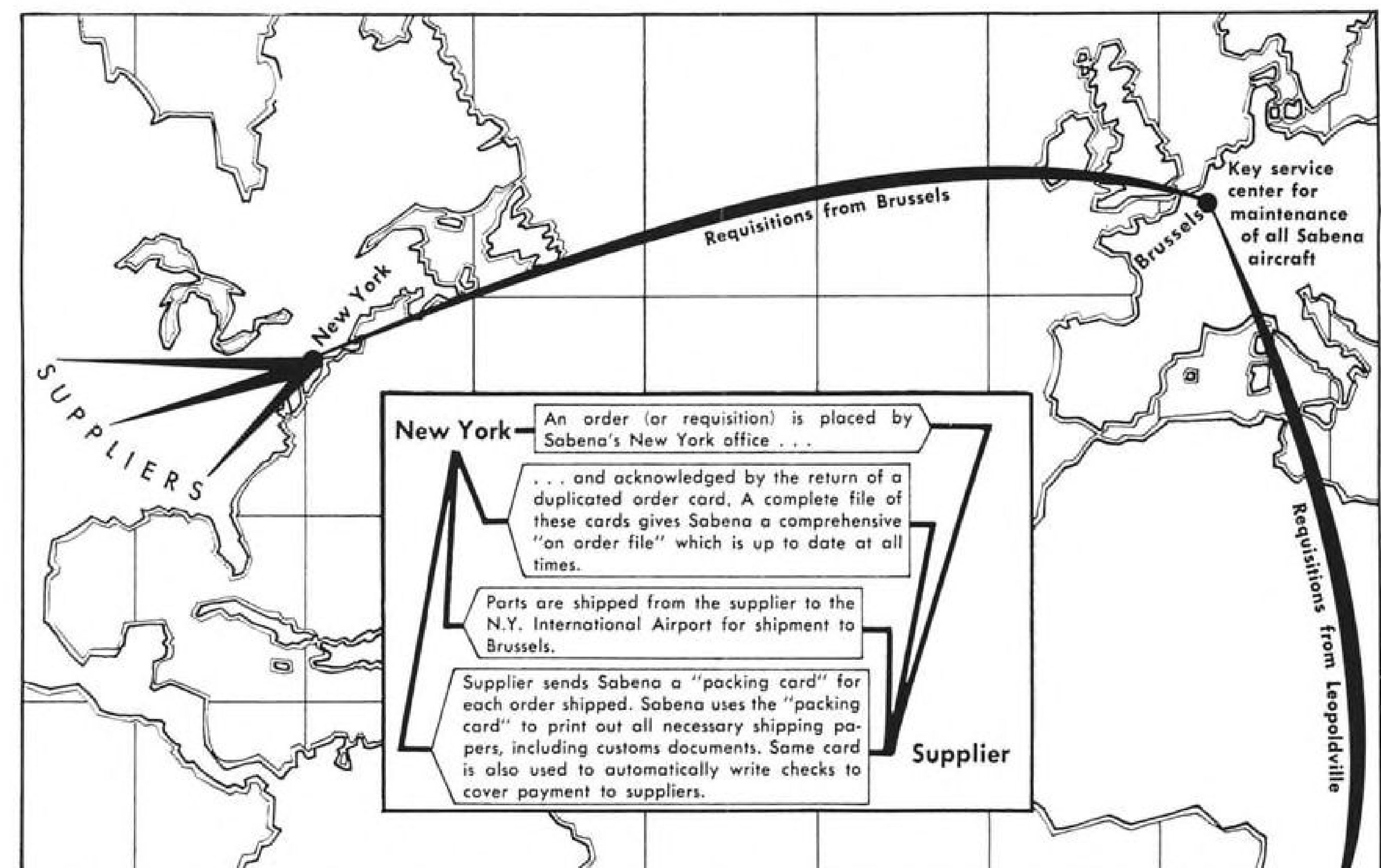
- **Mohawk Airlines** showed a first half operating income of \$99,564 compared with an operating loss of \$228,810 for the same period last year. Interest and other expense produced a net loss this year of \$22,715 compared with a net loss of \$336,962 last year. Total revenue this year for the period was \$5,165,268 compared with \$4,115,898 for the same period last year.

The logo consists of a black silhouette of a fish, possibly a koi, facing right. The word "Edo" is written in a white, stylized, cursive script across the middle of the fish's body. The fish is set against a circular background that has a scalloped or wavy bottom edge, resembling a bowl or a pond.

For complete data on Edo Model 345A Loran, send for Technical Manual to Dept. S-C.

Edo (CANADA) Ltd.
Cornwall, Ontario

International Sales and Service: **AEROMARITIME, INC.** 1000 Vermont Ave., Washington, D. C.



THREE-CONTINENT procurement network developed by Sabena Belgian World Airways includes radio between Brussels and New York.

Sabena Procurement Net Keyed to Jet Age

Sabena has five Boeing 707 Intercontinental jet transports on order for delivery late this year and early in 1960. Acquisition of this jet equipment means addition of possibly 20,000 to 30,000 items to a Sabena inventory which already includes about 100,000 different items, according to M. Curtiss Fillmore, manager of the airline's North American office, Technical Procurement Division, in New York.

The Division Office is the operating end of a supply pipeline from New York to Sabena centers at Brussels, Belgium, the key maintenance center and Leopoldville, in the Belgian Congo. Nearly everything purchased for stock shelves at Brussels and Leopoldville is manufactured in the U. S. and used on American-produced aircraft, according to Fillmore.

To meet jet age problems, Sabena adopted Air Transport Assn. Specification 200, a standardized system involving use of common language media (such as paper tapes and punched cards)

Sabena instituted the system with one of its major suppliers, Douglas Air-



CODED tape from radio transmission is fed into IBM machine to punch order cards.



FRENCH FLIERS CONQUER ANDES!

MERMOZ AND COLLENOT
LINK ARGENTINA, CHILE!



Santiago, Chile, Feb. 2, 1928—The first successful commercial flight over the Andes mountains between Argentina and Chile was completed today when Jean Mermoz and Alexandre Colletot landed their Laté 25 monoplane at Copiapo, Chile, after a 900-mile flight from Buenos Aires, Argentina. The intrepid airmen overcame sub-zero temperatures and radiator difficulties to pave the way for a regular commercial air service between the two countries.

FIRST IN INTERNATIONAL AIR TRAVEL! Since the very beginning of international flight, the exploits of French aviators like Blériot, Bossoutrot, Noguès and Mermoz have made aviation history. Air France is proud to continue this tradition of French leadership in aviation by offering the most non-stop flights both ways between New York and Paris and the fastest jet service between Europe and the Middle East. And next year Air France will put into operation one of the largest pure jet fleets in the world.



AIR FRANCE

WORLD'S LARGEST AIRLINE/WORLD'S FIRST INTERNATIONAL AIR SERVICE



Douglas DC-8 Production Tempo Increases

Five Douglas DC-8 jet transports are lined up at Douglas Aircraft's Long Beach, Calif., plant prior to starting certification tests at Edwards AFB. Assembly of 60th airplane is under way. Planes shown here will go to Delta, Pan American and United Air Lines; five jets on line are Douglas-owned and last plane is C-133 turboprop transport. Below is first of six DC-8s which will be operated by Trans-Canada Airlines (AW Aug. 3, p. 37). Aircraft is first of production DC-8s to be powered by Rolls-Royce Conway bypass jet engines, each producing 17,500 lb. thrust. Trans-Canada plane now is undergoing flight test program at Edwards.



craft Co. and Fillmore added "within two years we expect to have similar arrangements with all our major suppliers as well as many of the smaller manufacturing concerns and some distributors." He pointed out that Sabena has doubled its ability to process purchase orders with Douglas, through use of the system.

ATA Spec. 200 first was put into operation by United Air Lines last year, in cooperation with Douglas. ATA spokesman said system takes about 18 months to reach peak efficiency.

Another innovation of Spec. 200 is streamlining of paper work so that a single card processed on an International Business Machine accounting machine can:

- Place the order.
- Obtain verification from the supplier.
- Furnish documents needed for export.
- Make payment to the supplier without any requirement for a conventional invoice covering the cost.

Here's how it works: Sabena keeps a file of punched cards for each of the parts or items supplied by a given manufacturer, in effect, a supply catalog termed Procurement Data Cards and Procurement Data Reference Cards.

Thus, when inventory analysis determines that stock levels in Leopoldville

or Brussels are in need of replenishment, appropriate data cards are pulled from a master file to initiate the purchase order procedure. From this master file, order cards are forwarded from Brussels to New York, either by company pouch or by the Brussels-New York radio net.

Data filed by radio arrives in New York where it is converted into a tape. The tape is simply fed into an IBM machine and is converted to a punched card for transmission to Douglas, again either by mail or in case of AOG number (referring to "Airplane on Ground"), by tape, to speed the service.

Fillmore pointed out that each batch of requisition cards is covered by a control card to safeguard against errors and to provide the authorizing signature codes. A new control card is sent to the supplier, who merely duplicates the one received and sends it back to the Technical Procurement Officer; there is no form to be made out, or letter written.

When the supplier ships the item to Sabena's air cargo facility, or to a sea shipping agent, a packing card is sent to the Division Office to record specific data of the shipment and develop the necessary export documents, an item of significance to Sabena, which operates exclusively overseas.

Use of accounting machines in Spec.

200, Fillmore emphasized, has produced an important airline procurement by-product, a supply-dollar commitment report. System can, in a short time, provide data to management on:

- Dollars committed per supplier.
- Dollars by type of part.
- Total number of parts and orders involved.
- Total number of orders placed with each supplier.

In addition, overdue orders can be followed up quickly as an automatic procedure, eliminating the usual "troubleshooting" roles given to supply personnel.

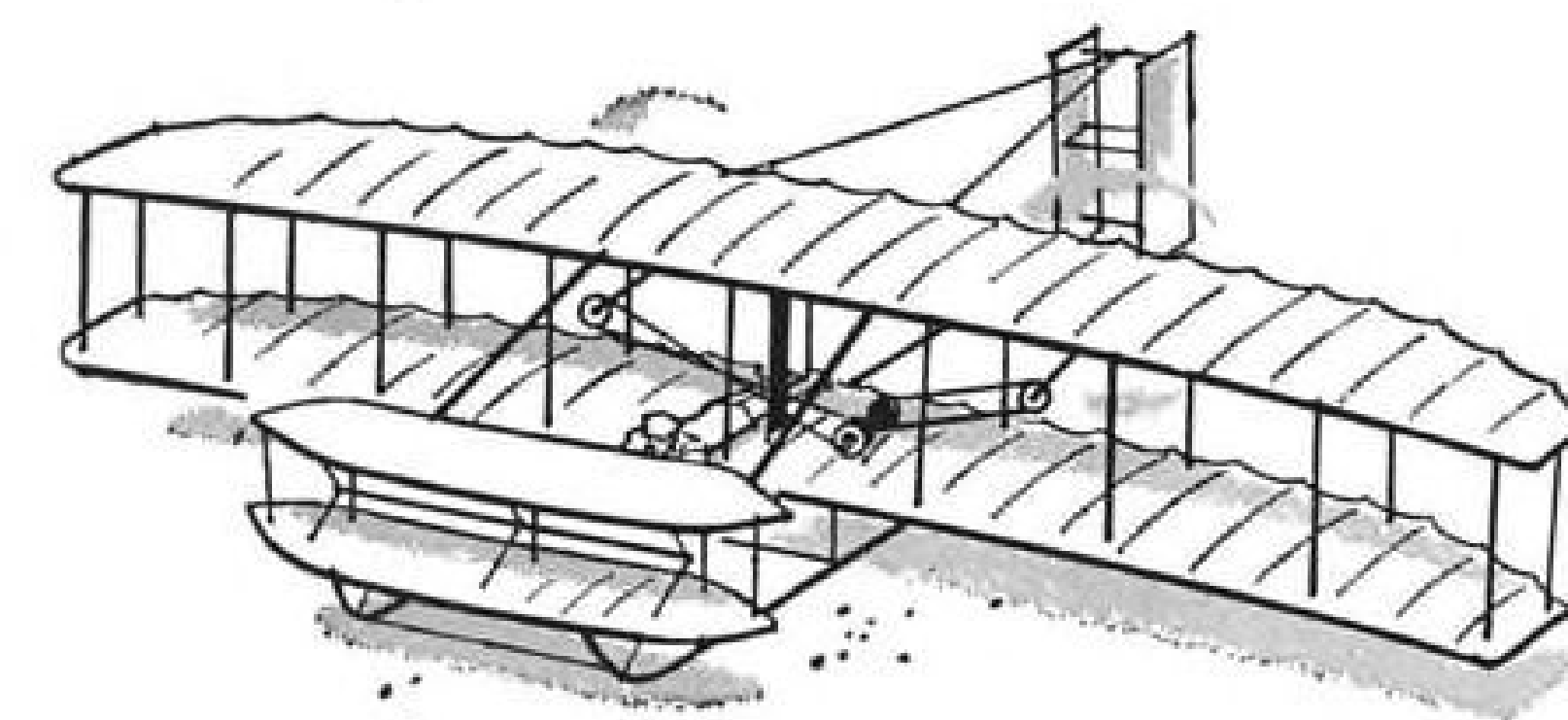
Fillmore said the new system has enabled the Division Office in New York to increase its work capacity by about 100% without a staff increase. System also allows Sabena to keep its fleet at peak performance from the viewpoint of safety and efficiency with a minimum practical dollar level of inventory, he explained.

Sabena's fleet, which requires this three-continent maintenance support, now consists of 30 four-engine transports, and a similar number of twin-engine planes, in addition to training aircraft and a helicopter service. The planes service 104 cities in 38 countries.

Announcing...

The most important
in aircraft oils

advance
since "Kitty Hawk"



— **PREMIUM** — →

AEROSHELL OIL W

AVAILABLE IN 2 VISCOSITY GRADES:

80 GRADE FOR SMALL ENGINES WHERE STRAIGHT
MINERAL OIL GRADE 55, 65 OR 80 IS NORMALLY RECOMMENDED

100 GRADE FOR LARGE ENGINES WHERE STRAIGHT
MINERAL OIL GRADE 100 OR 120 IS NORMALLY RECOMMENDED

It's the world's first non-ash, fully compounded dispersant aircraft oil to be marketed for both large and small piston-engine aircraft. This oil has *multi-viscosity* characteristics which reduce the need for seasonal grade changes.

Prior to the development of AeroShell® Oil W, all fully compounded aircraft oils had these two disadvantages—(1) pre-ignition and (2) spark-plug fouling—that were caused by the formation of ash deposits in the combustion chamber.

Now—for the first time, a completely *non-ash*, fully compounded aircraft oil is available for all piston-engine aircraft.

Performance of AeroShell Oil W is superior

to that obtained with the best straight mineral oils. AeroShell Oil W has been extensively flight-tested in a wide range of engines and the results show—

- 1 Significant reduction in oil consumption.
- 2 Reduced parts wear...increased engine life.
- 3 Cleaner engines—practically eliminates oil screen and filter deposits.
- 4 Easier starting and faster warm-up.

Already four airlines have converted their entire fleet operation to the use of AeroShell Oil W.

We will be glad to give you complete information on AeroShell Oil W—the most important aircraft oil advance in 56 years.

SHELL OIL COMPANY

50 WEST 50th STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA



AIRLINE OBSERVER

► New stewardess and purser contract recently signed by Pan American World Airways is expected to set the pace for union negotiations on other airlines. Transport Workers Union of America won for its members the highest rates for stewardess and purser flight service in the industry plus a provision for severance pay. Retroactive to Dec. 1, Pan American stewards and stewardesses will draw a starting monthly rate of \$285 for piston aircraft and \$328 for jets. A second increase scheduled for this December will boost the figures to \$301 and \$346. Also in December, employees with more than 30 months of service will draw \$419 a month for piston and \$482 a month for jet aircraft. Purser salaries now range from a beginning rate of \$417 and \$480 for the two types of aircraft and increase to \$438 and \$504 in December, with a maximum pay after four years of \$528 for piston aircraft and \$607 for pure jets.

► American Airlines reports that its jet fleet of Boeing 707-120s and Lockheed Electras carried almost half a million revenue passengers during the past six months of this year. The 707s carried 217,000 passengers more than 462 million passenger miles during the period for a sustained load factor of more than 90%. Over the same period, the company's Electra fleet carried more than 253,000 passengers an estimated 174 million passenger miles, with an over-all load factor of about 80%. The two types of aircraft, which make up only 17% of American's 138-plane fleet, accounted for 36% of the carrier's total passenger miles in the six-month period.

► United Air Lines has signed interline traffic agreements with Polish State Airlines and Hungarian Air Transport. Pacts provide passenger travel or cargo shipment over United routes and those of the two Soviet satellite carriers by issuance of a single ticket or air waybill. United previously signed similar agreements with Czechoslovakian Air Lines and Yugoslav Airlines.

► Federal Aviation Agency has issued a notice of proposed rule-making that would add two new jet routes in the Southwest and East. The first would extend Jet Route No. 58 from Dallas to New Orleans, bypassing a heavy concentration of military traffic in the vicinity of Chennault AFB, Lake Charles, La. The second would establish a new jet route between Spartanburg, S. C., and Gordonsville, Va.

► New five-year Air Express agreement has been signed between the scheduled airlines and the Railway Express Agency. Now being formally prepared for submission to the Civil Aeronautics Board, the agreement is considered a "major improvement" by both airline and Railway Express spokesmen who point out that cost-plus features are being eliminated in favor of a mutual sharing of gross revenues and equal rights for both parties in rate matters and other operating phases.

► Belgium's Sabena and Russia's Aeroflot airlines carried a combined total of slightly more than 4,000 passengers between Moscow and Brussels during the first year of direct air service linking the two capitals, according to Sovetskaya Aviatsiya, Soviet air force newspaper.

► All-Nippon Airways plans to order two Sikorsky S-55 helicopters from Mitsubishi Heavy Industries Reorganized, Ltd., which manufactures the helicopter in Japan under license. Delivery of the first machine is expected by early next year. All-Nippon spokesmen say the S-55 will be used for short range transport, and that their purchase represents a first step toward company adoption of large helicopters, possibly the Sikorsky S-58, for future operations.

► Financial firm of Walter E. Heller Co. is providing approximately \$500,000 for a used aircraft transaction handled through the Aircraft Exchange. Deal involves two Douglas DC-4s purchased by Seven Seas Airlines from Twentieth Century Airlines. Heller is a member of the exchange and the first financing source to be tapped through this service. The aircraft are to be used in charter work. Heller is primarily a factoring organization, which provides cash to a company by taking over its receivables, but also has other financial interests.

SHORTLINES

► American Airlines is scheduled to inaugurate air mail service on its Boeing 707-120 jet flights between Dallas and Los Angeles on Aug. 14. Effective Aug. 21, air mail will be carried on American's 707s between Boston, Chicago and San Francisco and Chicago and Dallas.

► British Overseas Airways Corp. carried 13,254 eastbound passengers on its U.S.-Europe routes in June for a load factor of 87.5%. Load factor breakdown was 85.8% in first class, 77.1% in tourist class and 91.7% in economy class. Passengers from Europe to the U.S. totaled 6,612. BOAC's eastbound transatlantic cargo for June was 212,964 lb.; mail for the route was 23,942 lb. Passengers carried by the airline from Canada to Europe totaled 3,842 eastbound, 2,975 westbound.

► Eastern and United Air Lines have linked their 81,524 mi. of private line teletype to expedite interline reservations. Eastern has similar communications with four other carriers, United with five others. Eastern's package vacation tours have shown an over-all increase of 27% in sales during the first six months of 1959 as compared with the same 1958 period. Principal gains have been in the Florida, Caribbean and Mexico markets, with Puerto Rico and the Virgin Islands showing the largest percentage gains.

► Iberia Air Lines of Spain reports that its eastbound transatlantic load factor for the month of June was approximately 92%.

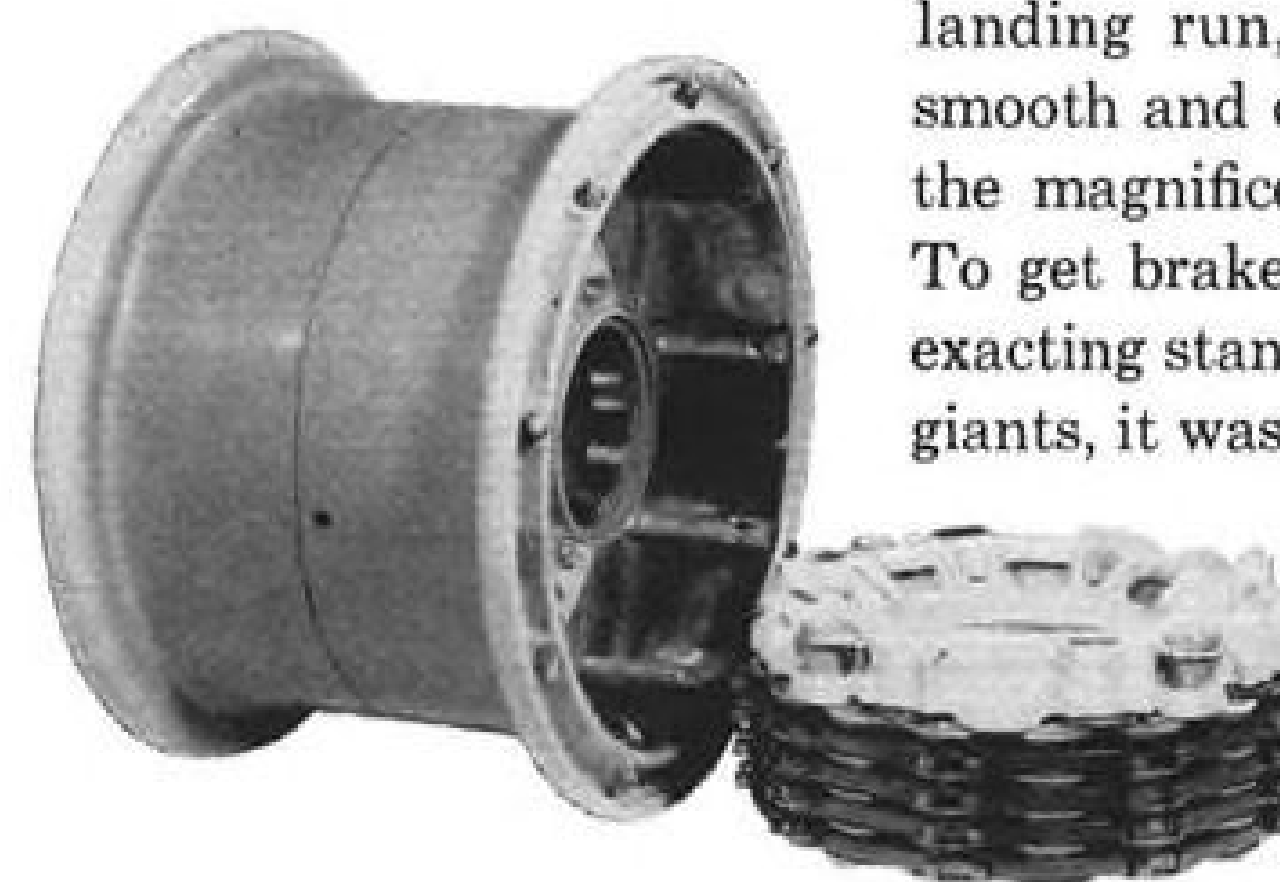
► Lake Central Airlines has added four new daily round-trip flights on its system to increase its service by 15%. Included are an additional round trip on the Indianapolis-Youngstown route, an additional round trip on the Indianapolis-Chicago route, an additional round trip between Indianapolis and South Bend and a new round trip between Cleveland and Columbus.

► National Airlines reports a 65.1% system-wide increase in package vacation sales for the three month period ending July 15 as compared with the same period of 1958.

► Seaboard & Western Airlines has moved into its new three-story headquarters building at New York International Airport. The structure houses the cargo carrier's executive and administrative offices and covers a 2.8 acre site on the airport's main road. Sales department offices will remain at 80 Broad St. in downtown New York.



JETLINERS DEMAND JET-AGE BRAKES

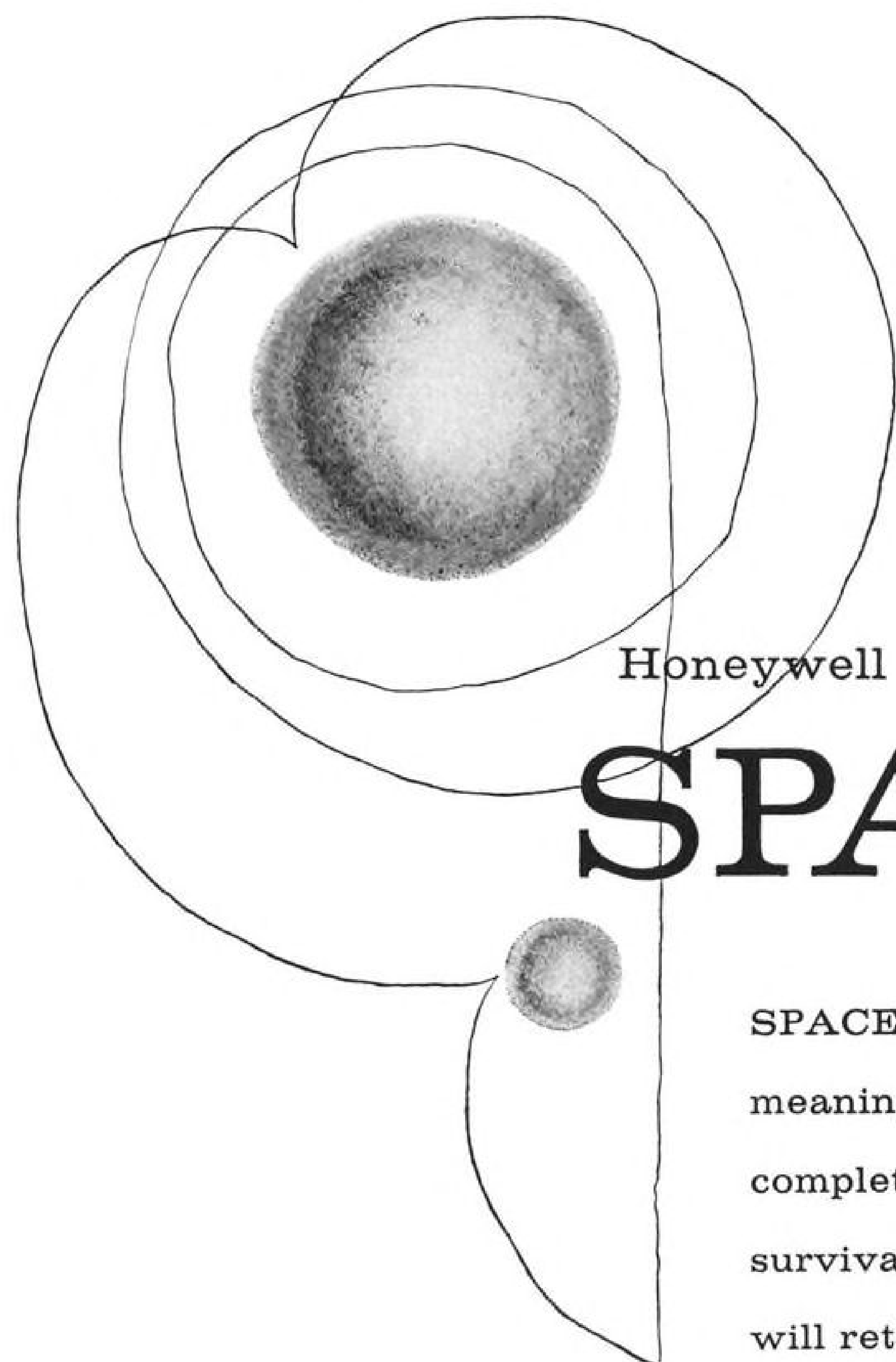


From touch-down to the end of the landing run, Bendix brakes provide smooth and certain ground control for the magnificent new jet airliners . . . To get brakes that measure up to the exacting standards of these swept wing giants, it was entirely logical to look to

the world's most experienced supplier . . . For similar reasons, Bendix brakes are regular equipment on the largest and fastest military jets, as well as fully certified by FAA for the new civilian jets . . . BRAKES BY BENDIX is another important reason why you can fly the jetliners with complete assurance.

Bendix PRODUCTS DIVISION South Bend, IND.





Honeywell calls it

SPACEABILITY

SPACEABILITY is a new term meaning the capability to completely equip man for survival in space. While he will retain the ability to exercise his judgment with manual controls, man's welfare in space will depend largely on automatic control of his navigation, flight and power—in fact, his total environment, including food, oxygen and waste disposal.

There are three areas indispensable to space operations: (1) motion control and navigation for vehicles of flight, including inertial systems; (2) environmental control for human activity; and (3) instrumentation and data processing both on the ground and in the air.

Recognition of Honeywell leadership in all three areas is exemplified by the fact that Honeywell controls are going into almost all space vehicles presently planned.

This Honeywell capability is benefiting the following projects, some of which have already been completed:

- Providing complete guidance and flight control system for Project Scout, the NASA launching vehicle for orbital and probe flights of instrumentation satellites.
- Developing navigation and guidance system for the proposed Martin version of Dyna-Soar, the Air Force pilot-controlled semi-orbital vehicle.
- Developing and producing an advanced space cabin environment simulator for the Air Force School of Aviation Medicine.
- Supplying orbital injection guidance reference systems for Project Vanguard's launching of satellites into predetermined orbits.
- Developing and producing attitude control for both orbiting and re-entry versions of Project Mercury, the NASA manned satellite program.
- Developing and producing attitude stabilization systems for vehicles used in re-entry test phases of Project Mercury.
- Human engineering studies and instrumentation development for pilot orientation in space flight for Project Mercury.

Corporate capability—With a notable background in missile and space systems management, as well as in the design, development and production of systems and components, Honeywell is fully qualified for work on all phases of prime missile and space systems.

Human engineering in relation to space flight is being studied by an entire project team at the Military Products Group's aeronautical facility in Minneapolis. The group is made up of specialists in anthropology, anthropometry, bio-chemistry, bio-physics, psychology and psycho-servo analysis. Their goal: optimum integration of man into a complex control system, which involves problems such as efficiently dividing labor between manual and automatic computation equipment.

Honeywell organization makes available to space projects unique capabilities and experience. These include Industrial Instrumentation, Computing and Recording complex; the services of environmental experts in the Temperature Controls Group; and associated members of the Military Products Group: Ordnance, Aeronautical, Boston, and Missile Equipment Divisions. The Corporate Research Center works closely with all groups.


Areas of interest and activity at Honeywell for space projects include the following:

Inertial guidance and navigation systems, gyros, stable platforms, accelerometers, computers, air data systems, ballistic trajectory control systems, horizon scanners, fix takers, reaction jets, control valves.

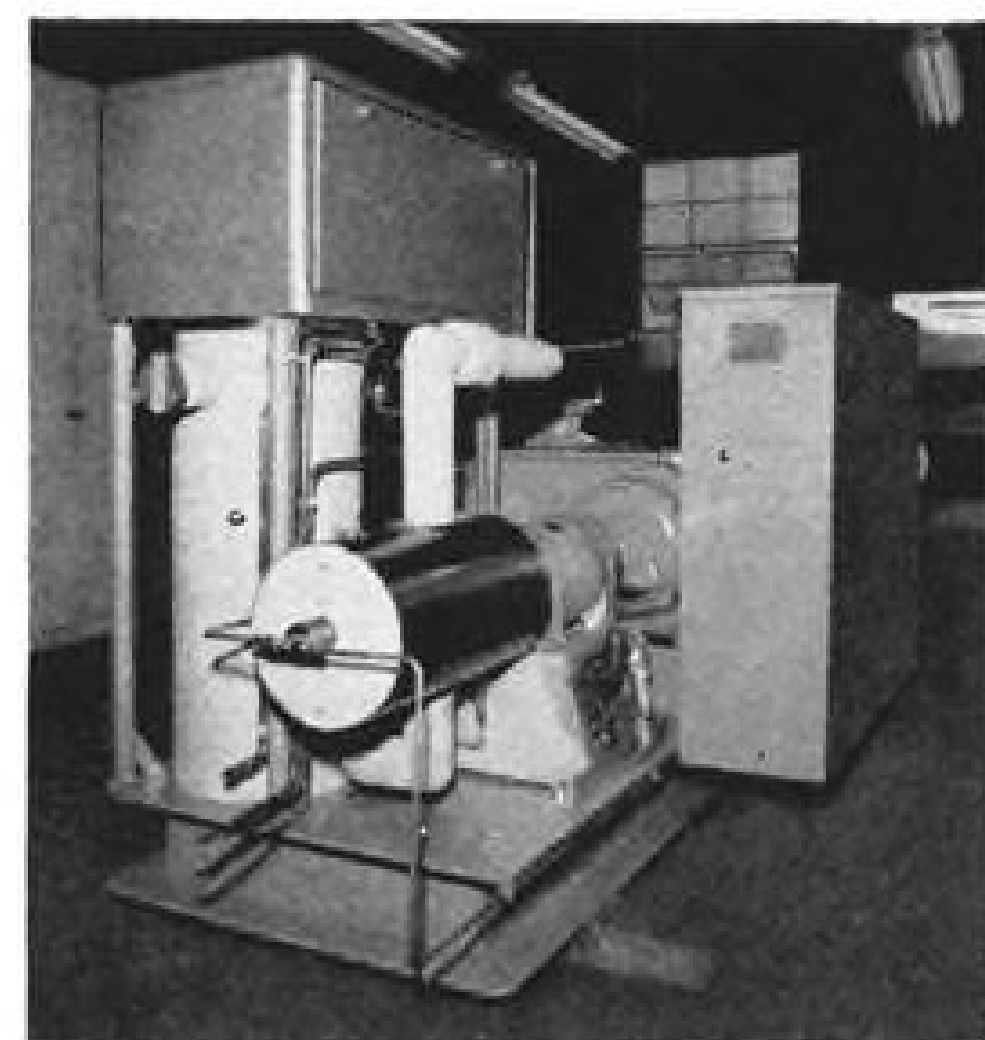
Other areas are flight data sensing and display systems, telemetry and recording systems, data reduction systems, pressure and temperature sensors, analog-digital and digital-analog converters, atmosphere composition control systems, temperature control systems, pressure control systems and recording devices.

If you have a problem that requires outstanding capability in control for space projects, call on Honeywell. For information write Honeywell, Minneapolis 8, Minn.

Honeywell

 *Military Products Group*

SPECIAL CRYOGENIC EQUIPMENT



High pressure—high capacity liquefied gas pump. Up to 90,000 scfh of liquid oxygen, nitrogen and other gases can be pumped to 15,000 psig, with no contamination. Built-in vaporizing equipment enables delivery of high pressure gas. Efficient and reliable, these units have gained wide acceptance by defense agencies and industry.

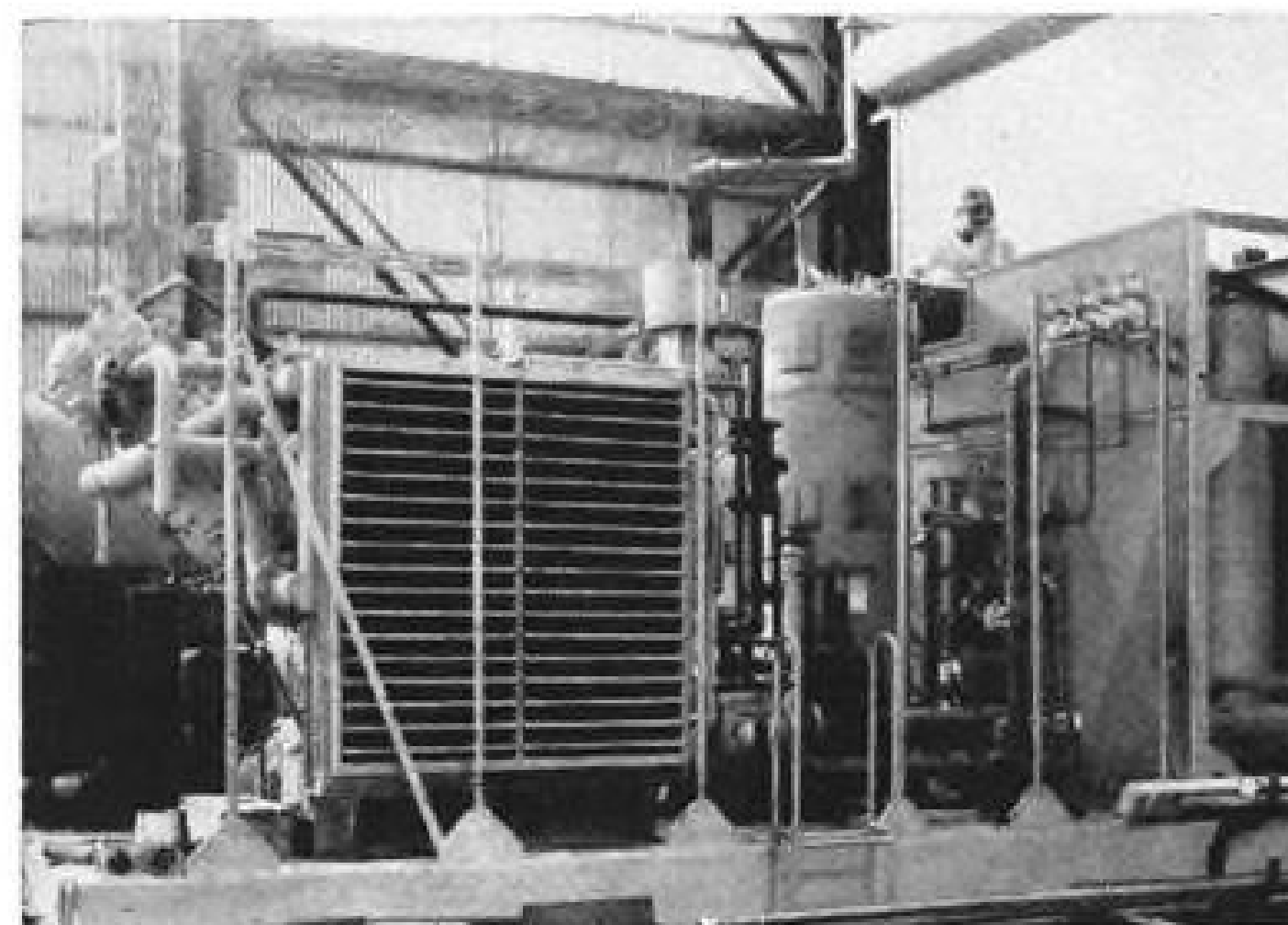
When you seek a proven solution to an unusual gas separation problem . . . when an entirely new low temperature process needs to be developed and made practical . . . when compactness and transportability demands are unusual . . . whatever your need for special cryogenic equipment, call on Air Products.

Air Products puts exceptional experience and skill at your command . . . a background of achievement that includes supplying a major portion of the cryogenic equipment for the defense program and, most recently, the first tonnage liquid hydrogen facility, engineered, installed and operated by Air Products for the U.S. Air Force.

Air Products offers an unequalled range of services . . . including research, engineering, manufacturing and operation . . . and has the organization to service all equipment.

We will be glad to give you details on what we have done, and what we can do. Consult us about your cryogenic requirements, problems and ideas. Air Products, Inc., Allentown, Pa. Phone EXpress 5-3311.

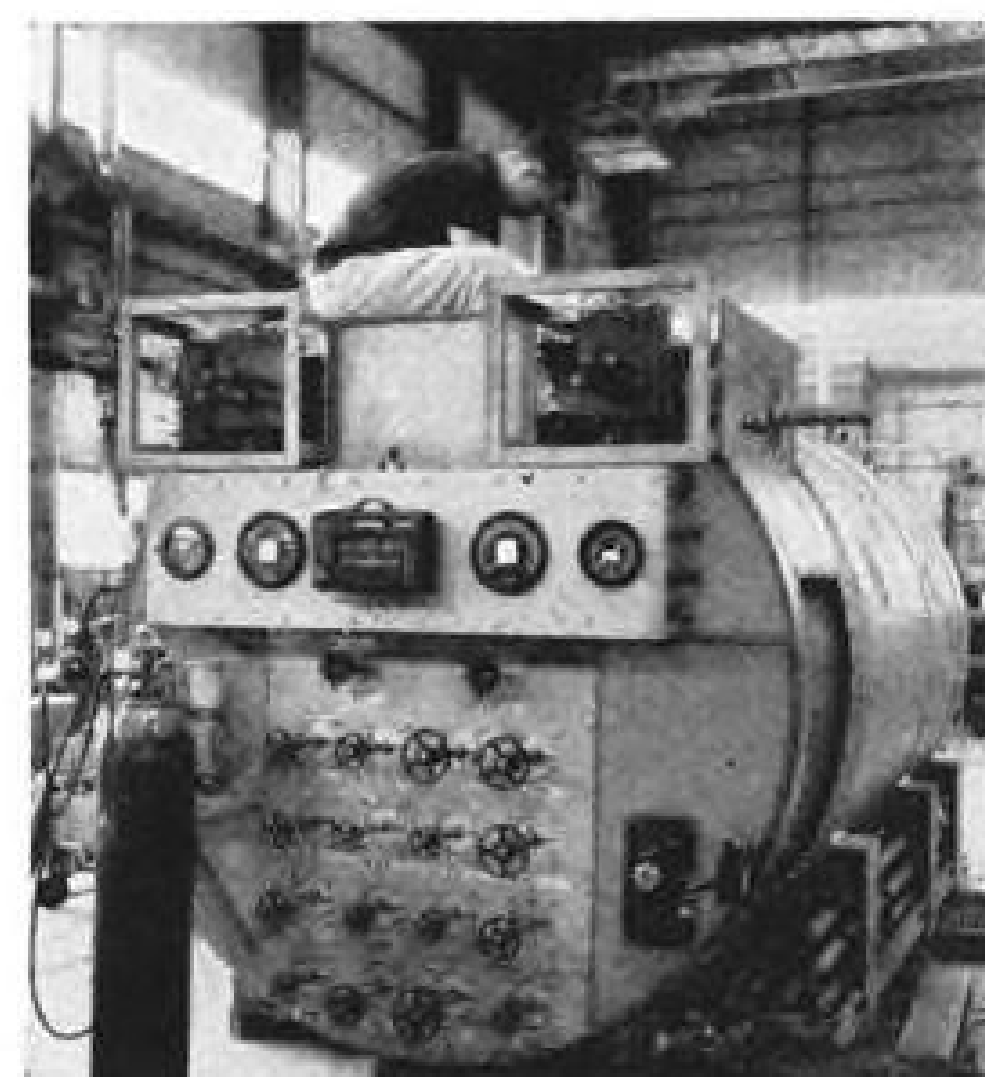
Some special equipment under construction at Air Products



High-capacity helium liquefier. This compact, semi-trailer mounted unit is also capable of liquefying hydrogen. Design of the process . . . requiring the extremely low temperature of minus 452°F . . . and construction of the heat exchangers, expansion engine, transfer lines and specially insulated compartments exemplify Air Products specialized cryogenic skills.



Shipboard liquid oxygen—liquid nitrogen generator. Air Products successful development of units like this was a major technological breakthrough in cryogenic equipment design. More than 40 are now aboard U.S. Navy vessels. This one . . . rated at 1.3 tons per day of high purity oxygen . . . is being tested on a special rig that duplicates the rolling and pitching motion of a ship.



Liquid oxygen—liquid nitrogen storage unit. Two separate tanks within a common outer shell can hold 750 gallons of LOX and 250 gallons of liquid nitrogen, with integral vaporizing equipment. This specially designed and constructed unit can withstand forces of up to 20 g's.

Air Products
... INCORPORATED

SPACE TECHNOLOGY

Hughes Takes Cautious Space Approach

By Russell Hawkes

Culver City, Calif.—Cautious step-by-step advance into the field of space technology characterizes the research projects of Hughes Aircraft Co.

Dr. Rex C. Mack, manager of advanced planning in Hughes' Systems Development Laboratory and ex-officio coordinator of space technology, contends that premature projects and poor logic have inflated the cost of space technology programs out of proportion to the results.

The Hughes idea is that solid achievements in space technology can only be based upon the careful accumulation of research information and improvements upon the tried methods of missile and aircraft technology. Work is upon a more conservative scale than that of some of the other major manufacturers in the space flight business.

Hughes has only about 50 scientists and engineers assigned to space projects on a full time basis. Other talent is drawn as needed from functional design groups elsewhere within the organization. The total number of professional persons thus employed seldom exceeds 100.

Advanced Projects

Despite the company's emphasis upon today's space technology rather than that of tomorrow, the company lists two advanced projects—a space ferry and atomic clock. The first of these is a space ferry design study being carried out in conjunction with Lockheed Aircraft Co. Hughes has responsibility for control and guidance. Thus far, the program has been carried on with Lockheed and Hughes money, but the study phase is nearing completion and Hughes believes the next phase of work will require government support, since it would probably involve the construction of test models and breadboard avionics.

The proposed space ferry would carry a payload of several tons into an orbit of between 100 and 1,000 mi. altitude and effect a rendezvous there with an orbiting space station. Hughes says that timing of further development is the only remaining issue.

Hughes and Lockheed are not attempting to specify the missions for which the space ferry might be used. The ability to make a precise rendezvous with an object in orbit suggests several possibilities. Most obvious use would be for the construction, supply and maintenance of stations in space.

Dr. Mack believes that such a space ferry probably could be delivered in 1965 if the necessary financial support is forthcoming. He reports that the task is largely within the present state of the art. Main lack is some actual experience in human reactions to the space environment. Dr. Mack said Project Mercury should provide an ample base for continued development.

The project has been underway for about nine months. Lockheed has a preliminary design airframe nearing completion and Hughes has laid out simulator programs for control prob-

lems to be expected throughout all the anticipated mission profiles. Dr. Mack says that control in most mission phases would be fully automatic as it is in ballistic missiles, but that a redundant manual override system would be provided to allow the crew to cope with unforeseen eventualities. Control would definitely be manual during last few hundred feet of the rendezvous and probably will be manual during the final approach and landing after re-entry.

The space ferry system is predicated upon the availability of one of the up-



Model Nose Cone Used for Systems Checkout

Full-scale model of Atlas intercontinental ballistic missile nose cone has been built by Avco Corporation's technicians to allow checkout of internal components through transparent skin. Visible equipment is part of telemetry and re-entry stabilization systems.

NEWS IS HAPPENING AT NORTHROP



Radioplane drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1

RADIOPLANE CREATES FIRST FAMILY OF UNMANNED AIRCRAFT TO TRAIN MEN, EVALUATE WEAPON SYSTEMS, AND SURVEY ENEMY TERRITORY

Radioplane is the world's leading producer of drones and space age recovery systems. As live targets, drones perform as aircraft—then can be recovered by parachute. As evaluators, drones simulate the appearance of the enemy threat while they score our weapon systems' effectiveness. On surveillance missions, drones are zero-length launched, fly cameras, take photos, and return with information within minutes. For 20 years Radioplane has led in the production of drones. Radioplane's leadership in the field typifies

the years-ahead thinking that continues to produce design concepts for tomorrow, hardware for today—developed, produced, and delivered on time—at minimum cost to the taxpayer.

 **RADIOPLANE**
Van Nuys, California, and El Paso, Texas
A Division of NORTHROP CORPORATION

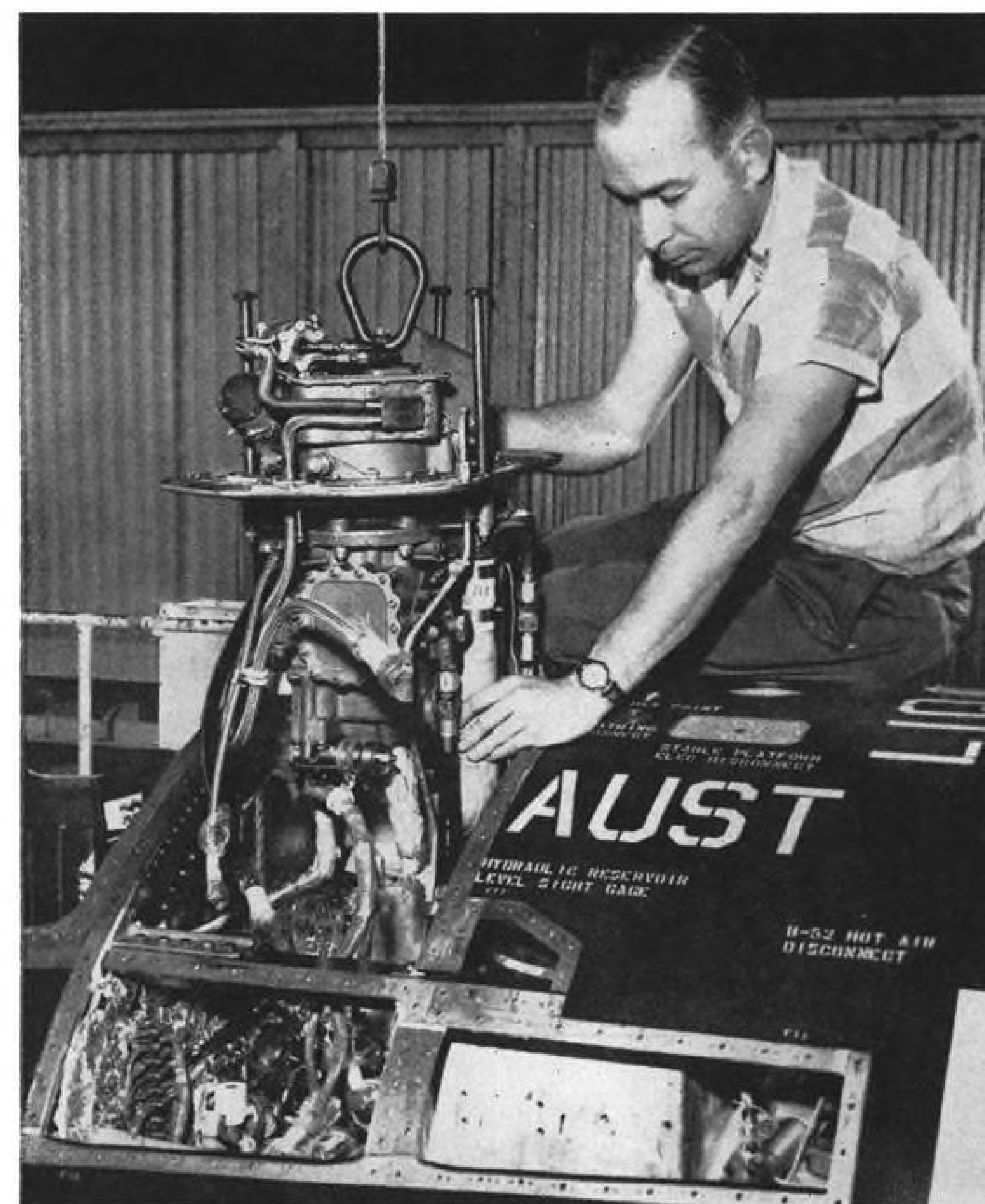
coming big boosters. Lockheed has not yet settled upon a selection.

Hughes has found that re-entry, as always, sets the most critical control parameter. Variations in the re-entry attitude program can strongly affect aerodynamic heating rate and can move the landing point along the course line by distances of 500 or 1,000 mi. Hughes engineers believe they will probably use jet reaction controls for trim during the re-entry phase as well as for primary control.

For missions of longer duration than those now foreseen for the space ferries, Hughes engineers believe that acceleration of flywheels or precession of massive gyroscopes would be more attractive for rapid short term adjustments in attitude. Experiments have shown that

these devices are rapidly saturated and Hughes is aware that it would be necessary to desaturate these periodically by the use of jet controls. However, the jets could operate at their most efficient points.

Hughes has treated the navigation problem in essentially the same manner as that of an interceptor missile guidance problem. No position reference would be needed aside from that provided by the orbiting rendezvous target and an inertial platform within the space ferry to derive present position for the solution of the intercept problem. To aid use of the rendezvous target as a navigation reference, or homer, some form of cooperative system would definitely be used. The infrared or radio beacon within the orbital rendez-



X-15 Hydrogen Peroxide Power Unit

Hydrogen peroxide-powered auxiliary power unit, developed by General Electric, is lowered into North American X-15 prior to recent glide test. Each of the two units used in the X-15 has a specific fuel consumption of 10.6 lb./hp./hr. and produces 4 kva. of 400 cps. a.c. electricity and 16 gpm. of 3,000 psi. hydraulic power. Operation cycle is up to 30 min., during which the two APUs produce all the electric and hydraulic power required to operate 1,300 lb. of instrumentation; heating elements in the pilot's pressure suit and throughout the X-15; the inertial guidance system and its computers; communication, telemetering and recording equipment; speed brakes; landing flaps, and control surfaces.

CHOOSE REDA PUMPS FOR YOUR AIRCRAFT REFUELING SYSTEMS!

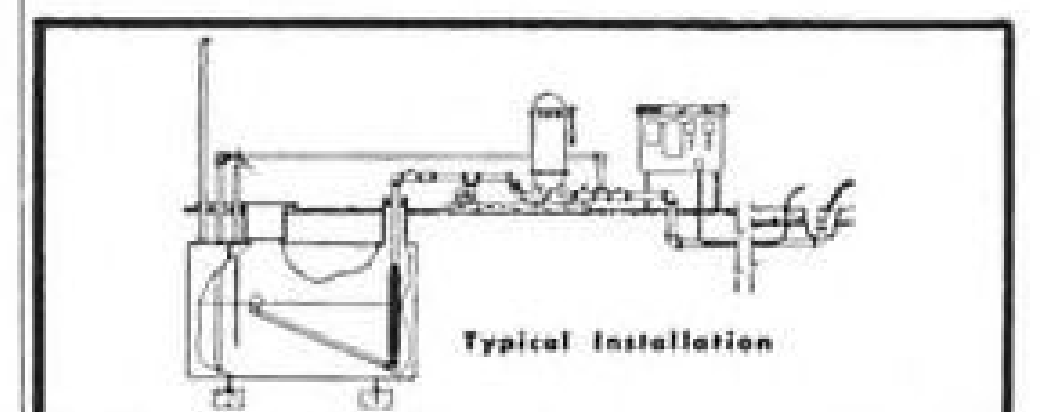


Viscount refuels at Tulsa Municipal Airport using Reda Jet-Fuel Submergible Pumps.

REDA Jet-Fuel Submergible Pumps Give These Important Advantages:

- **Underground Installation** — no surface structures.
- **No Explosion Hazards** — U/L approved models.
- **No Stuffing Boxes To Leak** — motor & pump in one unit.
- **High Volume at Required Operating Heads** — Models from 1 to 150 HP — capacities to over 1000 GPM.
- **For single or double hydrant systems, tank truck and test stand refueling systems.**

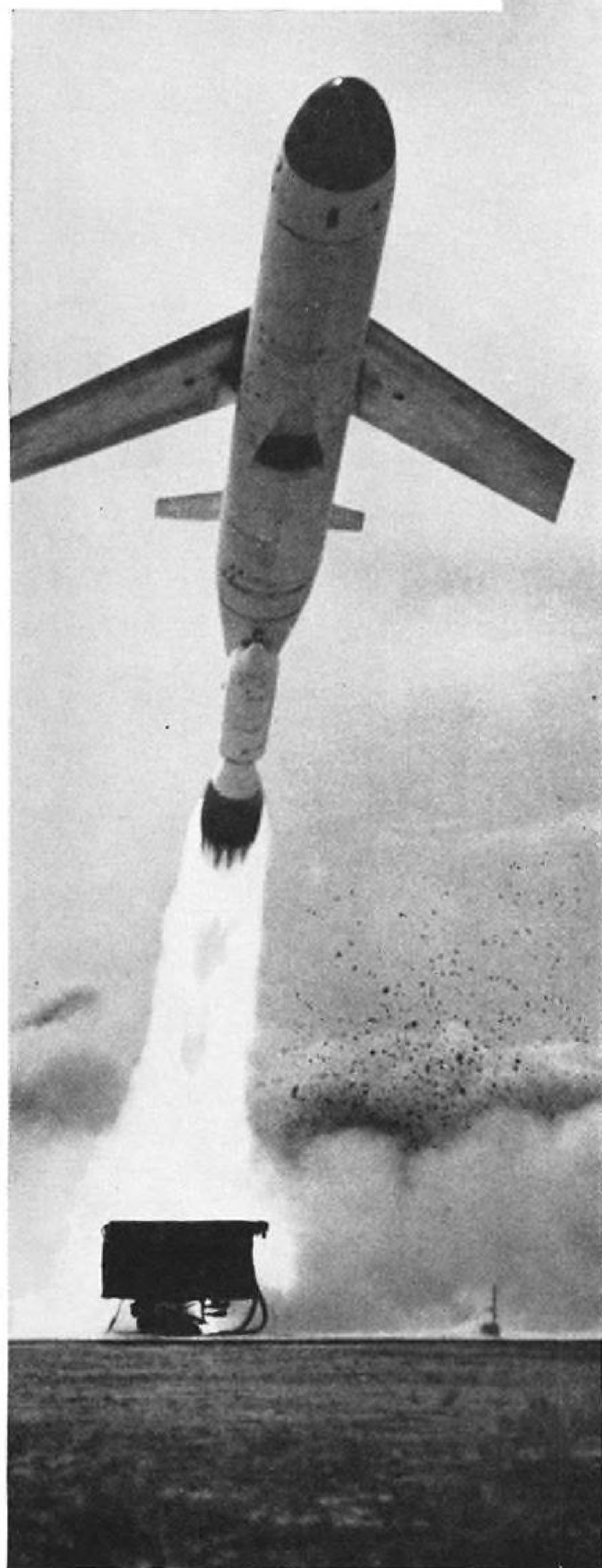
Illustrated is a typical Underground Storage and Hydrant Refueling System with Reda Jet-Fuel Submergible Pumps, used by Continental Air Lines. This system uses two storage tanks and two Reda pumps feeding into a filter and hydrant refueling system. It has proved to be less expensive in both installation and maintenance than a conventional tender system would have been.



Contact Reda Today For Submergible Pumps Especially Designed To Meet The Exact Requirements Of Aircraft Refueling Systems.

 **REDA PUMP COMPANY**
BARTLESVILLE, OKLAHOMA
World's Largest Manufacturer of Submergible Pumps for Oil, Brine, Water, Gasoline, Jet Fuel, Chemicals and LPG, for over 35 years.

MARTIN'S MACE



... equipped, of course, with Auto-Lite® Wire

America's leading airframe
and missile manufacturers specify
Auto-Lite Wire for quality and
extreme performance characteristics

Wire problems caused by high temperatures, fuels and lubricants, chemicals, and other agents are quickly solved when you call on Auto-Lite. At your service is America's foremost wire research facility—the Auto-Lite Wire Research Laboratory at Port Huron, Michigan. This ultra-modern laboratory is completely equipped to perform all qualification tests of wire for military specifications. For proven quality and reliability, specify Auto-Lite.

AUTO-LITE®

GENERAL PRODUCTS GROUP

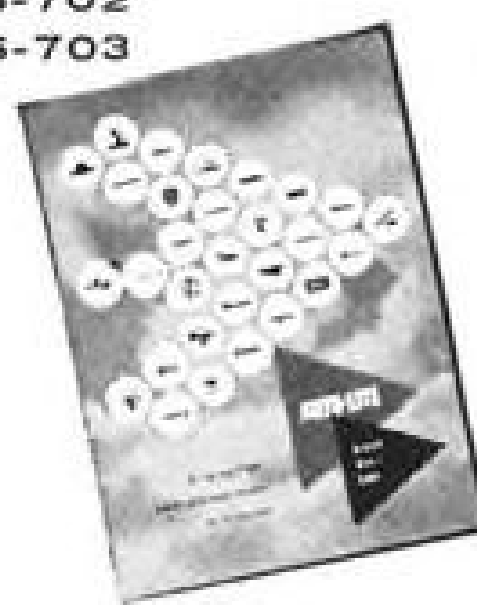
WIRE AND CABLE DIVISION • TOLEDO 1, OHIO

Plants at: Port Huron, Michigan • Hazleton, Pennsylvania

Look to Auto-Lite for all classes
and types of aircraft wire meeting
these specifications:

| | |
|-------------|--------------|
| MIL-W-5086A | MIL-W-16878C |
| MIL-C-7078A | NAS-702 |
| MIL-W-8777A | NAS-703 |
| MIL-W-7072A | |

WRITE FOR
complete aircraft
wire catalog



vous target would be powered by batteries or perhaps by solar cells, for unusually long duration missions.

Hughes and Lockheed believe that at first the ferry should be as simple a vehicle as possible and that roles and missions should be assigned at later dates when more is known about the problem and when some experience has been accumulated with possible solutions. The navigation system should be a logical extension of the all-weather fire control system and interceptor missile guidance system techniques with which Hughes has considerable experience.

Hughes' second advanced project is the well-publicized test of Einstein's general theory of relativity by comparing the output of a highly stable Maser oscillator in orbit with that of one or more upon earth (AW July 6, p. 26). Oscillators would serve as clocks to measure time dilatation.

Hughes Aircraft holds a contract for \$200,000 from National Aeronautics and Space Administration for the development of an experimental Maser clock for this project. The clock is expected to weigh about 30 lb. complete with batteries for a running time of three weeks and to occupy about one-half cubic foot, in volume. It is to have an error of only about one second in a thousand years.

Satellite Orbit

With the necessary stable time references available, NASA is expected to proceed with the satellite vehicle and other necessary equipment. The satellite will orbit at an average speed of about 18,000 mph. and an average altitude of about 8,000 mi. It will periodically telemeter the time count of its Maser clock to a ground station where it will be compared with a similar clock at that station. It is possible that the clock satellite will transmit only at perigee to reduce noise effects which accumulate with range.

According to the general theory of relativity, the Maser clock in the satellite should run slow, compared with the ground clock, for orbits below 2,000 mi. and fast for orbits above 2,000 mi. According to Dr. Harold Lyons, head of the Hughes Atomics Physics Department, this is because the relativistic effects of motion predominate below 2,000 mi., while the effects of gravity difference predominate above. The effects are of opposite sign and cancel at 2,000 mi. so that a clock in an orbit at this altitude and one on the ground would agree. At the 8,000 mi. height, the two clocks should differ by about one second in 60 years. A quantitative check of both special and general theories of relativity can be made by means of flights at various altitudes.

According to the special relativity

theory, a clock should slow to zero as it approaches the speed of light. General relativity theory on the other hand, shows that passage of time is controlled by the gravitational field about the phenomenon or clock by which time is measured. Electromagnetic frequencies radiated appear to be lowered in a stronger gravitational force so that any light which an earth-bound object might emit would tend to be redder than that from a similar light source in a high orbit. This gravitational effect has been called "the red shift."

A clock in an orbit about the earth conversely appears to be speeded up due to the fact that the gravitational attrac-

tion of the earth is less at the orbital altitude. Light emitted in the satellite trends toward the ultraviolet end of the spectrum—an effect called the "violet shift."

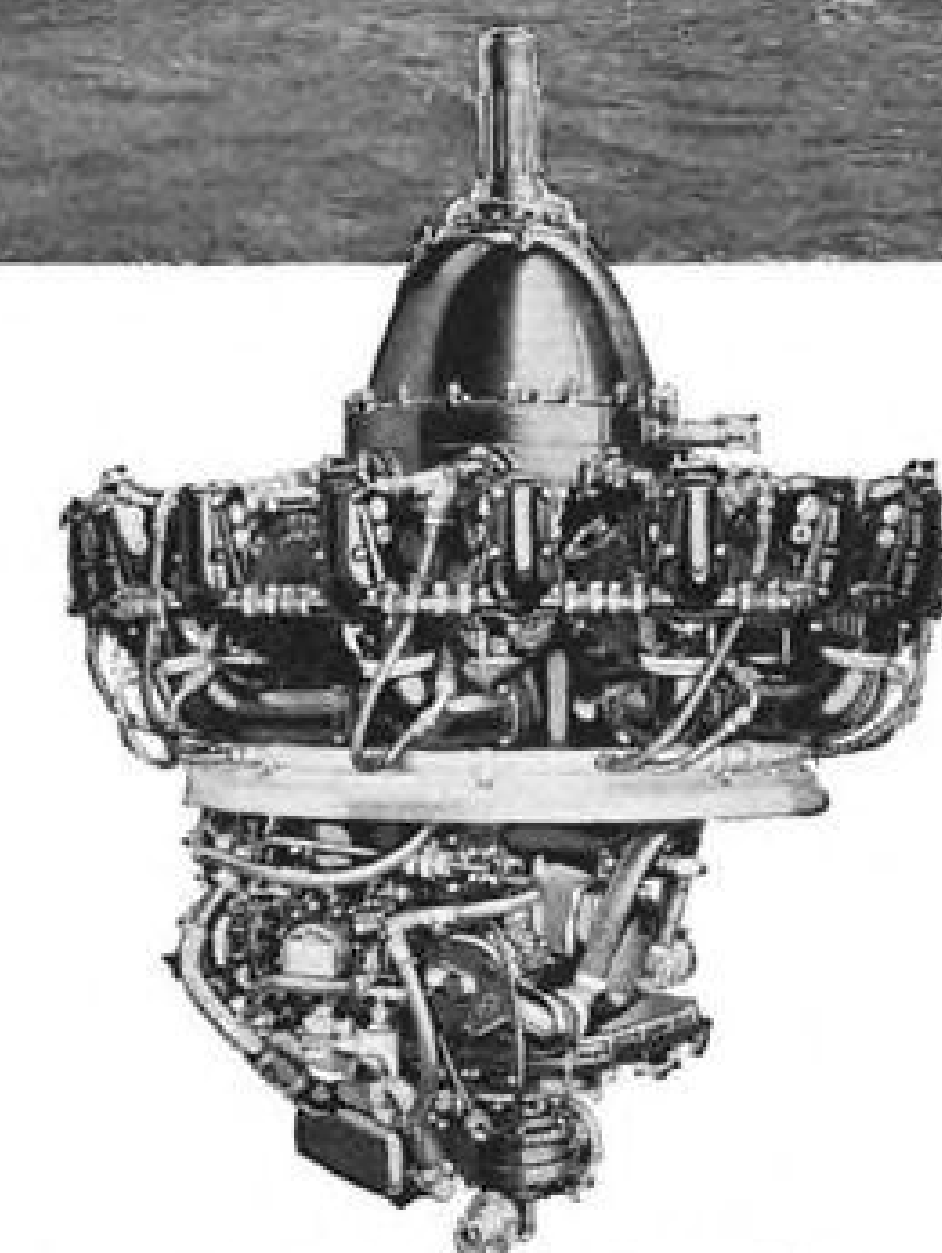
Investigations of the Maser have been going on at Hughes Research Laboratories for about four years. Dr. Lyons invented the original atomic clocks while working for the U. S. Bureau of Standards. The ammonia Maser clock to be used in the satellite experiment was invented by Prof. Charles H. Townes of Columbia University.

The relativistic clock experiment has been proposed often in the past. It was



POWER FOR THE HOVERCRAFT...

The Alvis Leonides Engine which has been extensively developed for fixed wing and helicopter application has been chosen to power the new Hovercraft, designed by Mr. Cockerell and built by Saunders-Roe.

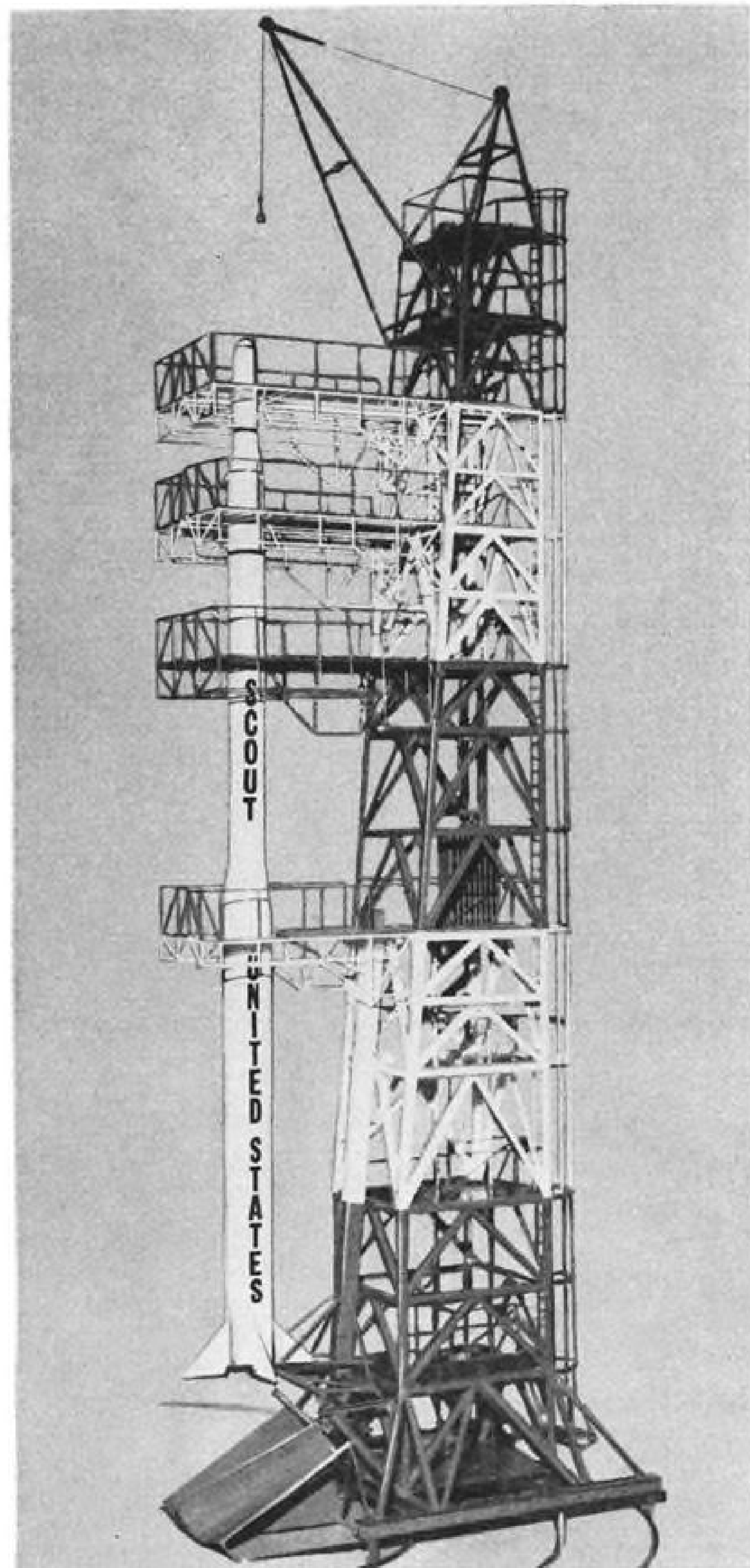


ALVIS LEONIDES AERO ENGINES

ALVIS LIMITED • COVENTRY • ENGLAND

Chance Vought Aircraft, Incorporated,

Announces Five New Divisions



VOUGHT INTEGRATING 70-FOOT ROCKET. This four-stage *Scout* space research vehicle is being readied by Chance Vought for NASA use. Vought was chosen over 12 other firms for the *Scout* development contract.



MORE THAN 500 ALREADY DELIVERED. *Crusader* fighters, grouped for delivery on this Chance Vought flight ramp, have been deployed in three different versions with the U. S. Navy and Marine Corps.

Chance Vought is pleased to announce the formation of five new divisions, effective August 1, 1959.

These divisions will point their activities toward technological fields that have become Space-Age specialties: Astronautics, Aeronautics, Electronics, Range Systems, and Research.

This realignment is the result of considerable study, both of company capabilities and of new business opportunities. It is an effort to bring all

of Vought's scientific/technical abilities and facilities to bear on the challenges and opportunities in the Space-Age future.

At the same time, the new structure has strong provisions for expanding activities that are traditionally basic at Chance Vought — such work as the advancement of manned aircraft design and production; pioneering in the human factors of flight, and aeronautical research.

ASTRONAUTICS DIVISION

Chance Vought is taking fullest advantage of its existing capabilities to obtain broader responsibilities in astronautics. Concentration will be on advanced vehicles for space exploration, and on ballistic and anti-ballistic missile systems, where the company will draw on 12 years' experience in the missile field.

Vought's first contract work with space hardware — integration of the *Scout* space rocket — is under way. The company is readying this research rocket and its launcher under a National Aeronautics and Space Administration contract.

Also, Vought and other members of the Boeing team are participating in the development of the *Dyna-Soar* boost-glide vehicle in competition for an Air Force contract. And in the human factors of space flight, Vought is already taking the lead with its orbital flight simulator and space-oriented cockpit laboratory.

AERONAUTICS DIVISION

Traditionally a vital field at Vought, aeronautics will see continued emphasis on design advancement. Scope will be broadened beyond manned aircraft to include a new generation of atmospheric missile types, antisubmarine systems, support systems and subcontracting.

Current contracts in this division include production orders for three versions of F8U *Crusader* series aircraft; study contracts in ASW; subcontracts for military and commercial aircraft assemblies, a Navy contract for development of an environmental protection and escape capsule for aircraft pilots.

ELECTRONICS DIVISION

Vought electronics will be developed, manufactured and marketed in increasing volume. Military systems under development include antennas and related electronics, ground support electronics and antisubmarine warfare apparatus. Technical and laboratory support of other company divisions will be a continuing task in Electronics.

RESEARCH DIVISION

Basic research aimed at generating new knowledge is this division's function. A new Research Center will provide creative environment for basic research. This work — as it evolves into applied research — will materially support all other divisions. Extensive facilities, including wind tunnels and a high-temperature lab, will be at researchers' disposal. Fields of research include astronautics, undersea warfare, nuclear studies, sea resources, the life sciences and electrogravities.

RANGE SYSTEMS DIVISION

Twelve years' experience in remote base operation qualifies Vought for additional business in a very new field — establishment and operation of test ranges and test equipment for missiles and space vehicles.

Genesys Corporation, a wholly owned subsidiary company, was formed in May of 1958 to intensify Vought's diversification into commercial electronics. Company emphasis is on automation, and its key personnel are engineers experienced in the fields of electronics, computers, magnetic memory, and other associated electro-mechanical devices.



COUNT DOWN!

for the conquest of space



"MISSION ACCOMPLISHED: DEPARTING LUNA 2205 ZEBRA"

This message, flashed across a quarter-million miles to Washington, D.C., will be awaited anxiously by millions.

But even then our first expedition to the moon will still face its most crucial test—the journey home to earth.

The success of that trip will depend in large part on rocket propellants—fuels and oxidizers that will have been stored for days in the tanks of the expeditionary vehicle and yet will respond instantly when needed.

Storable liquid propellants is one of the fields in which Rocketdyne has anticipated the future. For more than ten years, its propellant chemists have been studying, engineering, and testing combinations of storable fuels and oxidizers for greater storability and higher energy.

Storability PLUS high energy

Rocketdyne has tested these combina-

tions in all production and experimental engines. The results prove that today's storable fuels and oxidizers have these important capabilities:

- (1) High performance, even after months or years of storage;
- (2) Stability over a wide temperature range, permitting storage in missile tanks without rigid environmental controls;
- (3) Dependable performance, predictable even at extremes of heat and cold;
- (4) Instant readiness for firing at any time during the storage period;
- (5) Energy yields equal to or higher than those of conventional propellant combinations.

Second-generation missiles

The tests also prove that engines developed for conventional propellants can be converted to storable combinations rapidly and inexpensively—a significant consideration in the devel-

opment of second and third generation strategic, tactical, and air defense missiles.

Significant, too, is the potential performance of storable combinations. Research points to energy yields as high as 400 seconds of altitude specific impulse—performance 20 percent higher than that of today's combinations. These high-energy yields will offer new capabilities and greater flexibility for America's scientific and military programs.

Stepping stones to Space

Rocketdyne has designed and built much of today's operating hardware in the high-thrust rocket field. Engines by Rocketdyne power most of the military and scientific projects



POWER FOR AMERICA'S MISSILES

Thrust chamber production line for Thor and Jupiter at Rocketdyne's Neosho, Mo., facility moves smoothly.

sponsored by Air Force, Army, and NASA. This experience now becomes the point-of-departure for tomorrow's journeys into the unknown.

FIRST WITH POWER
FOR OUTER SPACE

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

too difficult to carry out until atomic clocks became available and rockets and satellites were developed to put the clock in orbit.

NASA is financing this project upon the recommendation of the Space Science Board of the National Academy of Sciences.

The Maser clock uses the vibrations of ammonia molecules at an unvarying 24,000 mc. as a time reference. The nitrogen component of the ammonia used in the Maser is the stable isotope nitrogen 15, sometimes used as a tracer in agricultural research. It is available in large quantities at about \$400 a gram. Nitrogen 15 ammonia is used in the Hughes Maser because it is a far more stable frequency reference than other forms.

Lvons says, "Other features of the Hughes design which provide accuracy or other performance benefits are a frequency divider and servo circuits of the phase-lock type, a highly stable double resonant cavity, temperature stabilization, precision cavity tuning method, a unique source for generating the ammonia beam and a parametric diode frequency multiplying circuit. The double cavity system greatly reduces reaction of the Maser output system on the ammonia molecules and eases the temperature control problem, while the cavity tuning method likewise provides a great reduction of possible interaction.

"Parametric circuits using gold bonded, germanium diodes make it unnecessary to use any electron tubes in the Maser clock circuits, thus greatly cutting down on battery weight. Ultimately the entire electronic circuitry will be transistorized making the clock rugged and light. Other Maser advantages are its relative insensitivity to magnetic fields which will be different at the surface of the earth and in orbit, its relatively rugged design and the fact that it is the only atomic clock which generates its own time signals.

"When the relativistic clock satellite experiment is done, it will be possible to conduct additional experiments on geophysics and velocity of light without adding equipment to satellites. We would like to see another clock-equipped ground station set up so that the satellite clock time signals could be received at both stations. The relativity measurement will automatically give the time the signals take to get to the stations, so that by methods of triangulation, the distance between the stations could be measured in terms of the known velocity of radio waves.

"Such measurements would give exact geometric shape of the earth and could be made over inaccessible regions such as water or mountains. Present orbital measurements of satellites



IRON FIREMAN

N4100

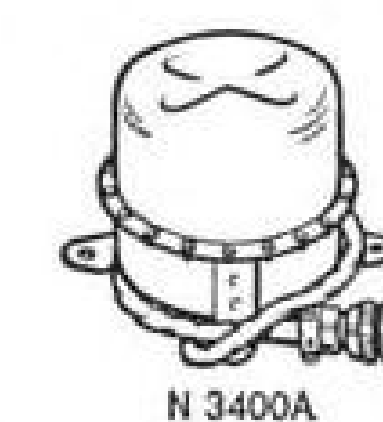
FREE GYRO

COMPACT • RUGGED • RELIABLE

The Iron Fireman Model N4100 is a cageable, two axis, free gyro, designed especially for missile applications. Angular displacements are indicated by a synchro pickoff on the outer gimbal, or potentiometers on both gimbals.

The gyro is designed with reliability and minimum size as primary considerations. The rotor, inner and outer gimbals are symmetrically designed in spherical configurations for maximum rigidity and minimum weight.

Construction throughout is of heat treated, cast stainless steel. The caging mechanism is designed for simplicity and reliability of operation. A center of gravity flange is provided for mounting.



N 3400A



N 3200



N 3700A



N 3700

IRON FIREMAN® *Electronics* DIVISION

2838 S. E. NINTH AVENUE • PORTLAND 2, OREGON

AT CAPE CANAVERAL...

Styroflex[®] Coaxial Cable

is a vital part of
the Air Force
Automatic-Tracking
Antenna System!

The powerful TLM-18 telemetry antenna now in service at the Air Force Missile Center, Cape Canaveral, Fla., is used for the automatic tracking of missiles and earth satellites. This huge "mechanical ear," specifically designed by Radiation, Inc., Melbourne, Fla., has an effective data reception range of over 1000 miles.

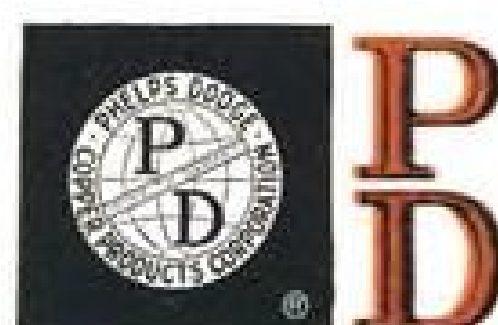
One of the key parts of this highly sensitive device is the $\frac{7}{8}$ " 50 ohm, aluminum sheathed Styroflex[®] coaxial cable that links the 60-foot parabolic reflector to the receivers. The task of carrying missile-to-earth signals from the antenna to the control building demands a low-loss, high frequency cable with a high signal to noise ratio.

The remarkable characteristics of Styroflex[®] cable not only meet these rigid specifications but also have extra operational advantages, including long operating life under severe conditions and stable electrical properties during wide temperature variations.

Styroflex[®] coaxial cable has earned an outstanding record for these qualities in a variety of industrial, mass communication and telemetering applications. Perhaps this cable can answer your particular high frequency cable problem. We invite your inquiry.

PHELPS DODGE COPPER PRODUCTS

CORPORATION
300 Park Avenue, New York 22, N.Y.



give the mass distribution of the earth rather than its geometric figure. This experiment can be reversed and the velocity of light measured in terms of the distance between ground stations. This could be done in different directions in space over paths of thousands of miles, thus checking on whether space is isotropic. The velocity of light could be measured for different satellite speeds, showing that it is independent of the motion of the source, as relativity requires."

Ultimately, Hughes hopes to get Maser oscillators with frequencies stable to one part in 100 billion. These highly stable oscillators would make possible far more accurate doppler navigation systems. Stable oscillator-based transmitters could be located upon the ground or in satellites and very small doppler shift would be very easily measured.

The oscillators could also be carried in the aircraft. Hughes is proposing such a system to the military services and to NASA.

Radiation Belts

Hughes also has proposed to Air Research and Development Command a theoretical investigation of the Van Allen radiation belts using relativistic techniques to determine such things as the relationship between the belts and their predictability.

One of the many smaller and more immediately practicable space technology projects at Hughes is the packet re-entry system. This is a subsystem designed for the return to the surface of the earth of a large member of instrument packages or other capsules from a single satellite. These could be ejected in a controlled sequence for such purposes as laying down a network of weather observation capsules to get almost simultaneous weather data all over the world. This synopsis of world weather made possible by several satellites using the packet re-entry system should prove to be very useful for research into the general circulation of the atmosphere, leading to better weather forecasting procedures, officials contend.

Re-Entry System

Hughes has been working in the packet re-entry system for only a few months. For analytical purposes scientists have designed a 35 lb. capsule with a payload of 5 lb., divided into eight 10-oz. packets, each with its own retro-boost system. Informal presentation has been given to NASA and to the military services. Hughes says the packet re-entry system is available anytime one of the agencies finds a requirement for it. System will be standardized for off-the-shelf sale.

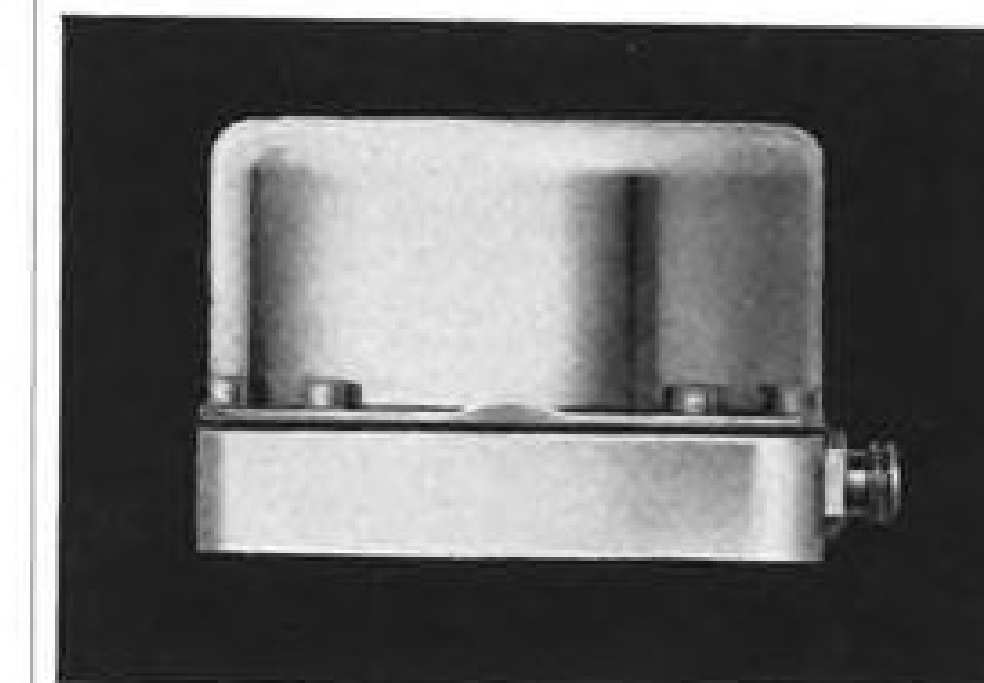
This involves considerable inaccuracy

because of the variety of possible instrumentation packages that could be used in these packets. Despite this, Hughes believes impact areas should be predictable with an error on the order of no more than 75 mi. Beacons in the packets could easily have that much range to permit final location and recovery by search teams.

Hughes Aircraft has been active in studies of communications satellites for about a year, and work has been in the field of concept as well as in the instrumentation packages themselves. Most interest in the industry has centered upon the so-called 24-hr. communications satellite which remains essentially fixed over a point in the equator since at its orbital altitude, it would have the same 15 deg. per hour angular velocity in its orbit as a point upon the surface of the earth.

A drawback to the 24-hr. communications satellite is that communications from the satellite to the surface of the earth would be poor for surface stations within 10 deg. of the Pole. Hughes is interested in a communications satellite serving primarily the northern hemisphere which would have a high eccentricity with the apogee north of the equator. Keplerian mechanics dictate that such a satellite would be over the northern hemisphere during as much as 90% of its orbit.

vibration pickup
1" x 1.42" SMALL
2 $\frac{3}{4}$ oz. LIGHT



VIBRAMITE

Highly sensitive...damped, yet with flat response to 2000 cps...omnidirectional...-85° to 500°F range. Most advanced instrument of its type today.

Send for  Bulletin 112.

MB ELECTRONICS
A DIVISION OF TETRON ELECTRONICS, INC.
1078 State Street, New Haven 11, Conn.



AMPEX:
turning point
for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

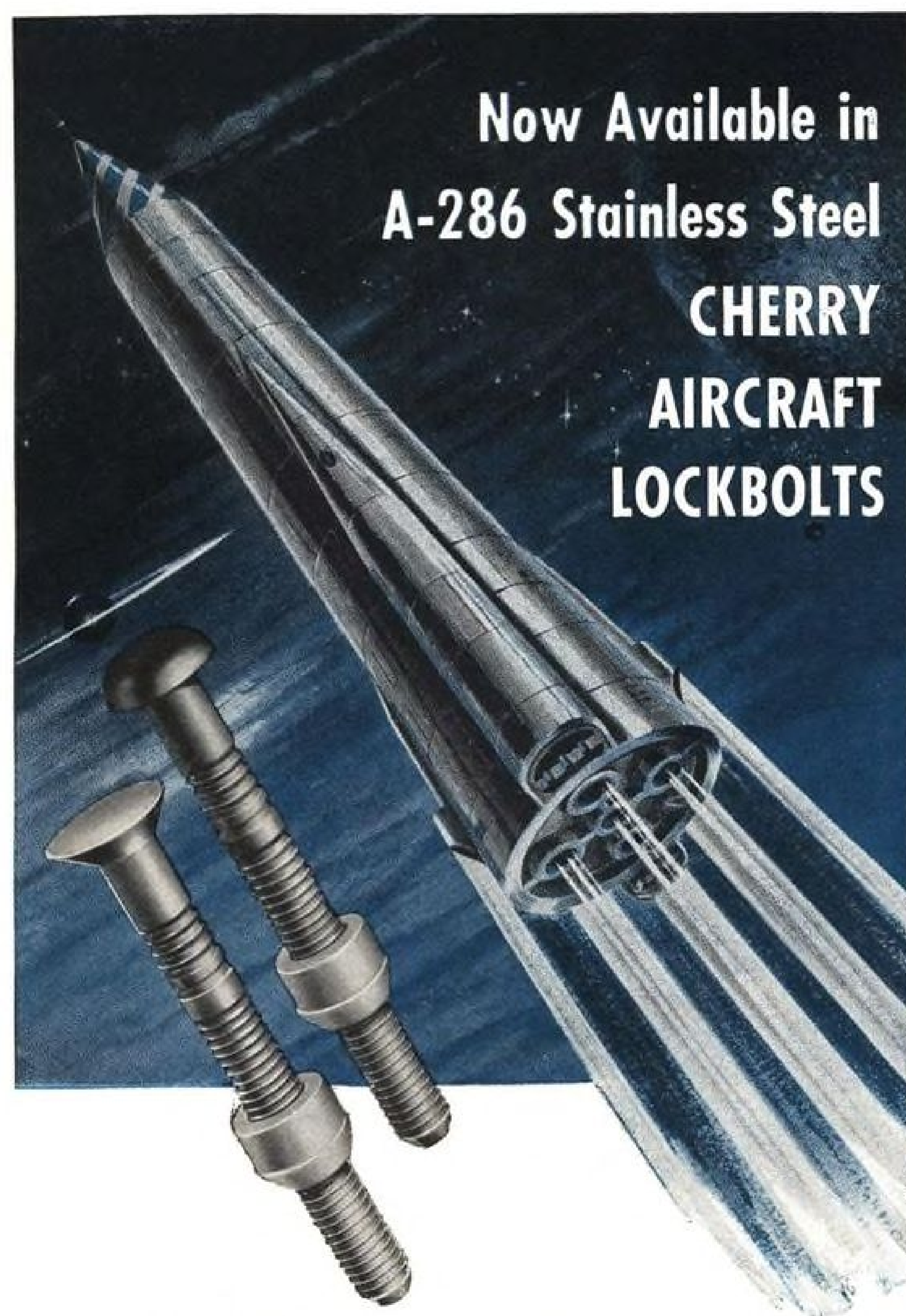
Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium-alloy Precision Reels. Widths of $\frac{1}{4}$ ", $\frac{1}{2}$ " and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters, and base thicknesses:

| AMPEX STANDARD TAPE LENGTHS (feet) | | |
|------------------------------------|-----------------------|------|
| REEL DIAMETER | BASE THICKNESS (mils) | |
| | 1.0 | 1.5 |
| 7" | 1800 | 1250 |
| 10 $\frac{1}{2}$ " | 3600 | 2500 |
| 14" | 7200 | 5000 |

*DU PONT TRADEMARK

For complete specifications or additional tape literature, write

AMPEX
MAGNETIC TAPE
934 CHARTER STREET, REDWOOD CITY, CALIF.



Designed especially for High Strength—High Temperature and liquid oxygen and other corrosive applications, Cherry Aircraft Lockbolts* are now available in austenitic A-286 Stainless Steel.

Available for the aircraft industry in a wide range of diameters, grip lengths and head styles in A-286 . . . Cherry Lockbolts are also produced in Alloy Steel

and Aluminum.

Cherry Lockbolts are structural fasteners providing simplicity and speed of installation with uniform high tensile preloads.

Shop men like them.

For information on Cherry Aircraft Lockbolts, write Townsend Company, Cherry Rivet Division, P. O. Box 2157-N, Santa Ana, California.

*Licensed under Huck patents RE22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

CHERRY RIVET DIVISION

SANTA ANA, CALIFORNIA

Townsend Company

ESTABLISHED 1816 • NEW BRIGHTON, PA.

Hydrogen, Hot-Shot Tunnels Record Heat

Canoga Park, Calif.—High temperature physics research is being conducted here using facilities built for the Aero Ballistics Laboratory, Army Ballistic Missile Agency, under a U.S. Army Ordnance contract. Three high temperature, high speed wind tunnels—two hot-shot types and one hydrogen gun type—are being operated by Rhodes & Blossom Applied Physics Research laboratory. Fourth facility, under a separate contract, is used to investigate controlled fusion for application to a gaseous reactor rocket engine.

Among other experiments, Jupiter nose cone tests have been run in a 12 x 12 in. hot-shot tunnel having 48,000 joules energy capacity. Unique features of the hot-shot unit are the following:

- Square test section and source flow nozzle which permits any desired Mach number and Reynolds number to be obtained by moving model up into the source flow nozzle.

- Force measurements in the tunnel are made by suspending the model, weighing a few grams, on a .005 copper wire. Precision measurements of .1% within one millisecond are possible by graphical integration of acceleration compared to a film record.

- Extreme purity level of the gases in the hot-shot is possible because electrode erosion is 100 times less than in other hot-shots, absolute level being less than 1 milligram or .04% of the gas mass at 8,000K. This low impurity level permits spectroscopic measurement of the temperature by means of a two color gray body intensity ratio.

Second facility developed under the Army Ordnance contract is a hypervelocity hydrogen gun also operated by a 48,000 joule capacitor bank. A 10-microsecond discharge time is possible, using one-half inch nylon models which move at 10,000 to 15,000 fps. As in the hot-shot, low impurity levels are possible because of the short discharge time and large electrode surfaces. Rhodes & Blossom is presently experimenting to obtain escape velocities with a known model shape in this hypervelocity tunnel.

Continuous hot-shot tunnel, which operates for 20 sec., also is in operation. Tunnel operates at pressures of 2 to 5 psig. at air temperatures of 11,000K. This is a battery-operated, stabilized-air heater which operates on 220 kw. power input. A two-throat system is used which permits temperatures to run below 2,000K.

Carbon impurity levels are below 100 parts per million throughout the range currently studied.



Bomarc reception committee
for the enemy intruder **COLLINS
ELECTRONICS**

SPLASH ONE . . . ENEMY AIRCRAFT DESTROYED

. . . Safely out from our heartland, intruding aircraft will be knocked out of the skies by this Air Force long range, pilotless interceptor. Launched at command from an electronic control center, the Boeing Bomarc seeks out its target at supersonic speeds. It unleashes its destruction at a precise instant determined by a highly educated radar proximity fuze developed and manufactured by Collins Radio Company under the direction of the Army's Diamond Ordnance Fuze Laboratories.



COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • BURBANK, CALIFORNIA

Marquardt

ADVANCED SIMULATOR-TRAINING SYSTEMS

FOR AIR AND SPACE

UNIQUE MARQUARDT CONCEPT SHRINKS EARTH TO
14-FEET



Advanced land mass simulation concept demonstrates Pomona Division capability in realistic simulators for lower-cost training of America's air and spacemen.

IN DEVELOPMENT:

A Marquardt-conceived land mass simulation system that shrinks the map scale factor to 1:3,000,000, while enabling the operator to distinguish landmarks smaller than a football field from any altitude! Application today: ground-training airmen for inter-continental missions at great savings in cost — using a single 8-foot map to realistically simulate the radar reflectivity and shadow effects of a 4,000-mile mission. Application tomorrow: training the free world's first space explorer for his safe return to earth.

IN PRODUCTION TODAY:

Pomona Division's AN/GPS-T4 Radar Signal Simulator, a relatively low-cost training system that is simple, compact, flexible and realistic; producing synthetic target and IFF video information for radar display. Current mission: training USAF aircraft controllers to direct interceptor missions. Ready adaptability will permit the T4 to simulate missiles, radar surface targets and sonar targets.

IN THE U.S. DEFENSE INVENTORY:

The USAF's AN/APQ-T1, AN/APG-T1A, AN/APQ-T2 and T2A, and AN/APQ-T3 simulator-training systems, plus the USN's 15WV-2 AEW/CIC trainer system — all developed and manufactured by the Pomona Division and its predecessor companies. Numerous sub-systems, up-dating modification kits, adapters, spares, and a worldwide field service section add to the organization's total experience.

POMONA DIVISION of The Marquardt Corporation is an able and experienced organization with demonstrated capability in advanced research, design, development and production. The result is reliable hardware which provides solutions to the problems of training military operational personnel.

Drawing on the Corporation's overall management-engineering skills, additional facilities and financial support, Pomona Division now offers industry and the Armed Forces a unique and proven ability to get the job done—delivering vital simulator-training system both on-time and at minimum cost.

OPERATIONS AT:
Van Nuys and
Pomona, California
Ogden, Utah
SUBSIDIARY:
Cooper Development
Corporation,
Monrovia, California

THE *Marquardt*
POMONA DIVISION CORPORATION
2709 No. Garey Avenue, Pomona, Calif.

Engineers and scientists capable of contributing to advances in state-of-the-art are invited to write to: Dr. Wendell B. Sell, Vice-President.

1956
Kaman flew the first helicopter to be powered with a gas turbine designed specifically for helicopters

1954
First to fly a helicopter powered by twin turbines

1951
First to fly a shaft turbine helicopter anywhere

1959
Kaman converts its production 100% to turbine powered helicopters, becoming the first major helicopter company to take this forward step.

KAMAN

In National Defense

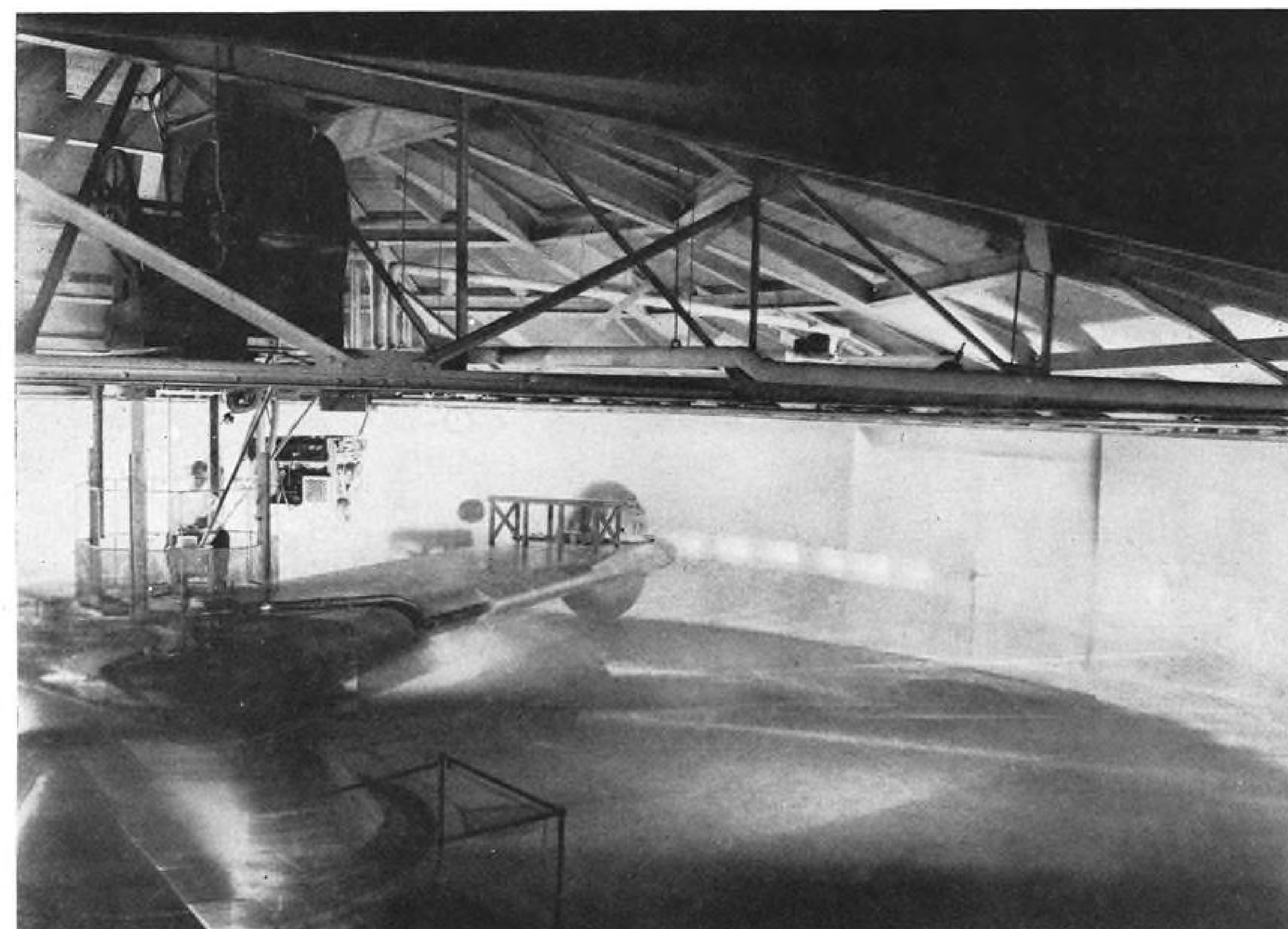


Kaman is part of the plan

THE KAMAN AIRCRAFT CORPORATION • BLOOMFIELD, CONN.



AVIONICS



MASSIVE 18-ton centrifuge checks operation and ruggedness of guidance systems developed by Massachusetts Institute of Technology.

MIT Sparks Inertial Guidance Efforts

By Philip J. Klass

Cambridge, Mass.—Many of the techniques and devices which spawned today's multi-million-dollar-a-year inertial guidance industry were conceived here in an obscure, aging brick building which once housed a boot-polish factory. The facility, known as the Massachusetts Institute of Technology Instrumentation Laboratory, is directed by Dr. Charles S. Draper, who also heads MIT's Aeronautics and Astronautics Department.

The inertial guidance system designed to direct three of the nation's long-range ballistic missiles to their targets—the Thor, Titan and Polaris—had their origin here at the Instrumentation Laboratory on the edge of the MIT campus.

Less than 15 years ago, Draper and a handful of associates were among the few who were optimistic enough to believe that they could achieve the near-fantastic improvement in gyro drift rate and accelerometer sensitivity re-

quired for a practical inertial guidance system, in a size, weight and at a price which would permit its use in aircraft and missiles. There were a few other such optimists at North American Aviation and in Army Ordnance.



DR. CHARLES S. DRAPER

The floated integrating gyro, which opened the way to orders of magnitude reduction in gyro drift rate and which now finds use on most inertial systems, came out of the Instrumentation Laboratory, as did the widely used pendulous integrating accelerometer. A mathematical approach to computing ballistic missile guidance commands, which permits major simplification of the missile's computer, is credited to Dr. J. H. Laning of the Instrumentation Laboratory.

Because the bulk of the laboratory's efforts have been government-sponsored, the resulting techniques and devices have become available to industry. More than half a dozen companies today are producing the floated integrating gyro originally conceived by MIT. The gyro also finds wide application in fire control systems.

The Instrumentation Laboratory has served as the development facility for the inertial systems which AC Spark Plug Division of General Motors is producing for the Thor and the ones



EAGLE

symbol of a superior Navy

The United States Navy has traditionally been proud of its fighting men and superior weapons. The Eagle Missile System is a concept which will continue this tradition into the future.

The Eagle Missile System is an advanced long-range air-to-air weapon for fleet air defense and intercept missions. It is truly a second generation missile concept in which the performance is built into the missile itself rather than the carrier aircraft.

The Missileer will be the aircraft from which the long-range Eagle missiles are launched. This long-

endurance aircraft will provide the ideal battle platform from which to carry out future aerial defense.

The Bendix Aviation Corporation, The Grumman Aircraft Engineering Corporation, Sanders Associates, Litton Industries, and the Westinghouse Air Arm Division are the key participants in the Eagle Program. The Bendix Systems Division has prime responsibility for systems management and engineering.

Better engineers and scientists interested in participating in such programs of the highest technical integrity are invited to write for further information.

Bendix Systems Division

ANN ARBOR, MICHIGAN



it will manufacture for the Titan. MIT designed the inertial system which General Electric is assembling for the Navy Polaris IRBM. The original Ship's Inertial Navigation System (SINS) for ship-submarine use also came out of this laboratory.

This important contribution to the nation's inertial guidance know-how has come from government funding which has averaged only approximately \$4 million per year since the end of World War II. The funds available in the early postwar years were considerably less than this average. This year, the Instrumentation Laboratory operations will cost about \$14 million, which includes work in areas other than inertial guidance.

Originally the Air Force sponsored the bulk of the laboratory's work in inertial guidance. Today the Air Force picks up the tab for about two-thirds of the operations, with the Navy covering the balance. All contracts are of a cost-reimbursement type without any fee because the laboratory is operated on a non-profit basis.

Laboratory Staff

At present the laboratory employs slightly more than 800 persons, of which nearly 300 are professional engineers and scientists.

The Instrumentation Laboratory plays another function which Draper believes is equally important to its more familiar one. This is education. Under Dr. Walter Wrigley, educational director, the laboratory conducts classified courses in inertial guidance for military personnel, and unclassified courses for MIT graduate students. This enables MIT to give students a good grounding in both theory and practical design aspects of inertial guidance using professors who are practicing the latest state of the art. This is important in a fast-moving technology.

MIT also has a program whereby industry engineers can come in as teaching assistants and enroll in inertial guidance or other MIT courses. The engineer's company pays his salary. Companies that have participated in the plan include AC Spark Plug, General Electric and Minneapolis-Honeywell Regulator Co.

The Instrumentation Laboratory, which took its present name in 1946, is a descendant of MIT's Confidential Instrument Development Laboratory, formed in 1940 to work on naval gun directors. The latter was an outgrowth of a small Instruments Laboratory, headed by Draper, which worked on aircraft instruments in the mid-thirties.

The computers which had been designed prior to World War II to direct shipboard guns against other ships proved too slow and cumbersome for use against attacking aircraft. Draper

Research Philosophy

Displayed in a prominent position in Dr. C. S. Draper's office in the Instrumentation Laboratory, although not originated by him, is this philosophy of research: "Research is a gamble. It cannot be conducted according to the rules of efficiency engineering. Research must be lavish of ideas, money and time. The best advice is don't quit easily. Don't trust anyone's judgment but your own, especially don't take advice from any commercial person or financial expert.

"And finally, if you really don't know what to do, match for it. The best man to decide what research work shall be done is the man who is doing the research. The next best man is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director, who probably is wrong more than half the time. Then comes a committee which is wrong most of the time. Finally there is the committee of company vice presidents which is wrong all of the time."

and his associates conceived and developed an extremely fast, small and simple gunsight which used a spring-restrained, viscous-damped rate gyro which proved far more effective for anti-aircraft use. This gunsight, known as the Mark 14, became a Navy standard and more than 100,000 were produced by industry.

Soon afterward the same basic technique was applied to a gunsight for use in aircraft. This gunsight, officially known as the A-1, sometimes is called the "Draper-Davis sight." Draper's collaborator was Col. L. I. Davis, now a major general, who had done graduate work under Draper at MIT in 1940 and at the time was chief of the Armament Laboratory at Wright Field.

From these original designs came an entire series of improved shipboard fire control systems, and the A-4 gunsight which gave the North American F-86 such a sharp edge over superior numbers of Soviet MiG fighters in Korea.

Fire Control

Near the close of World War II, the Instrumentation Laboratory turned its efforts to bomber defense fire control and interceptor fire control systems. The tail defense system used on the Convair B-58, manufactured by Emerson Electric, is an outgrowth of an MIT development. The Instrumentation Laboratory also was one of the first to successfully flight test a fully automatic interceptor fire control system in which the radar-computer controlled the interceptor's flight path directly through its autopilot, by-passing the human pilot.

This extensive background in gyros, servomechanisms and stabilization was a major factor which directed the laboratory's efforts into inertial guidance shortly after the end of the war. Another was the return of Dr. Wrigley from Sperry Gyroscope Co. In 1940, Wrigley had obtained his doctorate at MIT with an investigation of methods for indicating the direction of vertical from moving bases—a cornerstone of inertial guidance.

Although radar had proved a great boon to high-level, all-weather bombing in World War II, it had the important disadvantage of emitting electromagnetic radiation which alerted the enemy of impending attack and which could be jammed by enemy electronic counter-measures.

For these reasons, USAF's Armament Laboratory was anxious to find another approach to bombing-navigation system design which would not use tell-tale radar. The Instrumentation Laboratory tackled the job with the idea of using a combination of inertial and celestial techniques, since it did not then appear possible to obtain the component accuracies needed for an all-inertial system. The result of this program, known as Febe, weighed 4,000 lb. and was completed in 1948.

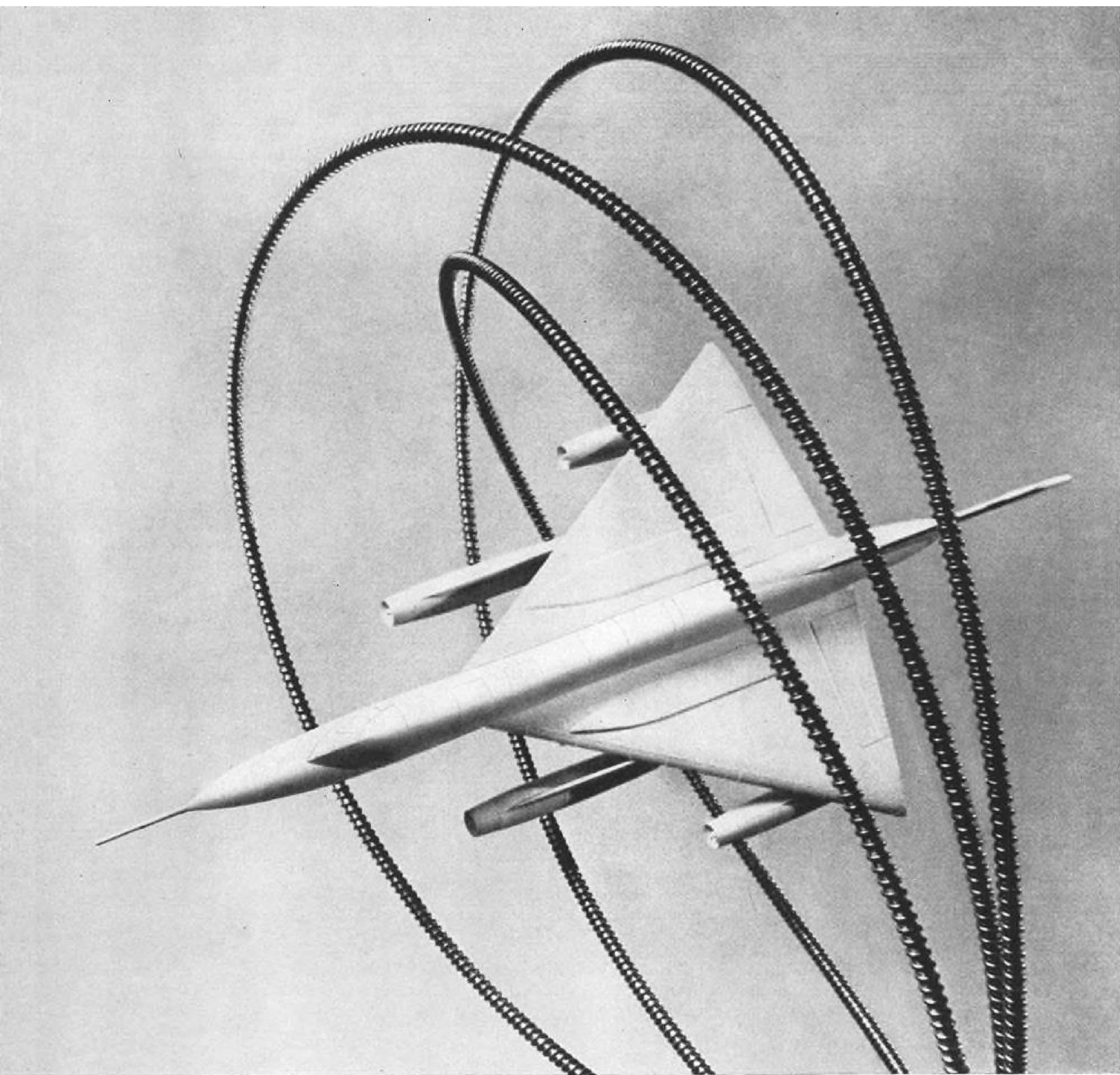
All-Inertial System

By this time the Instrumentation Laboratory had made sufficient progress in developing low-drift floated integrating gyros so that Draper and his associates were willing to stick their necks out and attempt an all-inertial bombing-navigation system for the Air Force.

By 1952, MIT had completed its first all-inertial bomb-nav system, known as SPIRE, weighing 2,800 lb. The system was installed on a Boeing B-29 and in 1953 it flew from Boston to Los Angeles automatically guided by its inertial system, carrying Dr. Draper to a classified conference on inertial guidance. When Draper announced the feat during the conference, it created quite a stir. The feasibility of inertial guidance had now been established in actual operation outside the laboratory. In 1956, the Instrumentation Laboratory began tests on a smaller system, called SPIRE, Jr., which weighed in at about 1,500 lb.

In 1953, Convair approached MIT to work on the development of an inertial system suitable for the Atlas ballistic missile. Out of this came the basic concepts of the system which eventually went into the Thor.

At the start of the Air Force's all-out ballistic missile program in 1954, there were still such sufficient reservations about the feasibility of inertial guidance that prudence dictated the development of two alternate guidance systems: radio-command and inertial. Originally, each of three original ballistic missiles



How to design remote control systems that are 95% efficient in a 90° bend. Or...

... how to get 18000° shaft rotation with up to .00055% accuracy. Or, remotely synchronize valves in a temperature range of -100° to 1200°. Or, design around any contour or bend without intermediate links or pulleys, and cut weight of systems by 54%-60% of cable pulley or rod and bellcrank systems.

The "how" is with TELEFLEX® systems. The "why" is the exclusive TELEFLEX helix wire cable design. No remote control cable anywhere gives such high sensitivity and response... such a reduction in weight and backlash... such design freedom with straight line, angular and unlimited rotary motion!

The technical advances made possible with TELEFLEX cable mean that TELEFLEX engineers have gone further and can offer more in the development of complete mechanical control systems for any purpose. Write today for catalog, or help on your specific problem. TELEFLEX Incorporated, North Wales, Pa.

TELEFLEX SYSTEMS offer unequalled design flexibility because they are the only systems to offer all three types of mechanical motion...



TELEFLEX
INCORPORATED

had dual guidance systems under development.

As the accuracy and reliability of inertial techniques improved, and the size and weight dropped, Air Force has settled on all-inertial guidance for each of its ballistic missiles.

Weight of the inertial systems for the Titan and Polaris can not be revealed, but a Wright Air Development Center Weapons Guidance Laboratory spokesman recently told AVIATION WEEK that there has been a 10:1 reduction in the size and weight of inertial systems in the past several years (AW April 6, p. 55).

Space Guidance

The nature of work under way at the Instrumentation Laboratory has changed somewhat from its early efforts. The laboratory continues to explore advanced techniques, such as the so-called "exotic gyros," and guidance techniques required for space probes, such as a Mars reconnaissance vehicle.

On the Polaris program, MIT is a co-prime contractor with Lockheed Aircraft Co. The Instrumentation Laboratory is responsible for the complete inertial system design which GE will assemble, and for monitoring and coordinating General Electric's efforts. Draper recognizes that this is an important and necessary mission, but he is not anxious to expand MIT's efforts in this direction.

The Instrumentation Laboratory is organized on a project basis for its Polaris and Titan programs. Each project contains the necessary gyro, computer, accelerometer and systems engineers. In addition, there are groups of specialists which serve all projects.

Although Draper's critics outside the laboratory sometimes accuse him of a lack of tolerance for competing ideas developed by others, project teams in the Instrumentation Laboratory are given considerable freedom in their design approaches.

Different Configuration

For example, the stabilized platform for the Titan employs a different configuration from that used for the Polaris missile.

The atmosphere here is an interesting combination of that found in an academic research laboratory and that found in an industry development laboratory.

Lines of authority and responsibility are moderately flexible. There is "none of the maneuvering for position often found in industry," according to one engineer who recently left industry to join the laboratory.

For these reasons, the laboratory has experienced only a moderate loss of personnel to industry, despite the higher

SPACE COMMUNICATION ANTENNAS

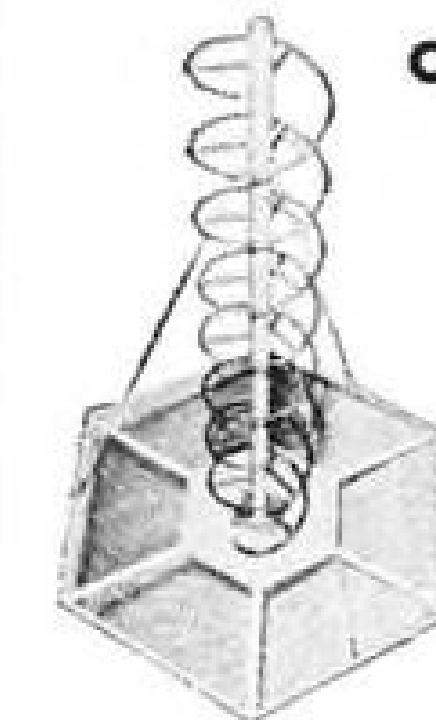


Andrew Quad-Helix antenna tracks long and medium-range missiles

Telemetry circuits between missile (or satellite) and ground station are reliably maintained with the ANDREW Quad-Helix Array. This system offers low VSWR, high gain, and easy control.

Gain is 17.5 db at 265 mc, 14.5 db at 215 mc. VSWR is less than 2.0:1 across this range. Polarization is right hand circular; impedance 50 ohms. Counterbalanced rotator provides 180° elevation and 720° azimuth tracking at speeds from 0° to 30° per second.

Optional remote control unit regulates speed and direction.



OTHER ANDREW GROUND-AIR ANTENNAS

TRI-HELIX ANTENNA
880-990 MC 17.5 DB GAIN TYPE 81068

| HELIX ANTENNAS | | |
|----------------|---------|-------------|
| FREQUENCY | GAIN | TYPE NUMBER |
| 108-132 mc | 12 db | H 19110 A-1 |
| 215-265 mc | 10.5 db | H 50140 A |
| 215-265 mc | 13 db | H 19110 A-2 |
| 260-320 mc | 13 db | H 19110 A-3 |
| 320-400 mc | 13 db | H 19110 A-4 |
| 400-500 mc | 12 db | H 19110 A-5 |



DISCONE ANTENNAS

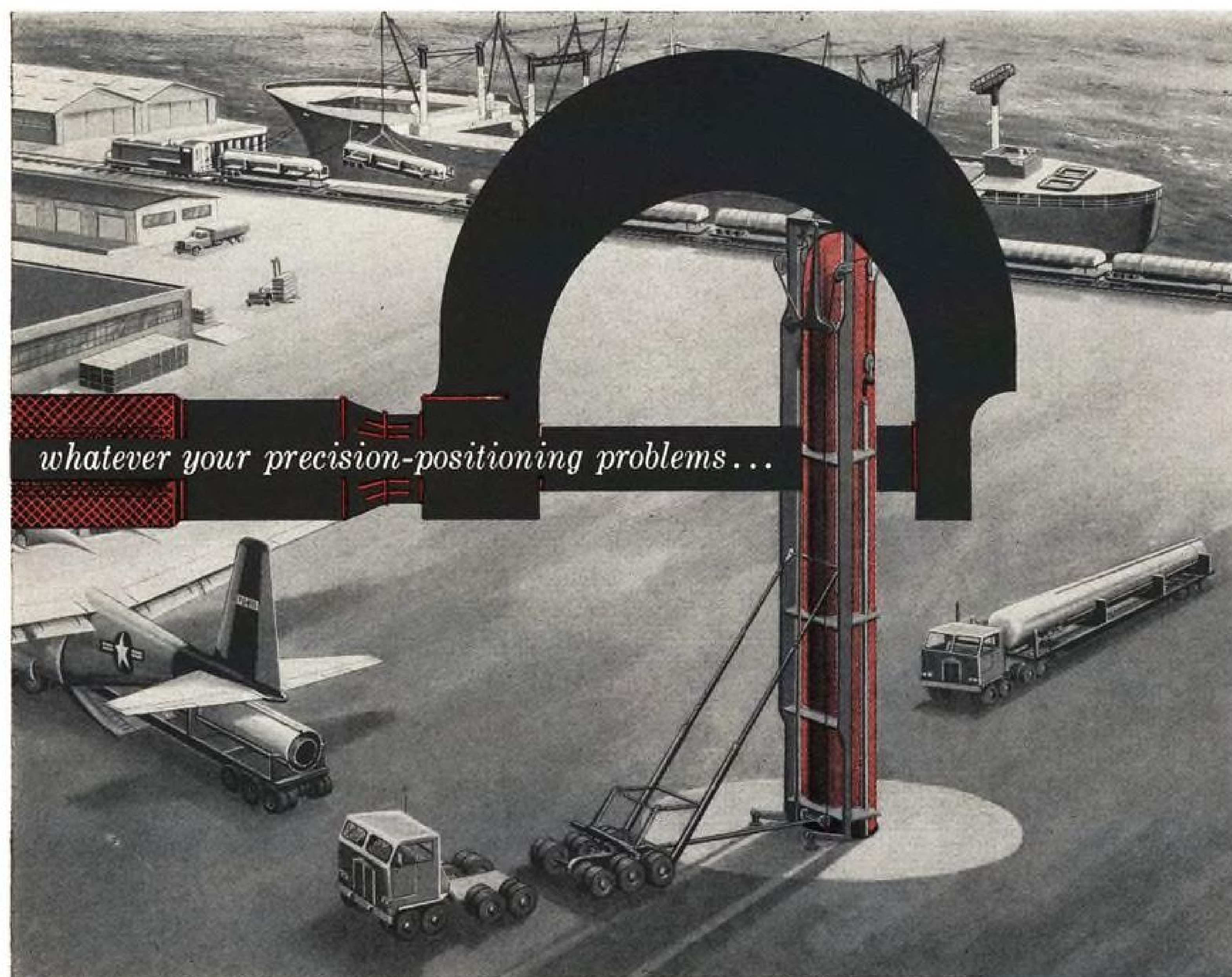
| FREQUENCY | TYPE NUMBER |
|-------------|-------------|
| 25-50 mc | 50154 |
| 50-108 mc | 51150 |
| 108-215 mc | 19050-1 |
| 215-420 mc | 19050-2 |
| 420-1000 mc | 19050-3 |

VISIT WESCON BOOTH 2001

Andrew
CORPORATION

363 EAST 75th STREET • CHICAGO 19
Offices: New York • Boston • Los Angeles
Washington, D.C. • Toronto

For full information on these and other ANDREW ground-air antennas, write today for Bulletin 8456



WESTERN GEAR CAN SUPPLY THE SOLUTIONS



To insure the reliability of the missile, its positioning must be accurately and cautiously handled. No matter what mode of transportation, truck, rail, air or water, there are Western Gear precision drives and related equipment engaged in the touchy and delicate task of handling the mighty "birds." Moreover, Western Gear's extensive experience and facilities enable the company to effectively handle your system requirements.

For complete information on our capabilities and facilities, write on your letterhead for Bulletin 5900.

WESTERN GEAR CORPORATION
Precision Products Division, P. O. Box 192, Lynwood, California

5921

salaries which the latter usually can offer.

Draper has received an impressive number of awards for his work at the Instrumentation Laboratory, including the Presidential Medal for Merit, the Air Force Exceptional Civilian Service Award and the Navy Distinguished Public Service Award.

Draper likes to describe himself as "only a greasy-thumbbed mechanic." This disarming qualification usually is employed just before he launches a devastating attack on an opposing point of view.

Unusual Background

The man who serves as a sparkplug for the laboratory is the product of an unusual academic background. He obtained his first degree in psychology at Stanford in 1922, began working in experimental psychology and soon found himself more interested in the instruments involved than the psychology. He moved on to MIT, obtained a B.S. in electrochemistry, a masters degree without specification (working primarily in aircraft powerplants) and finally a doctor's degree in physics. Draper has been a licensed pilot since 1928.

Although the Instrumentation Laboratory is studying exotic gyro concepts, Draper believes that the present floated integrating gyro concept can meet any foreseeable military requirements for missile guidance. And for space vehicle guidance, Draper believes that a combination of inertial and stellar techniques is the answer.

For this reason, the laboratory is devoting the bulk of its development effort to new methods of improving the accuracy and/or reducing the size, weight and cost of present gyro and accelerometer designs.

Beryllium Use

For example, it has pioneered in the use of beryllium for gyro construction. The metal has approximately the same rate of thermal expansion as steel, permitting its use in combination with steel where necessary. It has approximately 50% more stiffness than steel, yet weighs only slightly more than magnesium. Beryllium dust can be toxic if inhaled by machine operators, but this problem has been solved through use of vacuum dust catchers mounted in close proximity to the machine work.

With expanding industry activity in inertial guidance, and a fast-disappearing need for conventional aircraft/ship-board fire control systems, the nature of the Instrumentation Laboratory's work is likely to change in the next several years. Undoubtedly it will devote an increasing percentage of its efforts to the nation's space programs and already has several projects under way.

Multi-turns?

We got 'em!

Multi-turn potentiometer connoisseurs...the men who buy them...turn to Helipot to succor their circuits. They make their choice from the nineteen separate and distinct series of HELIPOT multi-turns, each with a myriad of models, scaled from 7/8" dia. x 1-1/2" up to 3-5/16" dia. x 6". They find it easy to pick the pot that suits their circuit...linear or non-linear...high temperature or standard range...with resolution from a three-turn 0.164% up to a forty-turn 0.00073%...and linearities to $\pm 0.01\%$!

Join the well-informed 7 out of 10* who turn to Helipot. Get the complete story on this profusion of multi-turns (plus a delineation of the HELIPOT single-turn line). Write for Data File K332.

*Based on a well-known national trade publication's own survey of thousands of pot specifiers and buyers.

Beckman/Helipot

Helipot Division of Beckman Instruments, Inc., Fullerton, California
Engineering representatives in 29 cities

60010 © 1959 B.I.I.

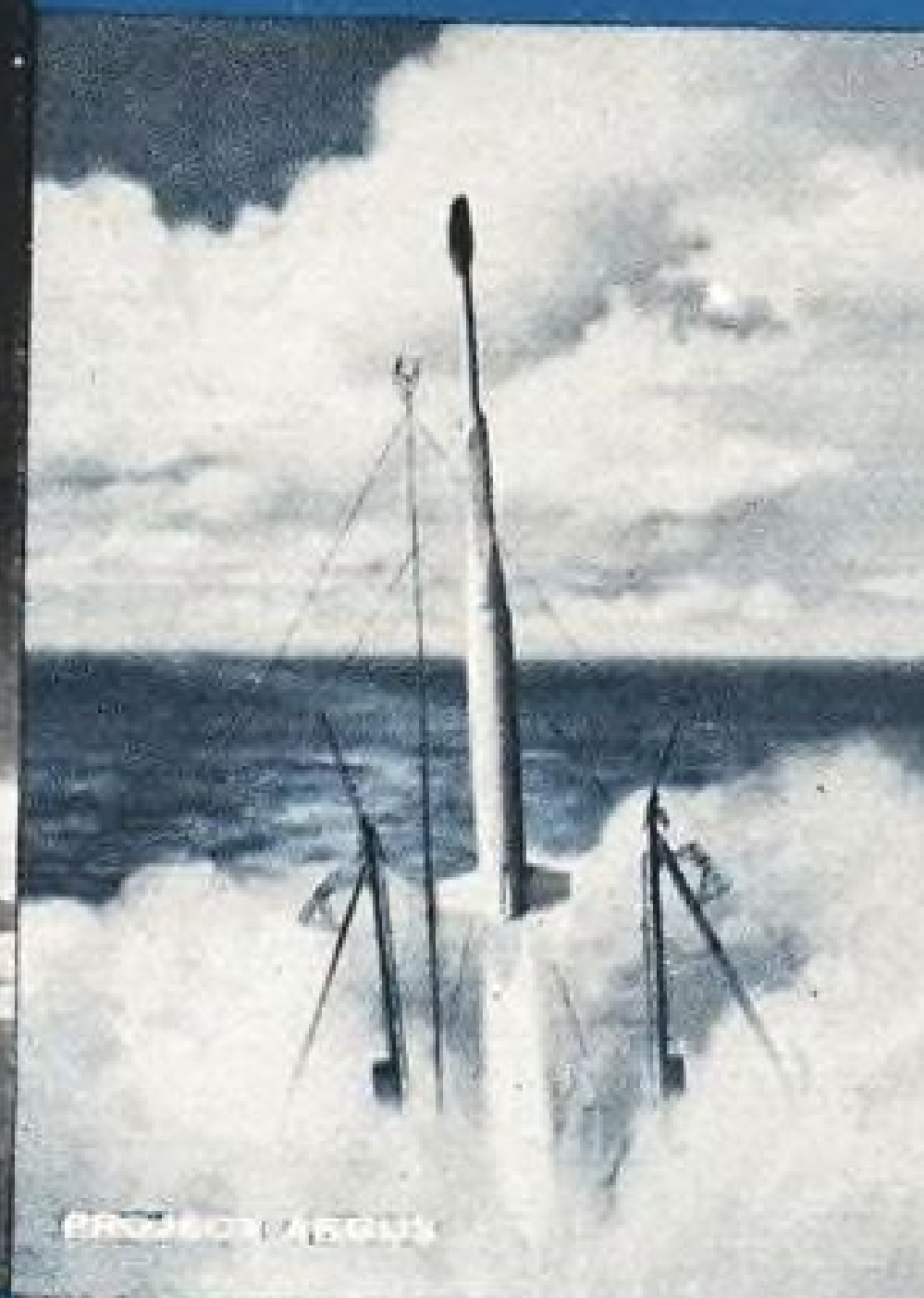
potentiometers; dials; delay lines; expanded scale meters; servomotors; breadboard parts



POLARIS FBM



DISCOVERER SATELLITE



PROJECT ARGUS



Q-5, KINGFISHER



SPACE STATION

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

ADVANCED PROJECTS AT LOCKHEED

POLARIS FBM—Lockheed is missile systems manager for the Navy POLARIS Fleet Ballistic Missile, under the cognizance of the Special Projects Office of the Bureau of Ordnance. Submarine-launched, the POLARIS will travel through three mediums in a single flight; water, air and outer space. With three-quarters of the earth's surface being water, practically no target in the world is outside its range. The solid-propellant POLARIS was designed with the future in mind—an approach that the Navy states has cut nearly two years from the original timetable.

DISCOVERER SATELLITE; MIDAS; SENTRY Designed and built by Lockheed Missiles and Space Division, the first of a series of DISCOVERER satellites was successfully placed in orbit in February. The Division has also been assigned the responsibility of systems manager for PROJECT MIDAS—an early warning system against ballistic missile attacks. The project will investigate the use of infrared sensors for detecting aggressor missiles at the moment of launch; and PROJECT SENTRY—an advanced satellite reconnaissance system. DISCOVERER, MIDAS and SENTRY are programs of the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division.

X-17—The nation's first successful reentry tests were conducted by the Air Force with the three-stage, Lockheed X-17 solid-propellant ballistic missile. The X-17 has pioneered many new techniques and the valuable experience gained from this program has facilitated development of other, inter-service projects, including the Navy POLARIS FBM. The Navy's history-making, 300-mile-high, Project Argus radiation explosions featured the X-17 as the vehicle.

Q-5, KINGFISHER—Developed for the Air Force, and currently being manufactured for the Army, the Kingfisher is designed to simulate enemy attacks to test the efficiency of our various defensive weapon systems. It is equipped with extensive instrumentation to register "kills" without itself being destroyed and can be recovered by parachute and landing spike to be used again, with marked savings in cost.

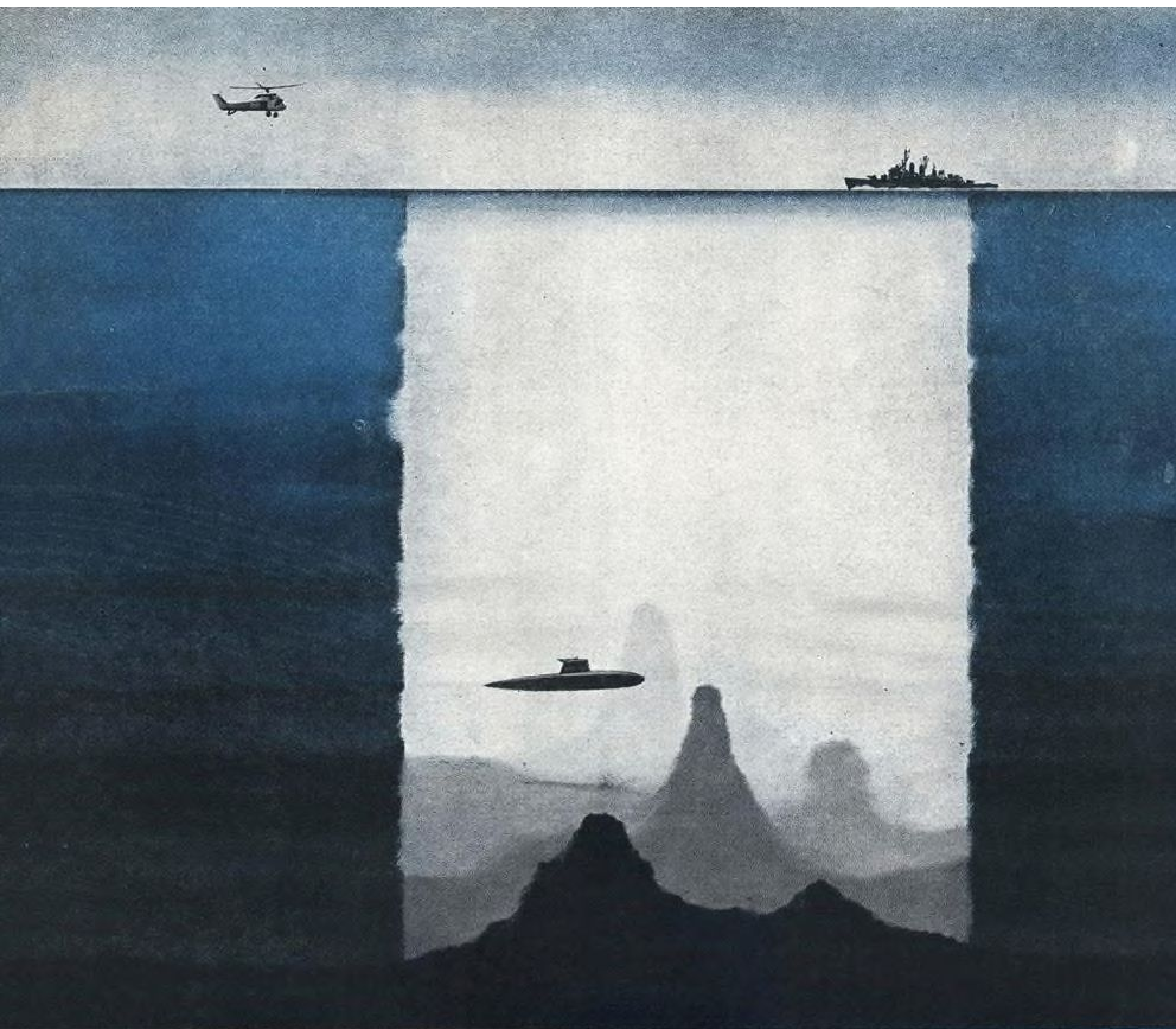
X-7—Lockheed's X-7 recoverable ramjet-engine test vehicle, developed for the Air Force, has established speed and altitude records for air-breathing vehicles and is also recoverable for re-use following flight.

SPACE STATION—An orbiting research facility, to serve as an advance base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by means of ballistic missiles and guided into a cluster on the same orbit.

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. H5-17, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed / MISSILES AND SPACE DIVISION

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



No hiding place for underseas prowlers

Raytheon sonar is as far-reaching as the sea itself. From the air, the surface and the depths, underwater vision is eliminating the hiding places of underseas prowlers. Development of sonars for the highly diversified vehicles and environments necessary to achieve complete surveillance requires a highly adaptable engineering staff.

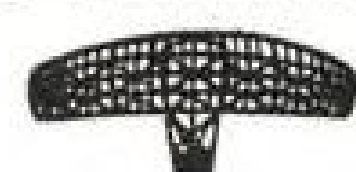
PROFESSIONAL ASSOCIATION WITH A FUTURE is open to qualified engineers and scientists with BS or advanced degrees. Positions are available in systems, development, design or manufacturing engineering of a wide range of complex equipments. Please write Donald H. Sweet, Government Equipment Division, Raytheon Company, 624 Worcester Road, Framingham, Massachusetts.

Engineering Laboratories: Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.
Manufacturing Facilities: North Dighton, Waltham, Mass.



Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION



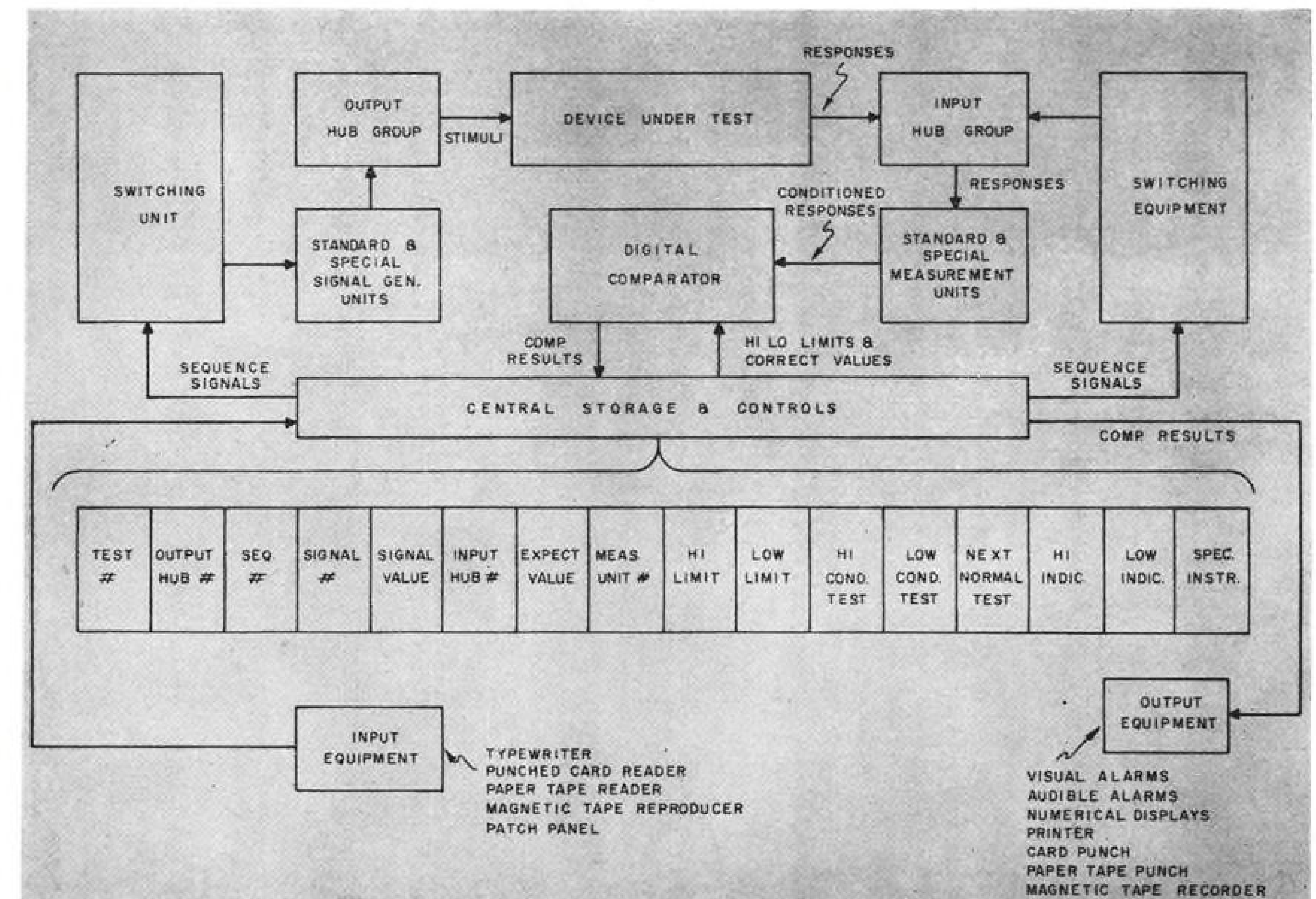
LAND



SEA



AEROSPACE



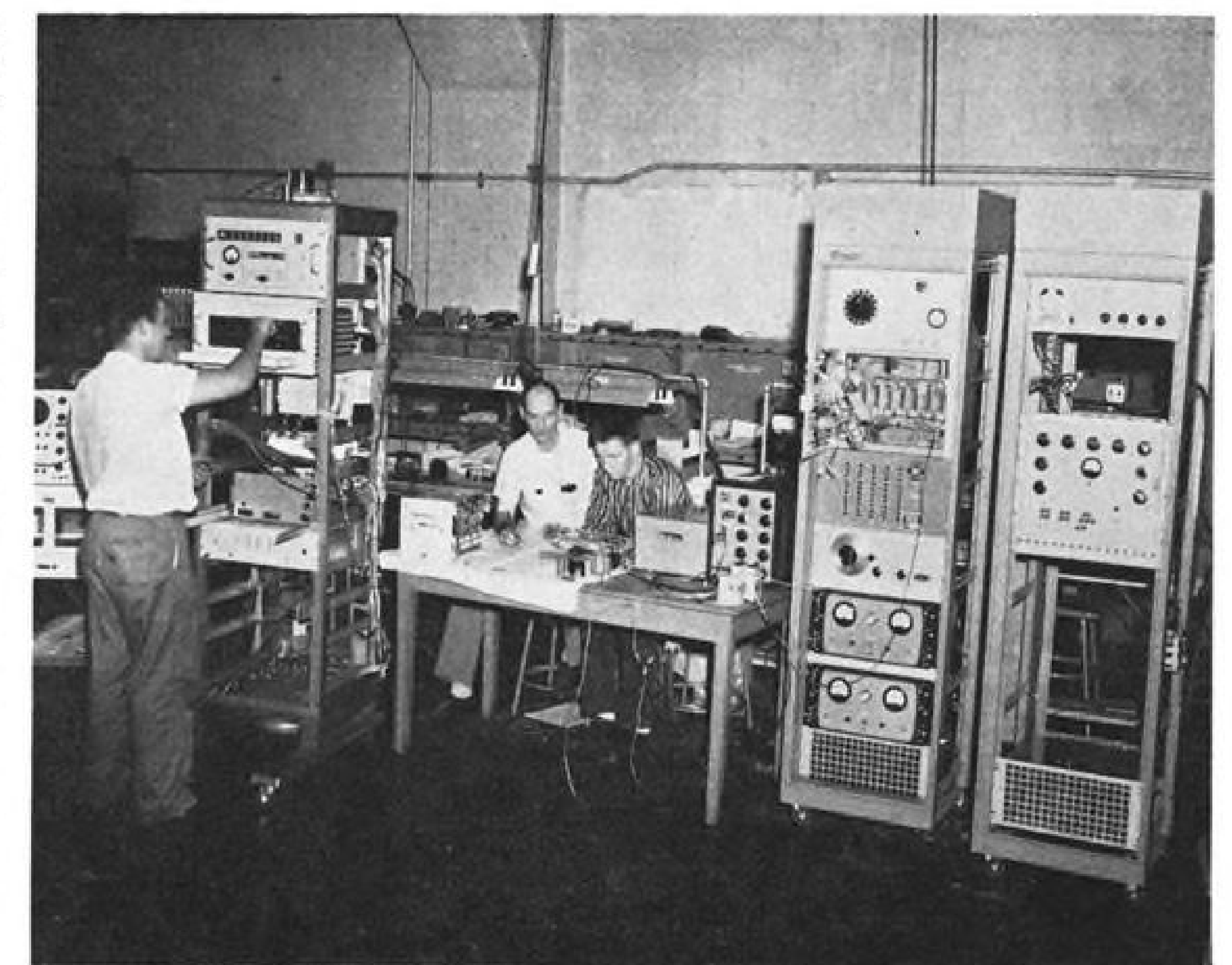
ULTRA HIGH SPEED automatic checkout equipment developed by Epsco for testing complex weapon systems is outlined above.

System Speeds Missile Pre-Flight Check

Cambridge, Mass.—Automatic checkout equipment which can make up to 10,000 test decisions per second, permitting missile pre-flight checkout in a few seconds or a full trouble-analysis in minutes, is being offered by Epsco, Inc.

The high-speed operation stems from the use of high-speed digital computer switching and decision-making techniques. All measurements are converted into digital form, allowing almost any desired degree of accuracy. The ultra-high-speed design also permits precise dynamic performance measurements on servomechanisms and other circuits where usual static measurements don't adequately evaluate circuit performance.

Speed-up of the checkout on a weapon/support system should permit a significant gain in operational life by reducing extensive test time, Epsco believes. For instance, at recent Dayton avionics conference, Richard W. Hanford, Missouri Research Laboratories, reported that one interceptor fire control system undergoes total of 700 hr. of testing in the airframe manufacturer's plant before it ever reaches the military user. Once in the field, 5 hr.



EPSCO missile checkout system includes monitoring equipment (left rack); test and calibration equipment in racks at right. Equipment on workbench is precision rms-to-d.c. converter.

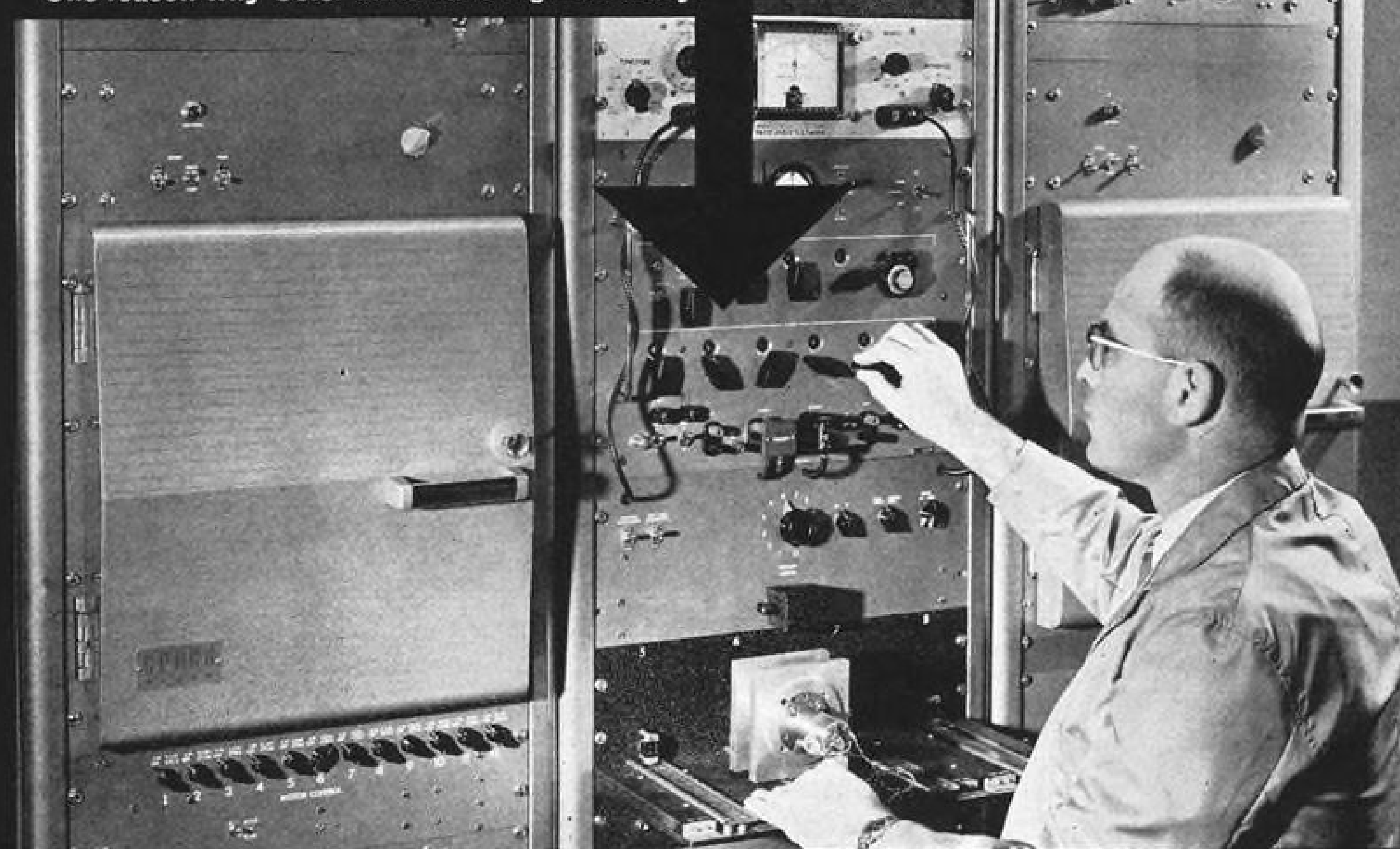
WHY *Oster*® MEANS HIGH ACCURACY

For Missile Guidance Systems . . . Highly Accurate

Precision Motor Tach Generators Utilizing Thermister Networks for Temperature Compensation.

- Calibrated to near 0° phase angles.
- Constant output from -55°C to +150°C.
- Manufactured from alloys with extremely low temperature coefficients.
- Mass produced under exceptionally rigid quality control.

One reason why Oster units have high accuracy:



BURTON BROWNE ADVERTISING

This Test Stand handles 12 units simultaneously, all temperature compensated to -55°C to +150°C. Also tests output voltage, phase shift and linearity. Test Stand has a speed accuracy of .01%, transformation accuracy of .001% and phase shift accuracy of 2 minutes.

For your exacting space age requirements, specify Oster motor tach generators.



New 16-page **MOTOR TACH GENERATOR CATALOG No. 6000.**

Lists 20 basic types for military, scientific and industrial applications. Request your free copy today — on company letterhead, please.

OTHER PRODUCTS INCLUDE:

Servos
Synchros
Resolvers
DC Motors

Computers
Indicators
Servo Mechanisms
Servo Torque Units

John Oster

MANUFACTURING CO.
Your Rotating Equipment Specialist
Avionic Division
Racine, Wisconsin

EASTERN 310 Northern Blvd. • Great Neck, Long Island, New York
OFFICE Phone: HUnter 7-9030 • TWX Great Neck N.Y. 2980
WESTERN 5333 South Sepulveda Blvd. • Culver City, California
OFFICE Phone: EXmont 1-5742 • TEXas 0-1194 • TWX S. Mon. 7671

Engineers For Advanced Projects:

Interesting, varied work on designing transistor circuits and servo mechanisms.
Contact Mr. Robert Burns, Personnel Manager, in confidence.



Goodyear Aircraft Designs BMEWS Antenna

Ballistic Missile Early Warning System (BMEWS) tracking radar antenna, shown in this artist's conception, employs an 84-ft. diameter antenna designed by Goodyear Aircraft Co. for Radio Corporation of America, BMEWS prime contractor. Antenna will be enclosed in a 140-ft. diameter rigid spherical radome. Prototype model now is being installed at RCA's Moorestown, N. J., facility for engineering tests. Tracking radar is an outgrowth of RCA's extremely accurate AN/FPS-16 monopulse radar, widely used for missile tracking and range instrumentation. Antenna tower is constructed on pylons extending through the building and resting on 55-ft.-wide 8-ft.-thick octagonal slab in the ground to provide extreme rigidity.

of test is required before each flight using conventional manual test equipment, Hanford said. This indicates that a sizable portion of a weapon's useful life now is consumed in checkout.

Epsco currently holds a number of contracts for automatic checkout equipment, not all of it designed for ultra-high-speed operation. The company is producing a high-speed system for General Electric which will monitor an atomic reactor. Other Epsco automatic checkout equipments have been or are being developed for AC Spark Plug's Thor inertial guidance system, for Convair's Terrier and Atlas missiles, and for Douglas Aircraft's Nike Zeus.

Epsco's first effort in this field was an engineering study of a complete rapid automatic checkout system (called RACO) for the Convair F-106. This effort was a natural outgrowth of Epsco's early start in the fields of pulse code modulation telemetry equipment and digital data reducing/processing systems. Company also sells certain off-the-shelf items, such as its high-speed analog/digital converters to some of its competitors in the automatic checkout equipment field.

Recently Epsco formed a new subsidiary, known as Monitor Systems, Inc., in the Philadelphia area which will specialize in automatic checkout and monitoring systems. The new operation is headed by Harry H. Rosen, former manager of data processing and computation at General Electric's Missile & Space Vehicle Department.

Flexible Designs

Because automatic checkout equipment usually must be designed concurrently with the weapon/support system it is to test, it must be sufficiently flexible in design to accommodate changes in the weapon/support system even after the latter has gone into field use.

This, Epsco believes, requires a universal type design and the use of taped test programs which can be easily revised or changed. Most other companies working in this field hold the same view.

Following are the basic elements of such an equipment:

- Test program, which gives sequence of tests to be performed and the allowable tolerance for measured values.
- Signal generators for introducing test

COMPUTING COMPONENTS FROM Librascope

Shaft-to-digital encoders meet rigid requirements



Librascope shaft encoders meet and surpass rigid requirements of airborne analog-to-digital translation. Shock, vibration and temperature extremes do not affect their continuous, noise-free operation.

- THEY'RE DIRECT:** A simple one-step means of digitizing analog data.
- THEY'RE RELIABLE:** Multi-million turns at high speeds with constant contact resistance.
- THEY'RE VERSATILE:** 14 basic models in wide range of capacities; special function codes built-in to simplify computer requirements.

For full details on Librascope encoders write for Catalog E11-1

| OUTPUT CODE | MODEL NO. @ | TOTAL CAPACITY | RESOLUTION PER TURN |
|--------------------------------|-------------|------------------------------------|---------------------|
| PARALLEL BINARY (LINEAR) | 740 | 10 bits (1024) | 1024 |
| | 743 | 13 bits (8192) | 128 |
| SERIAL BINARY (LINEAR) | 707 | 7 bits (128) | 128 |
| | 713 | 13 bits (8192) | 128 |
| | 717 | 17 bits (131,072) | 128 |
| | 719 | 19 bits (524,288) | 128 |
| SERIAL BINARY (SIN-COS) | 757† | 7 bits per quadrant* (4 quadrants) | 512 |
| | 758† | 8 bits per quadrant* (4 quadrants) | 1024 |
| BINARY CODED DECIMAL (8-4-2-1) | 723 | 2,000 | 200 |
| | 724 | 20,000 | 200 |
| | 733 | 3,600 | 200 |
| | 734 | 36,000 | 200 |
| GRAY | 735 | 360,000 | 200 |
| | 708 | 8 bits (256) | 256 |

*All models available with internally mounted isolation diodes for sequential multiplexing applications.

†Available in hermetically sealed servo-driven package as Models 757-S and 758-S.

*Including limit 1 and polarity information. Sine and cosine functions generated simultaneously and independently. One turn of shaft generates 4 quadrants of information.

Librascope

A
GENERAL
PRECISION
COMPANY

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION
LIBRASCOPE, INC. Commercial Division
100 East Tujunga Avenue • Burbank, California

ANOTHER FIRST...



THE ONLY *Electro-Reliable* A.C. TIMING MOTOR

*Thinner... Quieter...
More Reliable... More Versatile*

FINGER-THIN...

Only 9/16 Inches Short... Only 1 3/4 Inches in Diameter... very compact... reduces the size of your equipment.

WHISPER-QUIET...

Strictly an electrical motor... practically noiseless... no rattling of gears or ratchets.

HIGH TORQUE...

1/4 oz. inch at the rotor with an instantaneous start and stop... requires only 2 1/2 watts... can replace larger motors in recorders, controls and telemetering equipment.

HIGHEST RELIABILITY...

Longer life... no one-way gears or ratchets to fail... provides millions of operations without any trouble.

SPECIFICATIONS

Standard Voltage Ratings:
6, 12, 24, 115, 230 Volts
Frequency:
60 CPS Standard
25, 50 CPS Available
Power Input: 2.5 Watts
Maximum (60 CPS)

BASIC MOTOR
Weight: 4 ounces
Speed: 300 RPM
Torque: 1/4 oz.-in.
Length: 9/16 inch

WITH INTEGRAL GEAR TRAIN
Weight: 5 ounces
Speed: 300 RPM to 1/6 RPH
Torque: 30 oz.-in. @ 1 RPM
Length: 7/8 inch



WITH
INTEGRAL
GEAR TRAIN

© 1959



The **A.W. HAYDON Company**

222 NORTH ELM STREET
WATERBURY 20, CONNECTICUT

Custom Design & Manufacture Of Electronic
And Electro-Mechanical Timing Devices

flight approved...

by Able, Baker and Jupiter!

3 POLE 30X10 COMMUTATOR, 28 VOLT D.C. OR
115 VOLT 400 CYCLE HYSTERESIS SYNCHRONOUS

- #1 Pole 30 BBM contacts 75% duty cycle, data
- #2 Pole 30 BBM contacts 75% duty cycle, data
- #3 Pole 30 BBM contacts 50% duty cycle, sync pole

Interpole phasing to within
± 20 minutes arc maximum.
Sync pole leading edge elec-
trically lags data pole.

MILITARY: MIL-E-5272A, MIL-I-6181B, IRIG

- Temperature... -55°C to +85°C
- Altitude... 0 to 100,000 ft.
- Vibration... 15g 70-2,000 cps 3 major planes
- Shock... 50g 3 major planes
- Acceleration... 75g 3 major planes
- Service Free Life... Minimum of 500 hours without service
- Weight, 2,375 pounds
- Motor & Power... Full hermetic case.
115 volts hysteresis synchronous 400 cycle less than
12 watts. 28 volt d.c. ungoverned less than 4 watts.
Less than 0.2 ohms total with a lifetime variation of
approximately 0.03 ohms for the first 500 hours life.
100 megohms at 500 V. d.c.
- Contact Resistance... 100 megohms at 500 V. rms
- Insulation Resistance... 100 megohms at 500 V. rms
- Hi Potential Test... 100 megohms at 500 V. rms

Continuous
Commutation
from
Pre-launch
through
Recovery

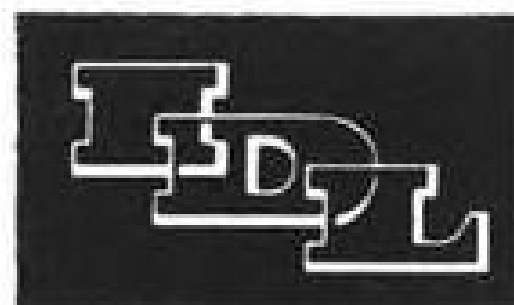
PAM or FM/FM
COMMUTATOR



WESCON BOOTH 1519

Write for Technical Bulletin 500416
(DC Motor) or 500417 (AC Motor)
giving specification data and pricing.

INSTRUMENT DEVELOPMENT LABORATORIES, INC.
A Subsidiary of Royal McBee Corporation
26 Mechanic Street • Attleboro, Massachusetts, U.S.A.



signals and transducers for measuring system-under-test response.

- **Comparator circuits** for making comparison of desired and measured values.
- **Decision making** (conditional transfer) circuits which enable checkout equipment to alter its test program as a result of its previous findings.
- **Read-out devices** for visually indicating test results and pinpointing faulty subsystems or subassemblies, together with means for permanently recording these results.
- **Self-checkout provisions**, which enables equipment to frequently test its own performance and to detect internal failure.

With the universal design concept, it is possible to build automatic checkout equipment for a variety of different weapon/support systems from a few basic standardized building blocks. The degree of sophistication depends upon the intended use. For example, a system intended for mobile field use to determine whether weapon is operational or not, or to isolate fault down to major subsystem, will be considerably less complex than one intended for factory test or overhaul base use.

Operational Features

One important feature in Epsco's new ultra-high-speed checkout equipment line, which it calls "Guardian," is the ability to make dynamic performance measurements on servo systems, such as radar tracking circuits, automatic flight control and inertial guidance stabilization circuits. With conventional slow-speed testers, a signal corresponding to a given angular displacement is introduced and the system is checked to determine if this signal produces a corresponding angular movement of the

Central Checkout Center

Washington — A single automatic checkout equipment center, located in the central U.S. and connected by landlines or radio circuits to military bases and installations around the country which would enable centralized center to check weapons at remote sites for operational readiness, was proposed here during the recent Military Electronics Convention.

Granville L. King, Packard-Bell Electronics Corp., said that such a center could save considerable money now spent for checkout equipment at each individual military base and installation. A centralized checkout point also would give military aircraft greater mobility because they need not transfer their checkout equipment to new bases. King said that Packard-Bell has conducted studies of such a centralized checkout center and now is doing advanced development aimed at this goal.

radar antenna, the control surface or the stabilized platform.

A servo system can successfully pass such a test, yet fall down seriously in actual operation because of velocity or acceleration tracking errors which cannot be detected by static test.

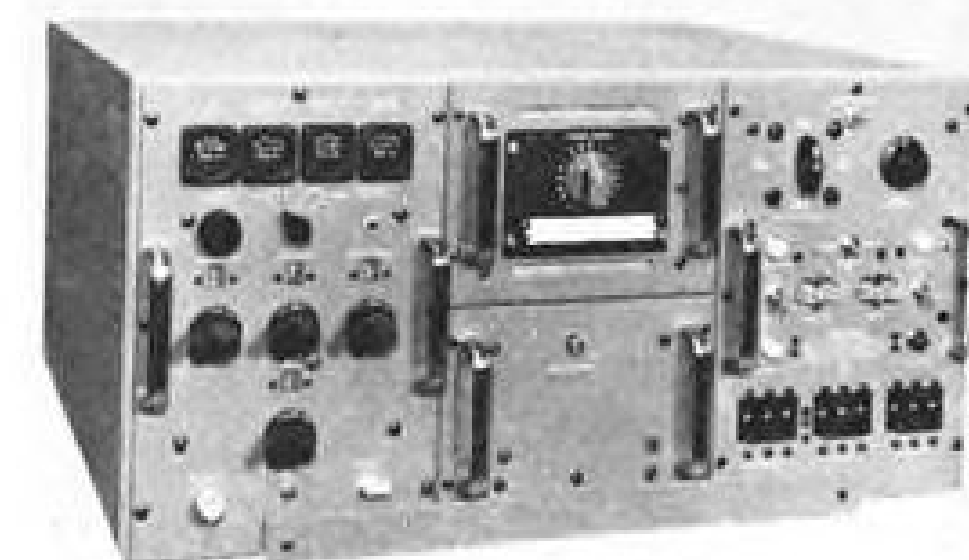
With Epsco's Guardian, a measured pulse of electrical signal can be introduced and the servomechanism's dynamic response can be measured in terms of the magnitude of its overshoot and its "settling time" to damp out to a prescribed value.

Another feature which can be provided is what Epsco calls an "urgency selector." This offers the operator two or more alternate test routines depending upon the urgency of the situation.

All measurements of voltage, current, frequency and/or power are converted from their original analog form into a binary (digital) code prior to comparison with desired values, which also are stored on tape program in digital form. If an accuracy of one part in a thousand is desired, a 10-bit code can be used. If greater (or less) accuracy is needed, a longer (or shorter) word length is employed.

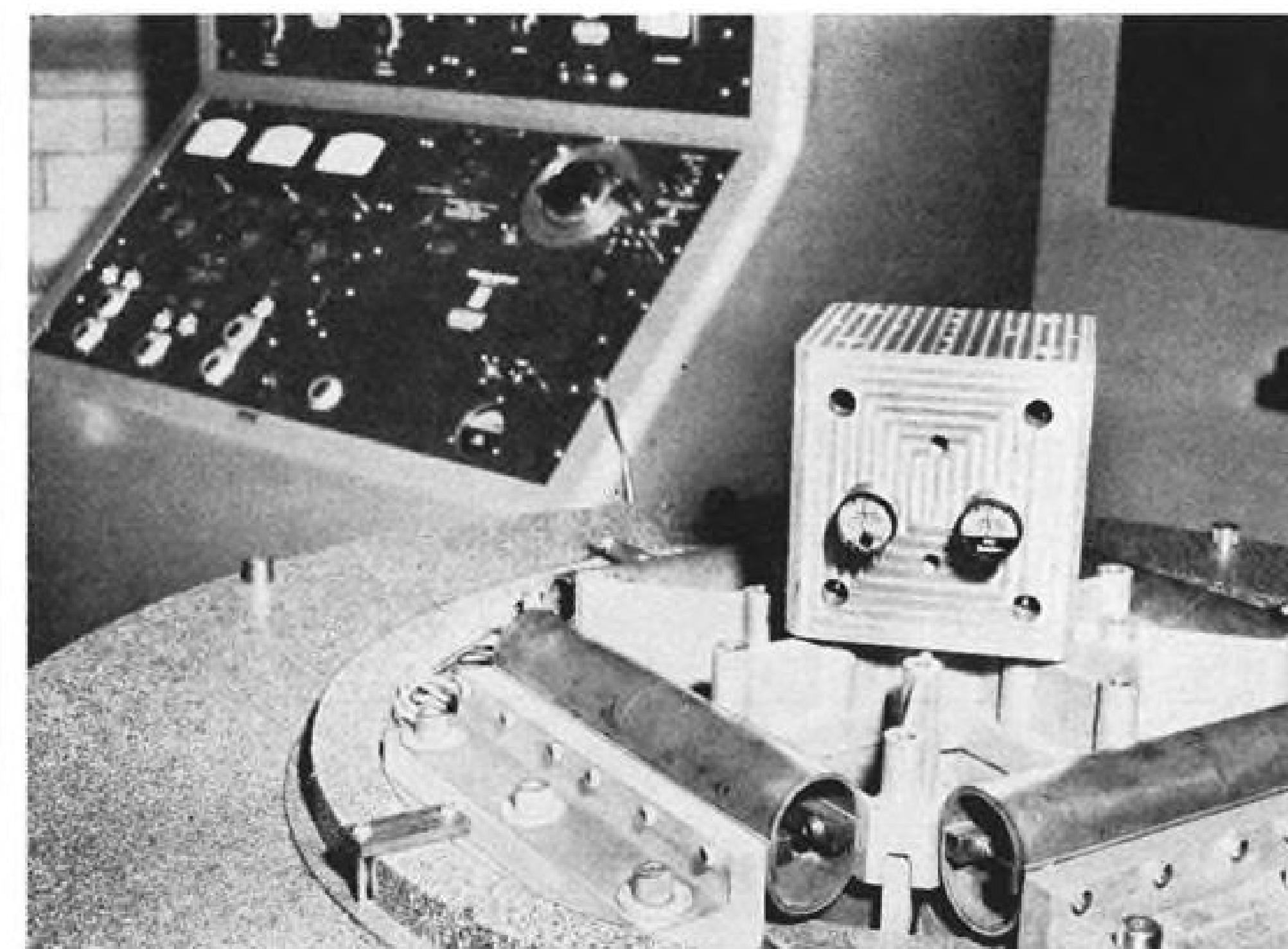
Conversion is accomplished by means of one of Epsco's standard high-speed analog/digital converters. The vacuum tube model can make 37,000 analog-to-digital 13-bit word conversions per second, or 44,000 per second for 11-bit words. A newly-developed transistorized converter can produce 25,000 analog-to-digital conversions per second or 100,000 digital-to-analog conversions per second for an 8-bit word length.

Epsco has recently developed a new device for converting complex analog waveforms into equivalent rms. value prior to digital conversion with an error of less than 0.01%, according to company president Bernard M. Gordon. This new converter is at least 10 times more accurate than any comparable device now on the market, Gordon says.



UHF Transmitter

High-power airborne UHF transmitter, rated 1 kw., weighs less than 200 lb., measures 30 x 27 x 15 in. Developed by Electronic Communications, Inc., new Model 28 provides 1,750 channels with 20 instantly available preselected channels. Transmitter is entirely self-contained, operates from 380 to 1,200 cps. power.



RMC-LINDSAY ONLY GAUGE TO STAND THIS TEST — This photograph shows vibration testing of RMC-Lindsay pressure gauges on the 3200 force pounds Calidyne Vibrator to 50 G output, amplitude .010 to .20. Cycling frequencies to 2,000 cps. The test is conducted so as to parallel actual installation conditions, with gauges subjected to 350°F under operating pressures. Complete test reports are available on request.

THE RMC-LINDSAY GAUGE IS RADICALLY DIFFERENT

from ordinary high pressure gauges

HERE'S WHY...

1. The RMC-Lindsay gauge is a multiple coil, helical bourdon tube type, restricted for overpressure.
2. The pointer is attached directly to the end of the coil, with no linkages or pivots to be affected by vibration.
3. Superior techniques in coiling, heat treatment, calibration, and material specification are new and exclusive with RMC.
4. No other gauge can match RMC-Lindsay specifications:



PRESSURE RANGE: Pressures in ranges 0 to 1,000 p.s.i. up to 15,000 p.s.i. with retard scales available. **OVERLOAD PRESSURE:** Nominal overload pressure factor of 2.0 times the maximum dial reading (higher factors available). **BURST PRESSURE:** Normally 3.0 times the maximum dial reading. **TEMPERATURE:** Not affected by temperatures up to 350°F. **VIBRATION:** Qualification test report available on pressure tests showing cycling, vibration, to 2,000 cps. at 25 G's, and resonant frequency vibration tests at 25 G's. **SHOCK:** Data available on MIL-E-5272 shock test. **PULSATION:** Practically unaffected by line pulsations of 3% of the full dial reading. **ENDURANCE:** To 250,000 cycles or higher depending on application. **ACCURACY:** Hysteresis friction and backlash are below readable limits. Absolute gauge accuracy to extremely low limits as required.

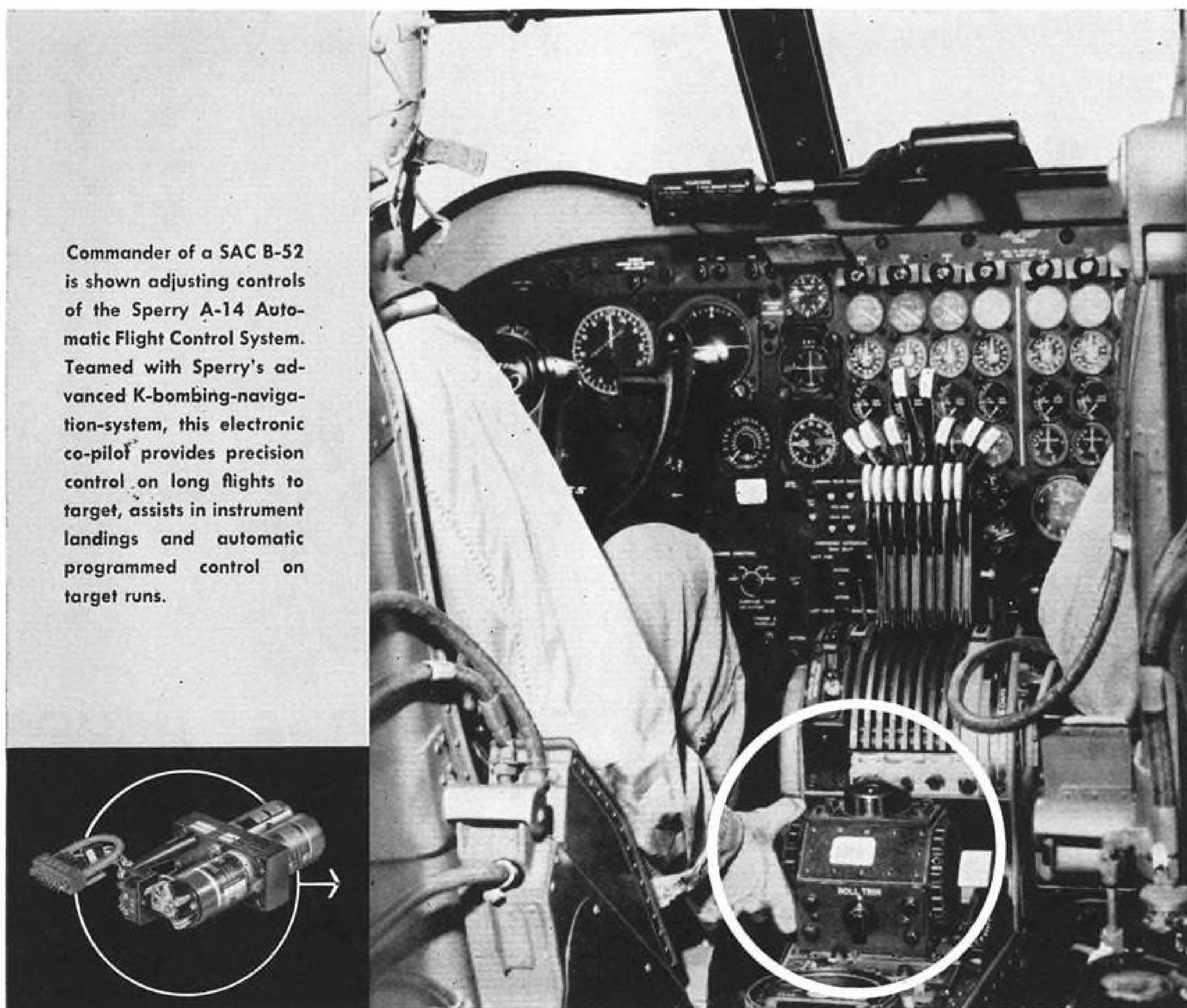


Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write, wire or phone either of the addresses below.



ROCHESTER MFG. CO. OF CALIFORNIA
1401-A S. Shamrock Ave., Monrovia, Calif.
ROCHESTER MANUFACTURING CO., INC.
221 Rockwood Street, Rochester 10, N.Y.

Commander of a SAC B-52 is shown adjusting controls of the Sperry A-14 Automatic Flight Control System. Teamed with Sperry's advanced K-bombing-navigation-system, this electronic co-pilot provides precision control on long flights to target, assists in instrument landings and automatic programmed control on target runs.



servo assist for sperry's electronic co-pilot

When the commander of a B-52 gives his Strato-fortress the order to execute this or that maneuver, the control system of his "electronic co-pilot" automatically applies just the right force on the control surfaces to obtain the desired maneuver under the prevailing flight conditions. That's automatic flight control at its finest!

Daystrom Transicoil helps provide the calculated muscle for this flight system in the form of servo controlled pitch, roll, and yaw follow up; coordination integrator; and pitch integrator.

Only the highest level of accuracy, performance, and reliability will do . . . for you, for us.

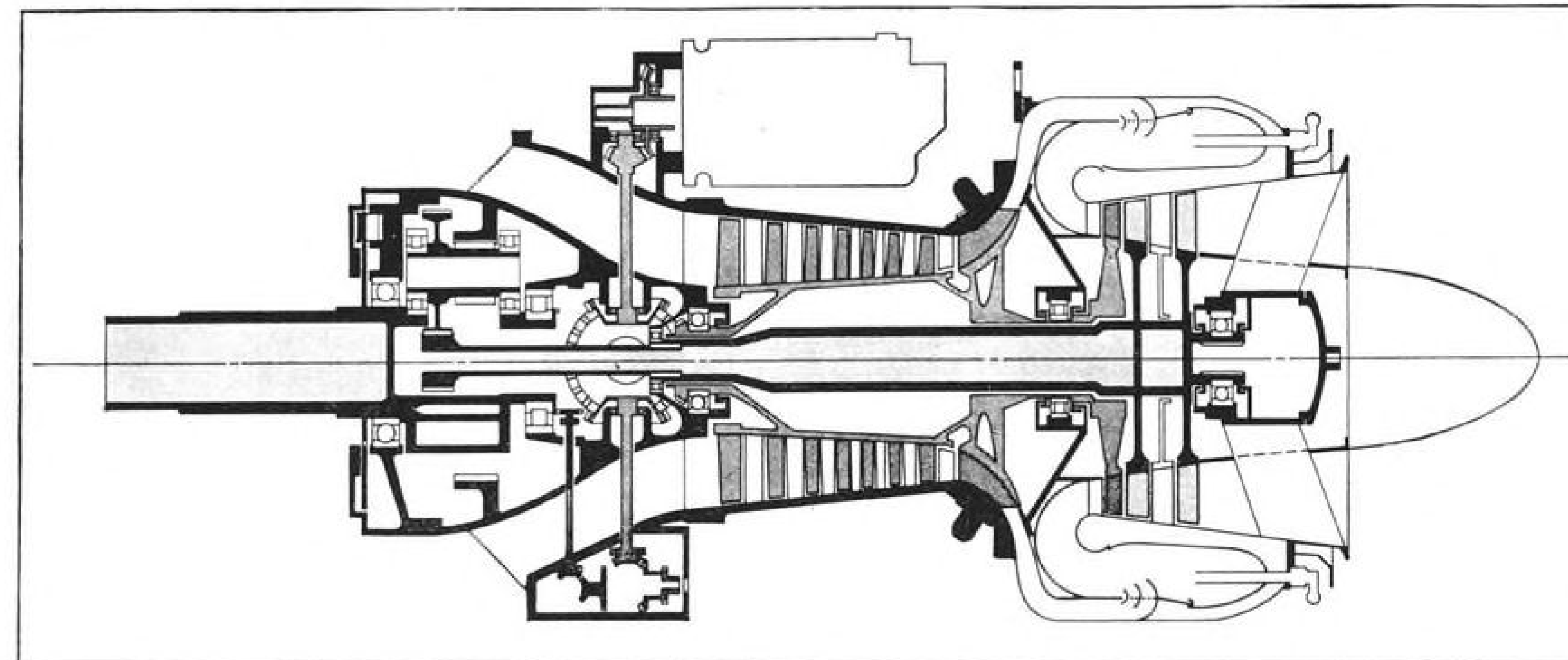
The engineering and manufacturing assistance you need to turn modern system requirements into optimized working sub-systems and assemblies is the very basis of our business. Contact us direct or through our local representative. Check into our 24 Hour Service on servo motors and generators. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pennsylvania. (Phone: JUNO 4-2421)

SEE US AT THE WESCON SHOW—BOOTH 3209

DAYSTROM TRANSICOIL DIVISION OF DAYSTROM, INC.

Representatives in Canada and Other Foreign Countries

AERONAUTICAL ENGINEERING



LYCOMING T55 two-stage power turbine rotation is reverse of compressor-driving turbine obviating need for intermediate stator.

Lycoming T55 Cleared for Airframe Use

By Erwin J. Bulban

Stratford, Conn.—Performance exceeding major specification guarantees was demonstrated by the new Lycoming T55 free-power turbine during its 50-hr. U. S. Air Force Preliminary Flight Rating Test, thus clearing the turbine for airframe installation.

First installation is scheduled for the Vertol YHC-1B Chinook helicopter, which is expected to form an important segment of the U. S. Army's future helicopter inventory. First T55 turbines for twin-engine YHC-1B delivery probably

will be delivered to Vertol by Lycoming Division of Avco Corp. in late summer of 1960. A 150-hr. test on the T55 probably will be completed by the end of August, 1960. FAA will coordinate with Lycoming on test as part of engine's civil certification program.

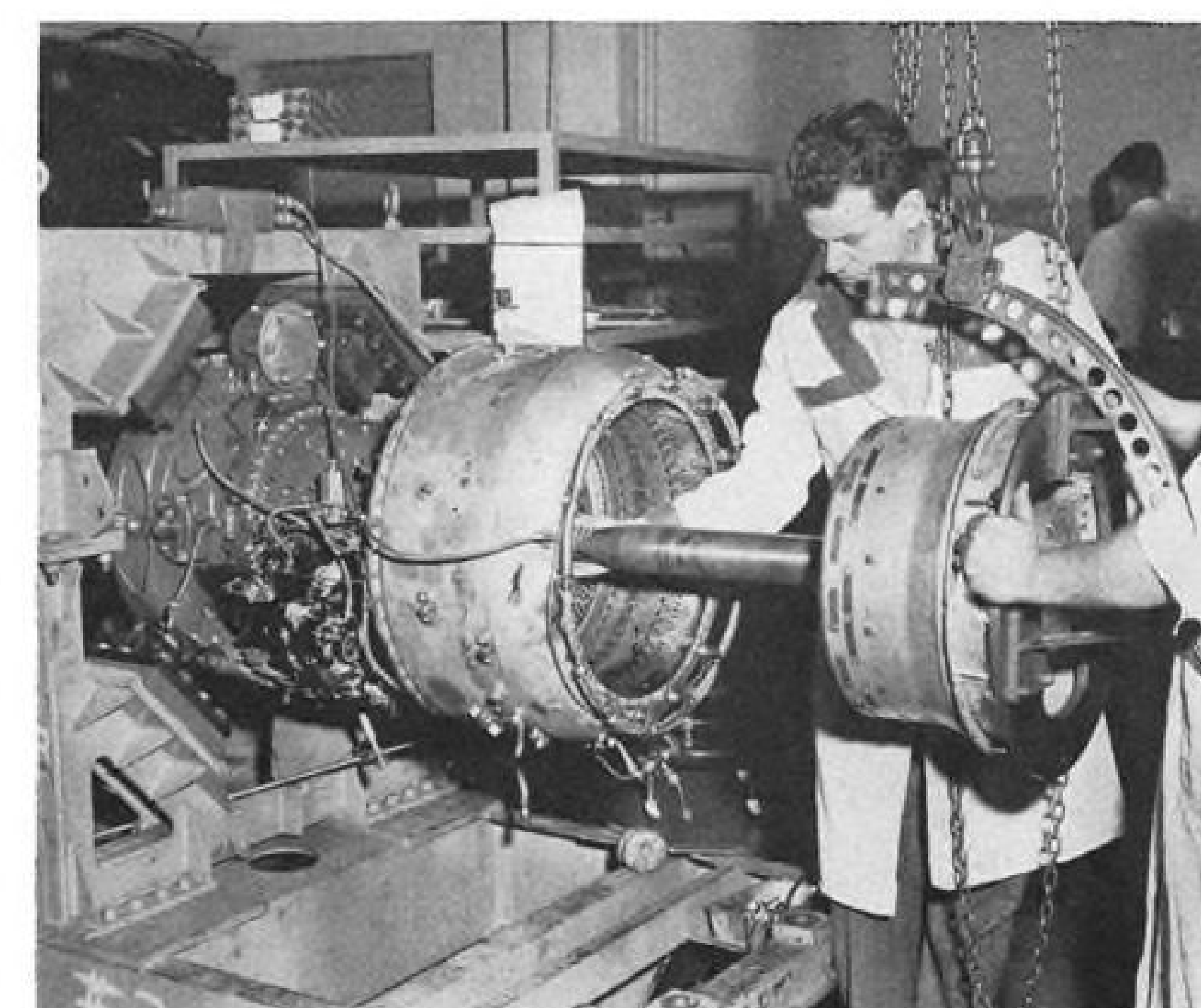
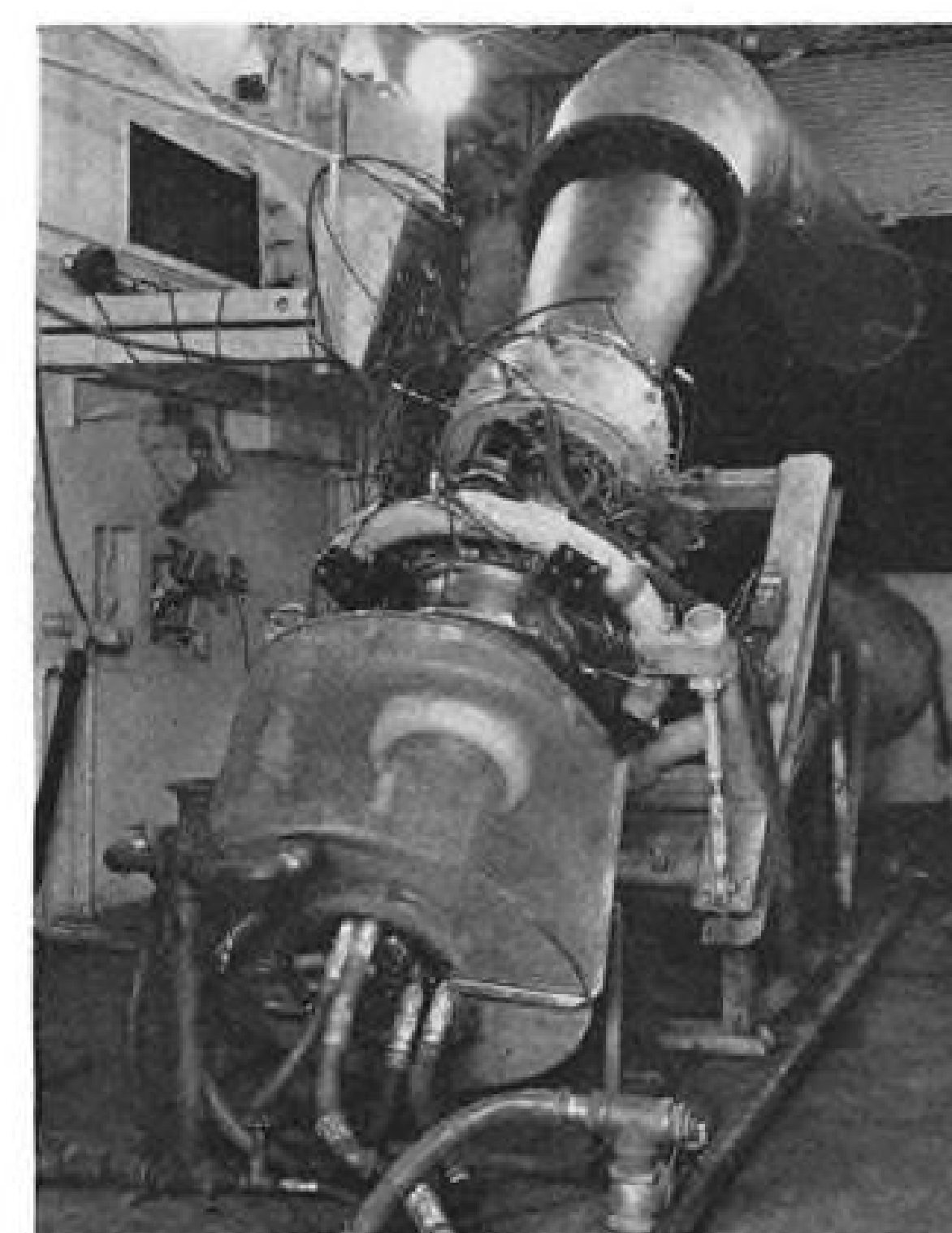
Minimum guarantees officially established as a result of the 50-hr. trial include these key performance areas:

- **Military power rating** of 1,900 shp. (1,985 eshp.), compared with Lycoming's guarantee, before the test, of 1,850 shp. (1,934 eshp.). Engine actually demonstrated output of 2,090 shp.

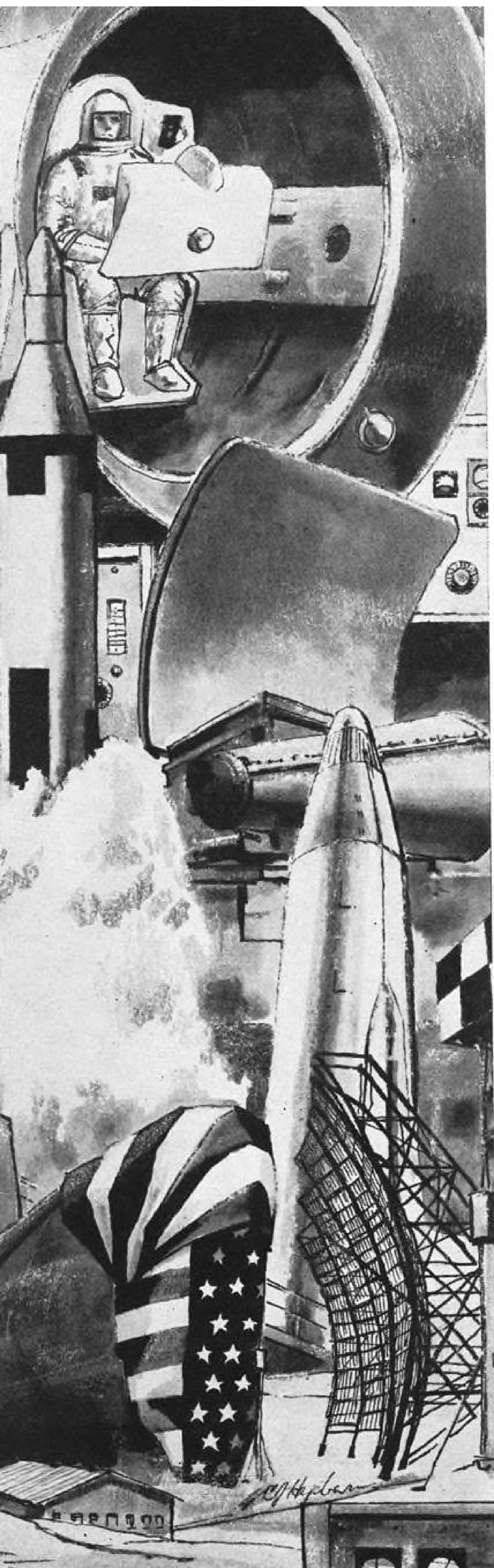
(2,190 eshp.) during the official test.

- **Fuel consumption** at military power of 0.670 sfc. (0.641 esfc.), compared with a previous Lycoming guarantee of 0.677 sfc. (0.648 esfc.). Engine achieved 0.617 sfc. (0.593 esfc.) during the official test.

Indications are that the minimum guarantee data is on the overly conservative side. This observation is based on comparing the maximum turbine inlet temperature used during Lycoming's tests (1,650F) with the actual temperature specified for the test of 1,600F, which indicates that Department of



ENGINE stops and starts were made at 45 deg. angle on test stand (left); complete power turbine assembly is removed (right).



*General Electric moves to
provide a more effective*

DEFENSE SYSTEMS CAPABILITY

Top systems management, technical talent are concentrated in Defense Systems Department with a charter geared to modern defense needs for:

- Systems-oriented management
- Pinpointed authority, responsibility
- Full back-up resources

RICHARD L. SHETLER

General Manager
Defense Systems Department

Richard L. Shetler is General Manager of the Defense Systems Department. One of the Company's outstanding system managers, Mr. Shetler's experience has included responsibility for some of the longest range radar systems ever built in this country.



KARSH, OTTAWA

Accelerating technological change, coupled with the increased complexity and wider variety of choice of weapons and weapons systems, has profoundly altered the defense requirements on industry.

In line with this requirement, General Electric's Defense Systems Department, headquartered in Syracuse, New York, draws together under one roof, the systems capabilities and long-range planning functions required to draw on all of General Electric to provide the total solution to specific defense problems of the military departments of the Department of Defense and other government agencies.

UNIQUE SYSTEMS ORGANIZATION

The Defense Systems Department is a unique department within General Electric's Defense Electronics Division. Completely systems-oriented, DSD has no need for equipment design or fabrication facilities. While it determines the specifications to be met, the Defense Systems Department assigns design and fabrication functions to other General Electric departments or to some subcontractors among the 45,000 suppliers to General Electric.

But overall responsibility to the customer for the complete weapon or support system always remains within the Defense Systems Department. This responsibility is fulfilled through the Department's

- Systems-oriented program management
- Competent systems engineering
- Continuous program evaluation
- Efficient specification and procurement

These specific capabilities permit the Depart-

ment to deliver the total system requirement on time, with the right quality, and at the specified price.

AUTHORITY, ACCOUNTABILITY

As the focal point within the Company for a specific system effort, the Defense Systems Department program manager has complete responsibility and accountability plus the authority necessary for the timely execution of the particular program.

OUTSTANDING COMPETITIVE ADVANTAGES

The Defense Systems Department offers its customers outstanding qualifications for meeting total prime and support system requirements including long-range planning and feasibility studies. For example, it has . . .

Demonstrated systems competence: Recent examples include the highly successful radio-command guidance system for the USAF's ATLAS ICBM which precisely guided the Atlas into orbit around the earth on December 18, as part of Project SCORE.

Full back-up resources: The full range of General Electric's scientific, engineering and manufacturing skills supports DSD capabilities.

For example, the Company's research and development programs, carried on by over 100 laboratories at an annual cost of 300 million dollars, provide the depth of knowledge for vital technological break-throughs.

For more information—or for a copy of brochure GED-3760, describing the Department's defense systems capabilities—write to R. L. Shetler, General Manager, Defense Systems Department, P.O. Box 457, Syracuse, New York.

216-1

Progress Is Our Most Important Product

GENERAL  ELECTRIC

what is energy conversion?

A method of doing work?
A change of state?
Regimentation of random motion?
Organized degradation of matter?
Is it reversible?

Because we are constantly preoccupied with energy conversion, we are interested in energy in all its forms—solar, nuclear, thermal, mass, magnetic, electrical, mechanical and radiant.

And in our attempts to convert one form of energy into any other form, we search for methods which will give us the greatest amount of energy output from the smallest possible input.

To aid us in our efforts, we call on a myriad of talents and capabilities: General Motors Corporation, its Divisions, other individuals and organizations. By applying this systems engineering concept to new projects, we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business



Division of General Motors, Indianapolis, Indiana

Defense and Lycoming are following a policy of taking the new 2,000-shp.-class turboprops through a program of gradual "small steps" rather than attempting major strides at this stage of their development.

Further indications of the T55's growth potential are seen in fact that the Chinook version—T55-L-5—a so-called "high-speed" model, the Lycoming specification guarantees 1,940 shp. (2,025 eshp.) military power rating and fuel consumption at military power of 0.656 sfc. (0.629 esfc.).

In the high-speed model, drive will be taken directly from the engine at 14,500 and feed to right-angle drive developed by Vertol, using the right-angle drive to provide necessary gear reduction at a weight savings over the conventional front-end reduction gearing. This idea also will permit installation of an integral oil tank and cooler system in the space otherwise occupied by reduction gear.

Lycoming believes that the present basic T55 also can be improved to produce 2,400 shp. with an optimum power turbine speed of 15,300 rpm. and a specific fuel consumption of between 0.59 and 0.625—the variation in fuel consumption depending on the development effort directed towards higher performance. This development could take approximately a year-and-a-half after qualification of the present T55-L-5 and could be achieved at an increase in engine weight of about 15 lb.

Advanced Version

A more advanced version of this powerplant, particularly aimed at further reducing fuel consumption, probably would result in a powerplant of 2,400 shp. with 15% lower sfc. and a power potential in the magnitude of an additional 15%, Lycoming engineers indicated.

Looking ahead towards turbojet applications of the basic T55 configuration, there are possibilities of overcoming some of the performance losses normally attendant in a straight adaptation by going to the bypass configuration. By removing the gear package in the front end of the engine and extending the power shaft, the T55 could make an economical two-spool multistage bypass turbojet—the bypass ratio dependent upon specific power requirements. The company apparently has been discussing a bypass jet configuration of its T55 with some prospective customers.

Some possibilities for fixed-wing applications of the turboprop T55 configuration include the de Havilland-Canada DHC-4 Caribou, which advanced to the point where test engines and specially designed propellers have been run by Aeroproducts Division of General Motors before budget cuts halted this project; and a later model of

Structures Engineers

The Columbus Division of North American Aviation, Inc. is seeking senior structures engineers for design, development and analysis on advanced projects, both aircraft and missiles.

Structural Analysts

Capable of computing internal load distributions and analyzing complex structures. Assignments include solution of redundant structures, loads distribution, structural testing or preliminary design support.

Airframe Designers

Will be assigned to an integrated structural group where the opportunity to calculate your own stresses along with responsibility for laying out airframe components is available.

Weights Engineers

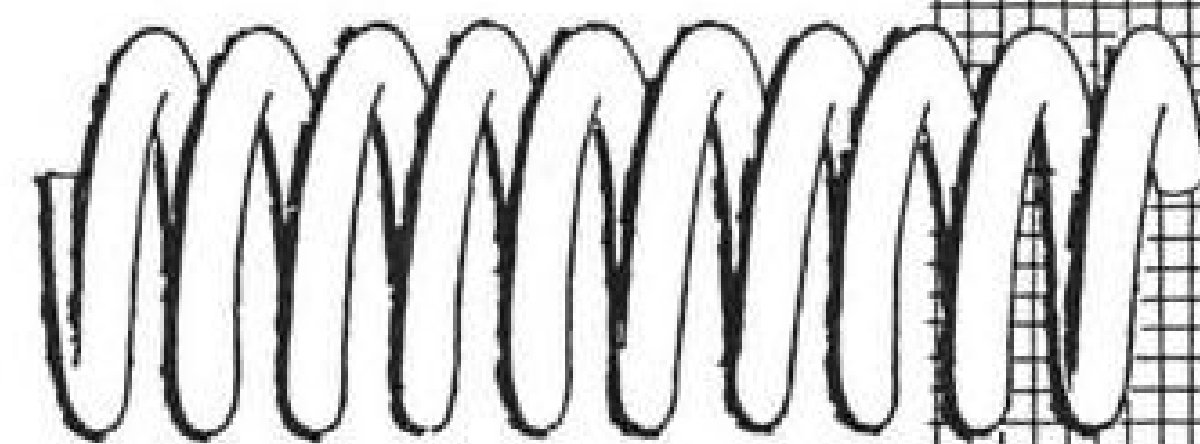
To analyze airframe structures from a weights standpoint, determining techniques for improving estimating methods on new types of structures and materials.

Reduce your working day by living close to the office in suburban Columbus. For more information, write to Engineering Personnel, Box AW-428, North American Aviation, Inc., Columbus, Ohio.

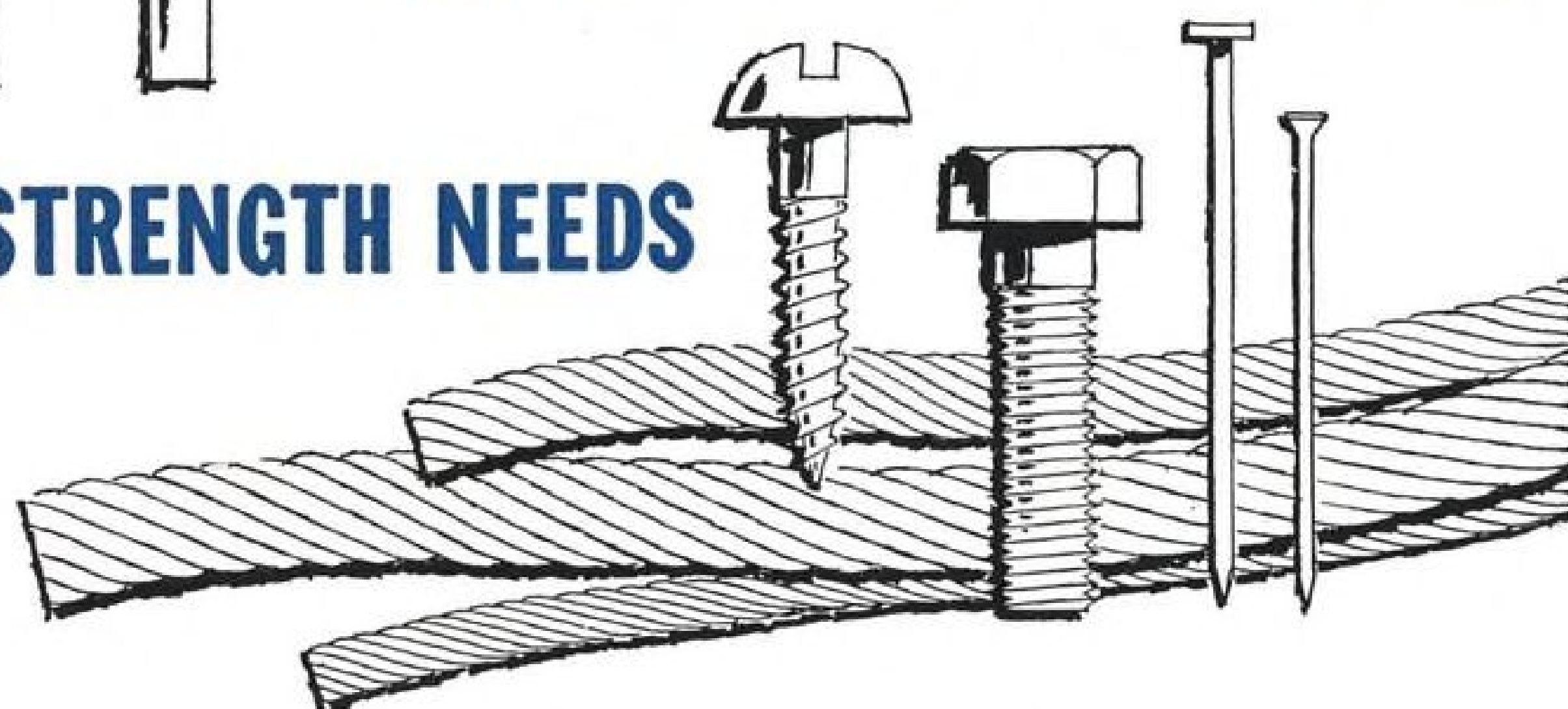
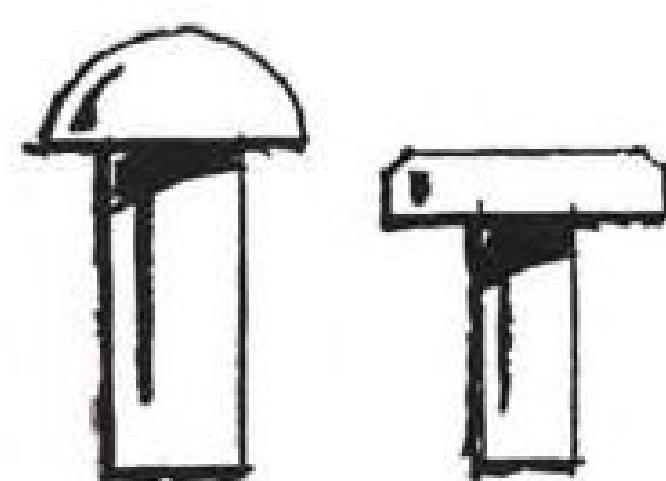
**THE COLUMBUS
DIVISION OF
NORTH AMERICAN AVIATION, INC.**

Home of the T2J Buckeye
and the A3J Vigilante

IF YOU MAKE ANY OF THESE



FOR CORROSION RESISTANCE
AND HIGH STRENGTH NEEDS



See what Allegheny Stainless steel wire can do to cut your costs

The assurance of uniform quality, order after order, shows up in lower shop costs in whatever you make from stainless steel wire. A-L specifications are faithful in every batch—in all grades of stainless steel cold-drawn wire, tempered to match many correlations of hardness and tensile strength.

If you make springs, you get uniform tensile strength in every batch of spring wire . . . and also with rope wire.

In weaving wire you get the same dead-soft temper and uniform properties for perfect weaving without ridges.

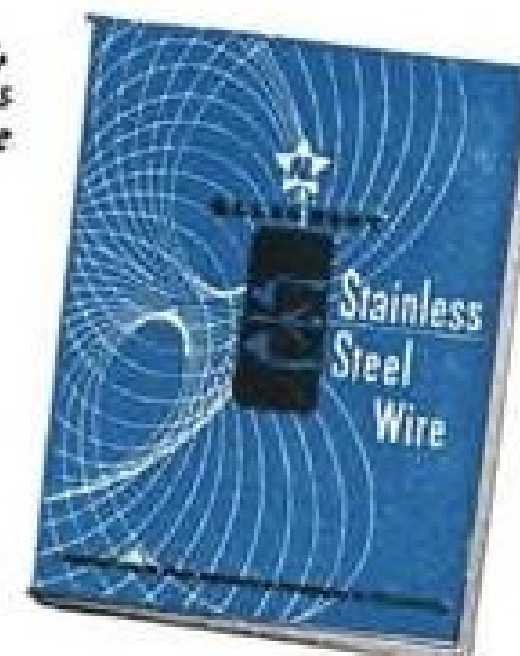
In cold-headed wire you get absolute uniformity that ties in with automation production processes.

Call on the A-L technical staff for help with selection or fabrication problems, or help in cutting shop costs in processing operations. They will be glad to work with you.

Whatever you make in stainless wire, Allegheny Ludlum offers you adequate stocks of all standard grades for fast shipment. Special stainless steel wire on order.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. AW-20,

Write for your copy of Allegheny Stainless Wire, Illustrated 20-page booklet, which fully describes analyses, physical properties, corrosion resistance and principal applications of stainless wire.



ALLEGHENY LUDLUM

for warehouse delivery of Allegheny Stainless, call RYERSON

Export distribution: AIRCO INTERNATIONAL

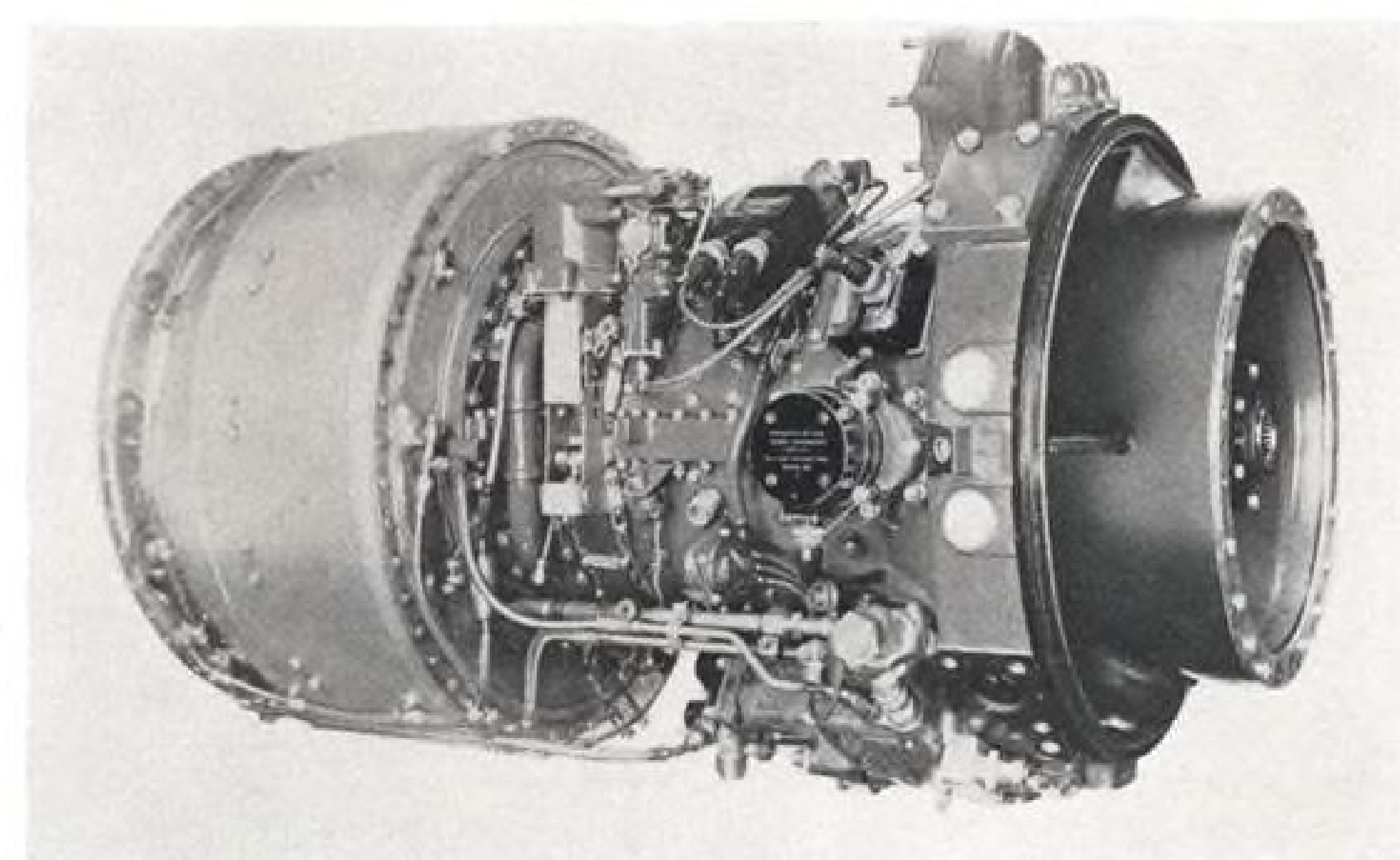
EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

WGW 7039

the Fairchild F-27, currently being produced with Rolls-Royce Dart engines.

Lycoming's T55 engineering team, heavily sprinkled with German technicians with considerable turbine background, is built around Wolfgang Stein and Hans Berkmer. Over-all direction is under supervision of Franz Anselm, vice president-engineering. Basic philosophy is to begin with simplicity and then refine on it. Result is a so-called "universal" engine.

In the T55, the first application of this concept has been fully applied. All models of the engine—turboprop, geared helicopter, high-speed front or rear drive helicopter, by-pass jet—are built from the basic power section. By changing the integral front-end reduction gear units, the T55 is adaptable to either turboprop or geared helicopter drive. The company emphasizes that such adaptations are possible at the field maintenance level without need of special fixtures or jigs or returning the powerplant to a depot. This capability is considered particularly valuable in cases where several different versions of the engine may be operational at a single base or closely situated stations, since many parts of the basic powerplant are interchangeable, according to the company. Favorable price structures on the basis of vol-



RIGHT SIDE of the Lycoming T55-L-3 is shown above.

ume production are a consideration.

Initial model, the 1,600-shp. T55-L-1 turboprop, began as the winner of a USAF design competition in June, 1954. Air Force then was interested in development of a propeller turbine aimed at "replacing" the piston Wright R1820 for future medium transports, and put some \$3 million into development up the time that it gave up this airframe program. U. S. Army, shopping around for a similar category en-

gine, took over the development in 1956. Lycoming had made the initial test run of the T55's gas producer section in December 1955. First run of a complete engine was in April, 1956.

In 1957, after several 50-hr. Preliminary Flight Rating Tests, indications were that there was considerable refinement remaining. The engine reportedly had proven that its basic mechanical design concept was sound, at the conservative turbine inlet tempera-

BENDIX SR RACK AND PANEL CONNECTOR

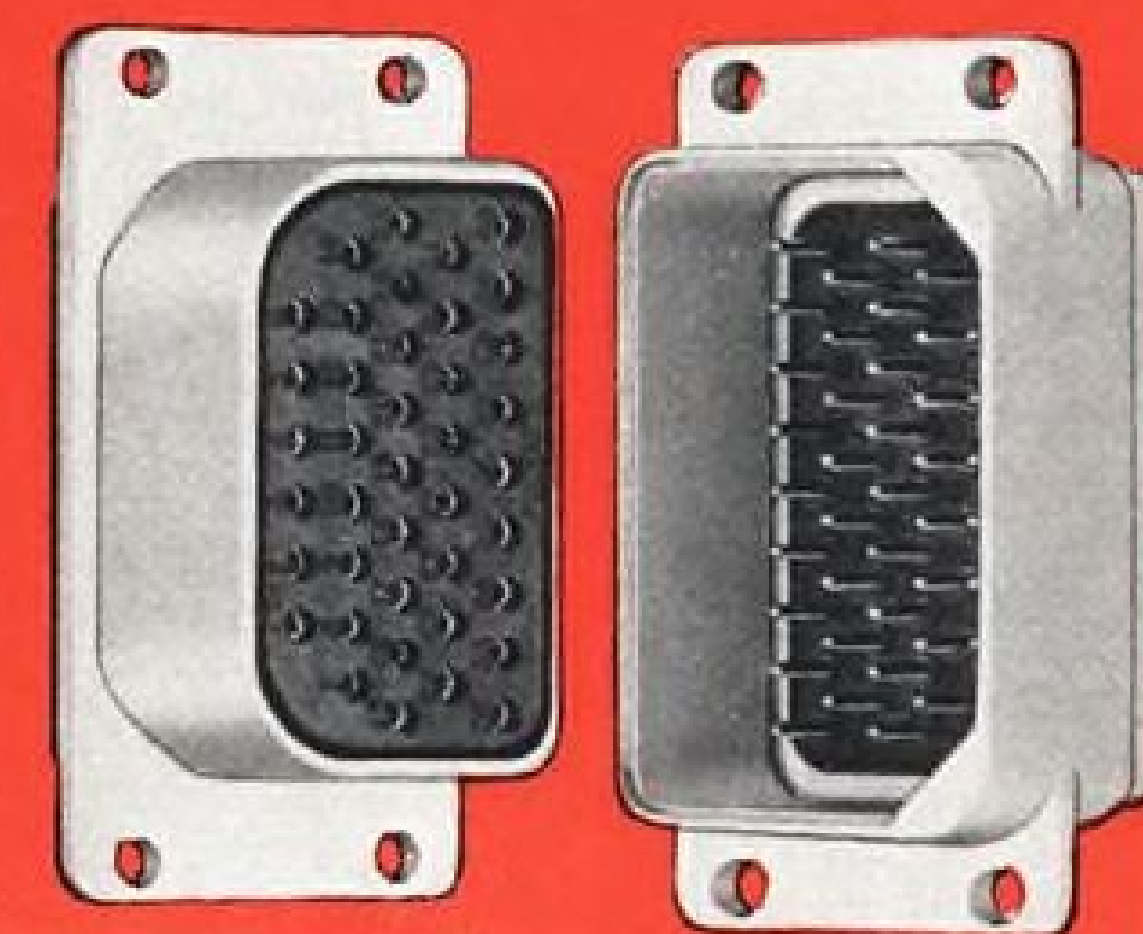
with outstanding resistance to vibration

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of -67°F to +257°F.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



FEATURES:

Resilient Insert • Solid Shell Construction • Low Engagement Forces • Closed Entry Sockets • Positive Contact Alignment Contacts—heavily gold plated Cadmium Plate—clear irridite finish • Easily Pressurized to latest MIL Specifications.

SCINTILLA DIVISION

SIDNEY, NEW YORK



Export Sales and Service: Bendix International Div., 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliates: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Illinois; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

ture of 1,550F, the engine had power reserves amounting to more than 100 hp. over design value, and performance depreciation during the official military preliminary test was negligible.

Two problems: Specific fuel consumption was up from the original goal as stated in the specification—due primarily to compressor design deficiencies which resulted in mismatched flows between stages and there were no firm application in sight for a powerplant of this power.

Development Charge

So in 1957, Lycoming redirected T55 development to the T55-L-3. Its specification called for output of 1,850 shp. At turbine inlet temperature of 1,650F at 6,700 rpm., esfc. was to be 0.648.

To overcome the problem of compressor deficiencies, the company realigned its test facilities, transferring portions of the work that had been carried out under severe handicaps at its Williamsport, Pa., plant to the turbine section at Stratford and spending \$1.5 million of Lycoming money on a new compressor test facility.

Payoff of this effort was successful completion of the T55-L-3's 50-hr. military preliminary test, which showed the engine had an esfc. approximately 5% under specification guarantees,

| Lycoming T55 Helicopter Engines | | |
|---|-------------|-------------|
| Major Specification Guarantees (Standard Day) | | |
| | T55-L-3 | T55-L-5 |
| Military Power Rating..... | 1,900 shp. | 1,940 shp. |
| | 1,985 eshp. | 2,025 eshp. |
| Fuel Consumption | | |
| Military Power..... | 0.670 sfc. | 0.656 sfc. |
| | 0.641 esfc. | 0.629 esfc. |
| Oil Consumption | | |
| Military and Normal Power..... | 0.20 gph. | 0.20 gph. |
| Front Drive Output Shaft Speed | | |
| Military Power..... | 6,750 rpm. | 14,550 rpm. |
| Maximum Turbine Inlet Temperature..... | 1,600F | 1,600F |
| Maximum Exhaust Gas Temperature..... | 1,100F | 1,100F |
| Engine Dry Weight..... | 600 lb. | 560 lb. |
| Maximum Continuous Flight Altitude | | |
| Conditions..... | 45 deg. | 45 deg. |
| | nose-up | nose-up |
| | 50 deg. | 50 deg. |
| | nose-down | nose-down |
| Acceleration from Flight Idle | | |
| to Military Power..... | 3.5 sec. | 3.5 sec. |

while producing some 200 hp. above guarantees.

Initial contract was awarded early in 1957, a mockup conference was held in September, 1957, first run was made in December, 1957 and the 50-hr. preliminary flight test rating run at 1,900 shp. was completed in March, 1959.

The T55 currently has some 3,000 hr. total running time.

Engine guarantees cover maximum continuous flight attitudes of 45 deg. nose-up and 50 deg. nose-down.

Design of the T55 basically follows precepts laid down on the company's smaller 860-shp. T-53 (AW June 9,

1958, p. 46)—ruggedness in the attempt to provide reliability in the field where a minimum of trained personnel and maintenance facilities may be available.

Basic over-all dimensions are changed only slightly over what might be expected, considering the more than doubling of power. The T55-L-3 is approximately only three inches longer than the T53-L-1 and about one inch more in diameter. This refined packaging included overhanging the first axial stage so that the forward roller bearing at the front of the power shaft is set underneath the first axial stage.

Ball Bearings

Use of a single-point ball bearing support at the rear of the shaft cut bearing distance, permitting the outer exhaust flange to be closer to the combustion chamber; shorter bearing distance on T55 permitted use of a more-constant diameter power shaft (on the T53 the "squeezed worm" power shaft was bulged in the center portion to bring critical speed above operating speed).

T55 air inlet housing is a one-piece magnesium casting forming an inner housing, an outer air inlet shell and four hollow connecting struts. The outer air inlet funnels air to the compressor and also serves as a mounting base for most of the external engine

components and accessories. Connecting struts provide the following functions: three of them act as anti-icing air ducts to channel hot compressor bleed air into the interior of the inlet housing casting; two struts provide passages through which oil enters and leaves the integral engine oil tank (T55-L-5 high-speed version) and three of the struts enclose the shafts delivering power to the engine-mounted accessories and components.

The inlet housing is the engine's main support structure, the four engine mounting pads being located about its periphery. The front face of the casting also is provided with bolt holes to allow mounting the engine cantilever from the face—the installed engine is largely supported cantilever from the inlet housing whether mounting pads or the bolt circle are used.

Gas producer rotor section consists of an eight-stage axial-centrifugal compressor and a compressor-driving turbine. First seven compressor stages are all-steel axial, the eighth is a titanium centrifugal. Axial and centrifugal stages are kept aligned by steel spacer rings; this assembly is held together axially over a steel retaining sleeve. By removing either half of the split compressor case, access is provided to that portion of the compressor.

Compressor-driving turbine is a

single-stage axial-flow wheel bolted to the aft end of the compressor assembly. Wheel has hollow blades, each fastened by a fir-tree attachment. Hollow blades are used to reduce weight and root stresses; if blade cooling is required at a later stage in the engine development, the cores could be used in this function, Lycoming points out.

Diffuser Assembly

Compressor diffuser assembly diffuses air leaving the centrifugal compressor stage to produce a final pressure ratio across the complete compressor, approximately 6:1 in the L-5. It also directs compressor discharge air into the combustion chamber. Diffuser housing is a rigid steel structural member that, combined with the combustion chamber housing, aids in maintaining rear-end bearing alignment. Power turbine section has two wheels turning in a contrarotating direction from that of the compressor-driving turbine, eliminating the need for an intermediate stator between the power turbines and compressor-driving turbines—a further idea to keep the engine length down. Power transmission shaft is hollow-steel and barrel-shaped with two ball thrust bearings at the aft end and a roller bearing at the front. Power shaft splines to a male output shaft at the front of the engine and is intern-



Reliable Airlines depend on Reliable Hose

Originators of high temperature
fluorocarbon hose assemblies

RESISTOFLEX

MODERN jets have proven Fluoroflex®-T (Teflon®) hose in rugged service for over four years. Fast new commercial airliners use Fluoroflex-T hose—for safety and economy.

Fluoroflex-T hose, with patented, specially compounded tube of Teflon, is non-aging—has no shelf or service life limit. Originated by Resistoflex, Fluoroflex-T was the first Teflon hose and it has been flying for five years on all types of jet and reciprocating engines and aircraft. It is available with Resistoflex swaged fittings or "Seal-Lock" threaded fittings.

Always specify the hose with highest performance and capabilities—not only for safety's sake, but for savings as well. Send for details. Write Department 287, RESISTOFLEX CORPORATION, Roseland, New Jersey. Other Plants: Burbank, Calif.; Dallas, Texas. *T.M., Pat. No. 2,853,319

*Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
*Teflon is DuPont's trademark for TFE fluorocarbon resins.





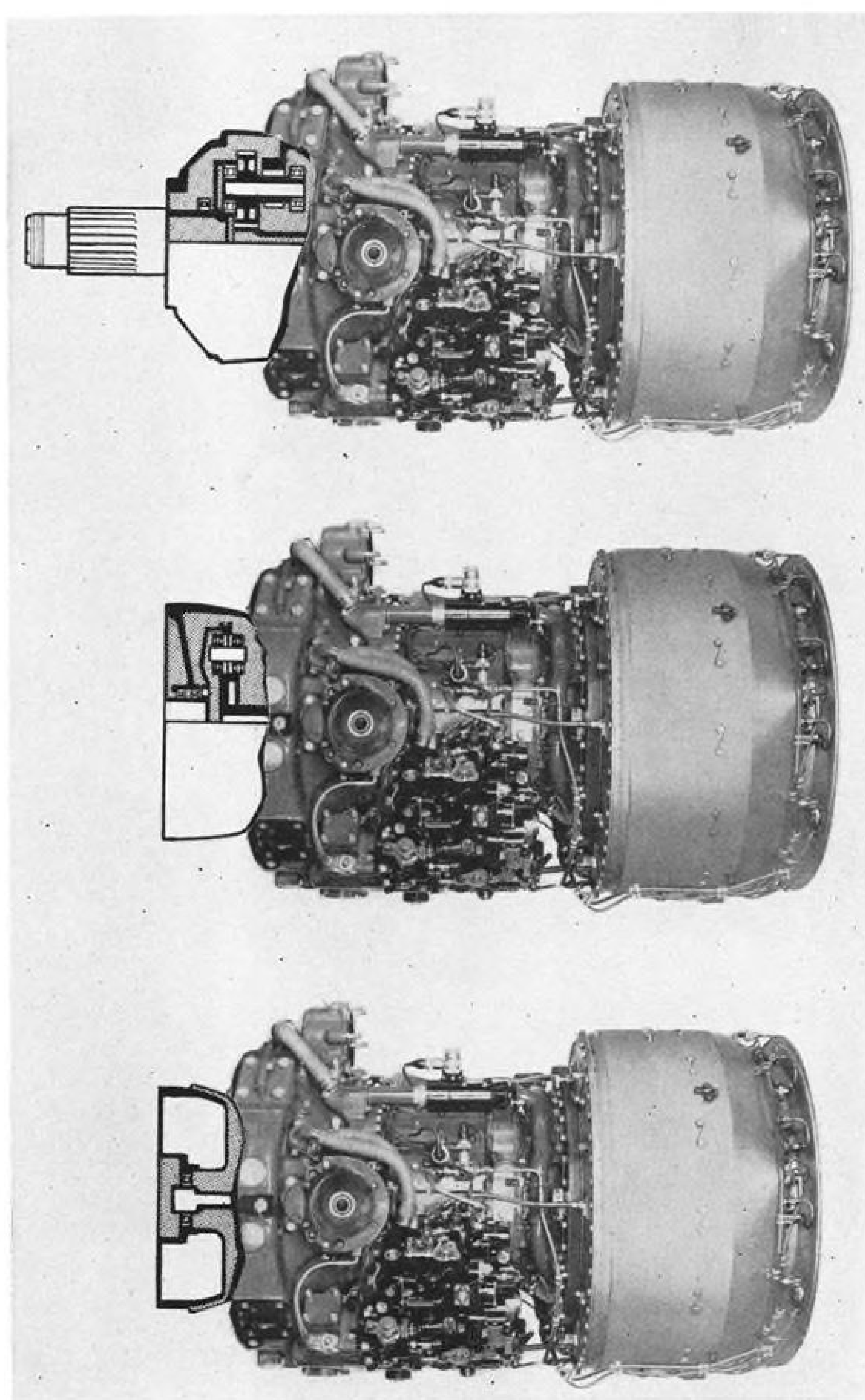
TEST TEST TEST

Today's complex systems and components that are a part of a weapon system require repetitive tests to ensure reliability and quality of product. Here, where we are working on missiles of every range, every speed, and every known propulsion method, this responsibility is in the hands of our Missile Laboratory, where we have some of the most elaborate equipment for this purpose ever assembled. Test Engineers are needed in the fields of electrical-electronic instrumentation system testing, and fluid mechanics, heat transfer and cryogenics. If you are an experienced engineer in these areas and wish to escape the ordinary, write or send resume to:

**A. H. Cunningham, Mgr.
Employment Services
12214 Lakewood Blvd.
Downey, California**

**MISSILE
DIVISION**

North American Aviation, Inc.



TURBOPROP, helicopter and high speed adaptations of Lycoming T55 are shown from top.

ally splined to couple to a power absorbing unit.

Power turbine and shaft assembly are removable as a unit by removing the bolts that mount the combustion chamber housing to the compressor diffuser housing flange. The operation also exposes the compressor-driving turbine, and can be completed without removing the engine from the airframe.

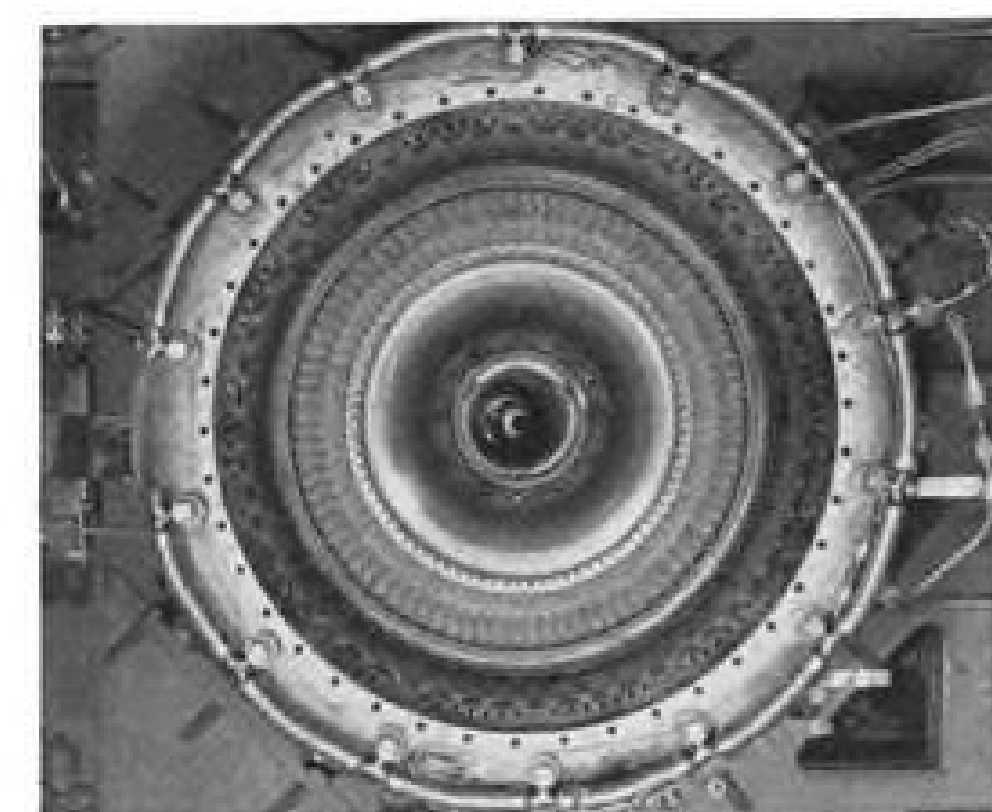
Exhaust Diffuser

The exhaust diffuser assembly is located aft of the two power turbine wheels. Assembly comprises an inter housing, an outer shell and six hollow

connecting struts. Inner bearing housing supports the two aft ball thrust bearings. Lubrication and air to cool the bearings comes into the housing via the hollow-struts of the assembly.

A single flange attaches the entire exhaust diffuser assembly to the rear of the combustion chamber. Power turbine, power shaft and exhaust diffuser assemblies can be inspected by unbolting the exhaust diffuser assembly from this flange.

The accessory drive gearbox houses an accessory gear train driven through a bevel gear mounted at the front of the gas producer rotor shaft. The gear train



COMBUSTOR can be pulled free from engine when 72 attaching bolts have been removed. Compressor turbine assembly is exposed above.

drives a lubrication and scavenge pump, a gas-producer speed tachometer generator and the Hamilton Standard engine fuel control unit—including integral fuel pumps. Main oil filter is mounted on this gearbox.

Two interesting features:

- **Mechanical torque measurement** originating from a torque-meter sleeve fitted over the engine output shaft. Any twist of the output shaft, as in power transmission, causes the sleeve assembly to ride up or down a cam surface fitted to the output shaft, forcing the torque-meter's sleeve to ride backwards or forwards along the long axis of the output shaft. This lateral movement is picked up by mechanical linkage, amplifying the signal and translating it into a rotational motion of a small output shaft in the torque-meter drive pad. The output shaft drives the "black box" on the torque-meter drivepad, in turn generating a d.c. electrical signal proportional to the degree of rotation of the torque-meter drive shaft, transmitted to an inverter and the a.c. synchro signal delivered to the torque indicator.

- **Interstage bleed system** to prevent surge at all low levels of compressor operation. System utilizes a pressure sensitive "belly band" or belt surrounding the bleed valve system between the sixth and seventh axial stages. The pressure-sensitive valve operates as a function of compression ratio. Belt snaps open during low pressure levels to permit engine operation close to the surge line, closes automatically when compression ratio is attained. Device is completely inoperative in the flight operating range.

Dassault Mirage 4 Fighter Attains Speed of Mach 1.9

Paris—Dassault Mirage 4 jet fighter reached a speed of Mach 1.9 on its 14th flight. Aircraft presently is powered by two Snecma Atar 9 turbojet engines. A larger 125,000 lb. gross weight version will be powered by two Pratt & Whitney J75 engines, built under license by Snecma.

new **PAYMOVER**® tractors



handle largest jetliners

American, United, TWA, Continental and Braniff all use these new 'PAYMOVER' towing tractors for the ground handling of the largest commercial jet aircraft.

The Frank G. Hough Co. is the only manufacturer to successfully design, produce and deliver towing equipment (in the 22,500 to 35,000-lb. drawbar effort class) to all these leading airlines.

Models T-225SL, T-245S, T-300SL and T-350SD are designed specifically to handle big planes with speed and safety under normal conditions. They feature 4-wheel drive, 4-wheel power steering and fully automatic or power-shift transmissions with torque converter drive...a combination of power, traction and maneuverability for years of up-to-date towing service.

The unique power-assisted steering system on 'PAYMOVER' tractors insures maximum maneuverability for safe, fast and

accurate spotting of any aircraft. It provides the operator with a choice of front-wheel steering, rear-wheel steering or four-wheel steer. The latter permits diagonal "crabbing" movements of the tractor either right or left.

There are other 'PAYMOVER' towing tractors (2,500 to 45,000 pound drawbar effort) for towing, pushing and other prime mover work at airports, truck and railroad terminals, and industrial yards. Complete details and specifications will be supplied at your request. Fill in and return the coupon below.

HOUGH®

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY — INTERNATIONAL HARVESTER COMPANY

THE FRANK G. HOUGH CO.
976 Sunnyside Avenue
Libertyville, Illinois

☐ Send data on
'PAYMOVER' towing
tractor of _____
drawbar effort _____

Name.....

Company.....

Title.....

Street.....

City..... State.....



The Shape of Flight The shapes of things that fly have always been determined by the materials they are made of. Feathers form wings that are basically alike for all birds—and membrane forms an entirely different wing for insects. It takes thousands of years, but nature improves its materials and shapes, just as technology improves the materials and shapes of aircraft. But here the improvements in materials are so rapid that designs become obsolete almost as soon as they are functional.

Today, the aeronautical designer has types of materials that didn't exist just a few short years ago. Steel is a good example—five new types have become available in the past year through USS research: USS Airsteel X-200, an air-hardenable alloy steel with 230,000 psi yield strength; USS Strux, an alloy steel with close to 300,000 psi tensile strength; USS 12 MoV and USS 17-5 MnV Stainless Steels for high speed aircraft and missiles; and USS Stainless "W", a precipitation hardenable stainless steel.

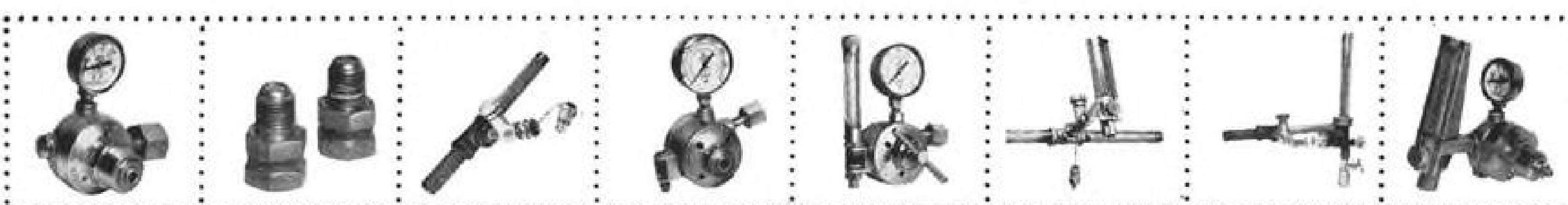
Write for complete technical information about these remarkable new materials.
United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS is a registered trademark





**WITH AIRCO'S
COMPLETE LINE OF CONTROL DEVICES FOR
ARGON, HELIUM, CO₂, AIRCOMATIC "75"***



| | | | | | | | |
|---|---|--|---|--|---|---|--|
| Single-Stage Fixed Pressure Regulator Low in cost . . . sturdy. No flow rate tampering. | Flow Adapter —Exact gas flow needed. Prevents tampering . . . saves. | "B" Station Valve for Flow Adapter —reliable shutoff. Compact, sturdy, versatile. | Fixed Pressure Two-Stage Regulator —exact gas flow needed. For two operations. | Two-Stage Flowmeter Regulator —complete flow coverage for virtually all uses. | Station Flowmeter —complete coverage. Low cost . . . extremely rugged. | Dual Range Flowmeter —complete coverage. Versatile, excellent readability. | Single-Stage Flowmeter Regulator —Rugged, compact. No heater required for CO ₂ . |
|---|---|--|---|--|---|---|--|

*75% Helium, 25% Argon

For full particulars on how to specify the most economical Airco Gas Equipment for your application, see your Authorized Airco Dealer, or write to Airco direct. Ask for the new Gas Flow Control Equipment Catalog. It's free.



AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N. Y.

Offices and authorized dealers in most principal cities

On the west coast—
Air Reduction Pacific Company
Internationally—
Airco Company International
In Cuba—
Cuban Air Products Corporation
In Canada—
Air Reduction Canada Limited
All divisions or subsidiaries
of Air Reduction Company, Inc.



LARGE canopy and lengthened nose differentiate Gnat trainer from standard Mk. 1 fighter. Fuselage was lengthened 9 in.

Folland Pushes Gnat as T-38 Competitor

Hamble, Hants., England—Folland Gnat tandem-seat jet trainer, scheduled to fly later this month, is a forerunner of a proposed supersonic version planned to compete with the Northrop T-38 series (AW July 20, p. 19).

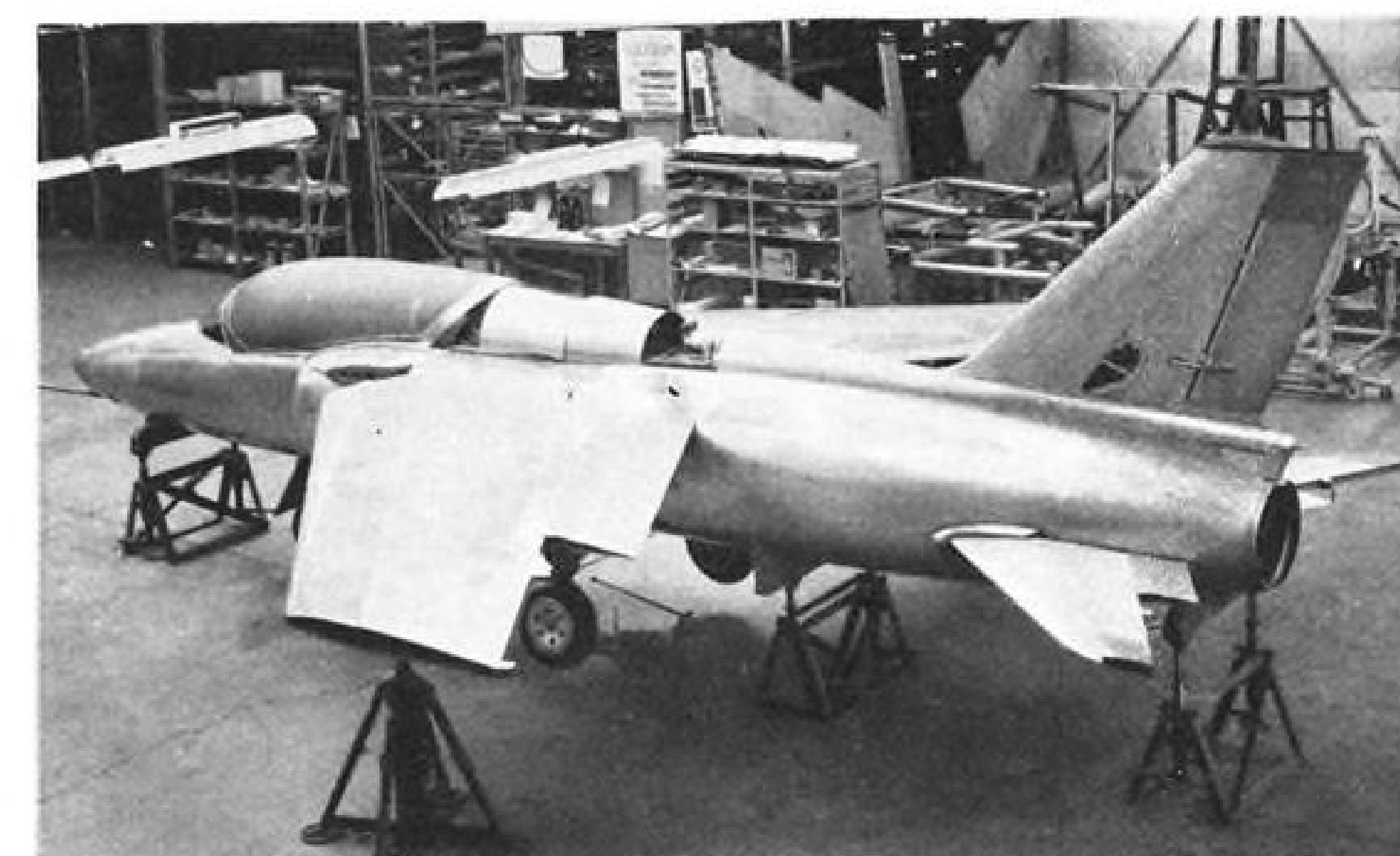
Present Gnat trainer performance is subsonic; the wing thickness ratio is 7%, the Bristol-Siddeley Orpheus Mk. 100 engine is rated at 4,230 lb. static thrust and there is no afterburner.

Folland claims that with a 5% wing and afterburning, the Mk. 2 trainer will have better rate of climb and landing speeds than the T-38-2, but its top speed and endurance will be somewhat under that of the Northrop product.

Company acknowledges that the T-38 is the airplane it has to beat for export orders in the international market. But a look at the time scale for both airplanes indicates that Northrop has a healthy lead and will undoubtedly continue to hold it.

Folland now has an order for 14 pre-production trainers, built for the Royal Air Force to evaluate at the request of the Ministry of Supply. The company expects to get a follow-on production order soon and negotiations have been underway for some time (AW Aug. 3, p. 23). Gnat Mk. 1 fighters have not sold at the hoped-for rate; 60 have been ordered in total, but no new contracts have been signed for the little fighter in more than 13 months. The first prototype Gnat flew almost five years ago.

The trainer is basically the Gnat Mk. 1 fighter with a new wing, lengthened fuselage, two seats, new vertical



INCREASED size of vertical tail is apparent in view above. Rotatable fixtures are used (below) in completing assembly and installations in forward fuselage section.



it's
1492 again...
in outer space!

Philco Ground-Space Communications System commands and tracks **DISCOVERER** satellite

DISCOVERER . . . the United States' newest earth satellite . . . is opening new vistas on the frontier of outer space. And Philco is proud to play an important role in this renowned achievement as a part of the Discoverer Team . . . in conjunction with the Lockheed Aircraft Corporation and the Air Force at the direction of the Advanced Research Projects Agency of the Department of Defense.

As the subcontractor for Discoverer's entire communications system, Philco designed and developed the vast complexity of ground-space communications, tracking, commanding and data gathering and processing systems.

The Philco-designed and equipped system observes and commands Discoverer through a series of

five tracking and data collection stations in Alaska, California, Hawaii and a specially equipped ship at sea. Philco continues its participation in the Discoverer Program by assisting in the actual operation and maintenance of the communications and data handling network.

Philco's part in the Discoverer Program is typical of the many and diverse advanced research and development activities being conducted in our laboratories on the East and West Coasts where outstanding career opportunities abound for Engineers, Mathematicians, and Physicists.

In the wonder-world of advanced electronics, look to the leader. Look ahead . . . and you'll choose Philco!

PHILCO®

GOVERNMENT AND INDUSTRIAL DIVISION
WESTERN DEVELOPMENT LABORATORIES
PHILADELPHIA, PENNSYLVANIA PALO ALTO, CALIFORNIA

and horizontal tail surfaces and a different engine. In many other respects, says the company, the airplane uses components of the Mk. 1 fighter.

Trainer requirement for tandem seating resulted in a fuselage length increase of about nine inches. This was done by extending the fuselage aft of the pressure bulkhead which formed the back of the fighter cockpit. Fuel tank and equipment bay, which were in this location, have been moved to make room. The fuel is in the intake fairings replacing the twin 30-mm. Aden cannon and ammunition boxes, and the equipment is moved to the nose.

Windshield is curved and a large, single-piece blown canopy covers student pilot and instructor. Company says that about 40% of the few castings used on the Gnat Mk. 1 are used.

New wing has increased area to give improved low-speed handling, and a slightly reduced wing thickness ratio. The fighter version has been flying with an 8% wing, and the trainer now has seven. Wing area for the trainer is 175 sq. ft., which is 40 sq. ft. more than on the fighter.

The inboard ailerons of the fighter have been dropped in favor of the more conventional outboard movable surfaces; split flaps are added inboard. Improved lateral control results at low speeds. About 100 gal. of fuel are carried in integral tanks in the wing.

The increased wing area and lengthened fuselage meant increasing the vertical and horizontal surfaces. Longitudinal control remains similar to the fighter; elevator is mechanically locked to the tailplane stabilizer to give a slab surface. If there is a hydraulic failure, the elevators are unlocked and then operate manually. Ailerons are powered, but the rudder is operated manually against feel springs.

Folland Type 4 lightweight ejection seats are fitted. This fully-automatic seat is a development of a design by the Swedish Saab Aircraft Co. Seat ejection velocities will be on the order of 80 fps. Leg restraint gear is used, and other features of the seat include a combined parachute and seat harness and a single connection for oxygen, microphone and earphones.

Total internal fuel is 260 gal., which the company says will give a two-hour endurance. Two drop tanks carrying 66 gal. each can be added, and increase endurance to just under three hours.

Future development of the Mk. 2 trainer will have a 5% wing, which will have less area than the trainer wing now used. It would be about 150 to 160 sq. ft., according to chief project engineer R. K. Page, plus full-span leading edge flaps and an advanced lateral control system.

Engine afterburning might be one of

two types, Page added: either the Swedish development which is used on de Havilland Ghost and Rolls-Royce Avons in Sweden, or a Bristol-Siddeley design. The latter is probably the basic Bristol Wee-Heat developed some years ago for the Orpheus but so far not used in any service application.

Expected performance for the Mk. 2 trainer will be Mach 1.5 at altitude. Time to climb to 50,000 ft. will be about three and one-half minutes from time of brake release, Page estimates.

Span of the current Mk. 1 trainer version is 24 ft., length is 30 ft. 9 in., and over-all height is 9 ft. 7½ in. Gross weight is 7,500 lb.

Maximum level flight speed for the Mk. 1 trainer is Mach 0.97, ceiling is over 45,000 ft. Takeoff distance ground run is about 1,500 ft.; landing distance with a drag chute is about 1,740 ft.

CJ-805-3 Attains Mach 1.1 in XF4D

General Electric CJ-805-3 turbojet engine installed in a Navy-leased Douglas XF4D has attained Mach 1.1 and 50,000-ft. altitude. Test program included air starts at altitudes to 42,000 ft. During 20 flying days in June the XF4D exceeded 7 hr. of utilization per flying day.

An important announcement to SENIOR SCIENTISTS



If you are ready to accept the challenge of supervision and to cope with rapid technological developments, you should know about —

Norair's Newly Established

ASTRO-SCIENCES GROUP

New positions are available for a selected few, highly qualified men in the following areas:

Aerodynamics
Life Support Systems
Astronautics
Space Electronics
Space Systems Design
Space Physics
Space Propulsion Systems

POSITIONS OPEN TODAY

In each of these areas Norair's Astro-Sciences Group has at least one top position that offers an exceptional likelihood for rapid advancement.

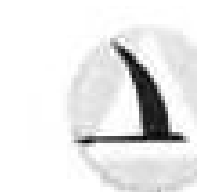
This expanding group offers the senior scientist assignments to determine the state of the art, technology and experimental research studies in the major fields outlined above.

Areas of assignment deal with space flight mechanics, space vehicle propulsion systems, space cabin design, astro-biology, space navigation and control systems, ground support systems, geophysics, magnetic field physics, and astrophysics.

If you have a degree, preferably an advanced degree, with a minimum of 8 years of related experience and some directly applicable experience, you are invited to apply to:

Mr. John Andre
Engineering Center
1001 E. Broadway,
Hawthorne, California
OR 8-9111, Ext. 1893

All applications will be given the utmost consideration and handled in the strictest confidence.



NORAIR

A Division of NORTHROP CORPORATION



MH-1521 Broussard has a span of 45 ft. and length of 28.2 ft. Wing area is 274 sq. ft. Payload of 1,655 lb. can be hauled 745 mi.

Aviation Week Pilot Report:

French Broussard Has Good Rough Field

By Robert I. Stanfield

Paris—French-built single-engine, all-metal, six to eight-place MH-1521 Broussard is a high-wing workhorse with twin vertical stabilizers, capable of hauling up to 1,655 lb. of freight 745 mi., and which can operate into the most primitive and small landing fields or strips.

Good flying characteristics and short-field capabilities were evidenced during AVIATION WEEK flight evaluation, in which the Broussard—grossing about 4,400 lb.—was maneuvered at 50 kt. (57.5 mph.) indicated, and flown off and onto a grass strip in 400 ft. and 200 ft., respectively.

Airplane, manufactured in Rheims, France, by Societe des Avions Max Holste, is geared to operate in tropical climates and into the standard Algerian field of about 900 ft. length. Powerplant is the Pratt & Whitney 450-hp. R985 engine, which turns an all-metal Hamilton Standard 2D30 constant speed propeller.

Cost of the Broussard is 20 million French francs—about \$40,000—which includes standard dual controls and instrumentation, and optional VHF, HF, radio compass, panel lighting, navigation-landing lights, cabin heating and sanitary equipment. Total orders—among the highest ever placed with a French aircraft company—have called for 458 aircraft.

Of the total, 385 were earmarked for

the French air force (of which 212 have been delivered), 24 to the French army, 3 to the navy, 2 to civil aviation authorities. Civilian orders include the demonstrator, owned by Max Holste, plus 44 deliveries to Algeria, Argentina, Brazil, Cambodia, Gabon, Haute Volta, Madagascar, Morocco, Sahara, Sudan and Tunisia.

Production is at the rate of eight airplanes a month, with current orders running through March, 1962.

Civil-Military Versions

In addition to its light-cargo capabilities, the MH-1521 is commercially applicable as a six to eight-place transport or executive airplane, and as a duster-sprayer. Militarily, the French have used the airplane extensively during brush-fire warfare for field liaison, medical evacuation, photo-reconnaissance, transport and as a flying command post.

Sitting on the ground, the Broussard presents a solid, rugged appearance. Its orthodox structure was designed to provide quick and economical repairs, overhauls and inspections. All structural parts are removable and interchangeable; seats can be dismantled at about one minute per unit, leaving a clear cabin floor; wide jettisonable door—3.78 by 4.2 ft.—can be easily dismantled, for expeditious loading of cargo or stretchers.

The MH-1521 is constructed of ribs and stringers with dural sheet skin riveted. Fuselage has a rectangular sec-

tion at cabin level, while the floor is ovoid. Two main couples of box structure support the wings. Landing gear and bracing masts attach to the main front couple.

Each half of the spring-steel gear is connected to the fuselage by two attachment parts, one rigid, the other guided for blade strain. The tail wheel is steerable and self-centering.

The rear section is constructed of two reinforced couples on which the tail plane, tail wheel and tail cone are fixed. Latter is screw assembled and can be quickly dismantled for maintenance of elevator control and gear. The two fins and tail plane are all metal. Elevators and rudders are fabric covered on a metal structure.

Engine cowlings consist of three removable panels attached on a frame fixed on the engine mounting. Lateral panels are fixed with Dzus fasteners and held in open position by rods, facilitating dismantling. Light-alloy wing fuel tanks, supported by three bridges, are welded. The oil tank is stainless steel. Ducts are fireproof.

The wing center section includes a front and a rear spar connected by ribs. The forepart is made of two duraluminum sheets (of constant thickness, decreasing height) riveted on a duraluminum core. Rear spar is made of folded duraluminum plate. The upper skin is riveted and the lower screwed on the frame.

The leading edge is divided spanwise

BUSINESS FLYING



SMALL workhorse is geared to operate into 900-ft. strips, in tropical climates. Agricultural version grosses 5,953 lb.

Capabilities

into three boxes for easy maintenance and interchangeability. Assembly to the wing center section is via screws, readily removable for inspection. Wing masts are steel tube, with fairing. Slotted flaps and ailerons are of fabric-covered metal structure, attached to rear spar by cast magnesium struts. Removable wing tip is made of two welded half shells.

Aircraft's Instrumentation

Demonstrator flown by AVIATION WEEK pilot was the six-place company-owned F-BICX. Aboard were Pierre Clostermann, chief pilot for Max Holste, and two passengers. Gross weight of the Broussard was about 4,400 lb. As an alternative to the six single seats, customer may order two forward seats and a pair of three-seater "banquettes" for transportation of eight passengers.

Engine controls, grouped in two separate sets on both the left and right side of cockpit, include levers for manifold pressure, prop control and mixture. Dual stick-type flight controls also are standard equipment. Main folding instrument panel carries flight instruments on the left, engine instruments centered and radio controls and circuit breakers on the right side of the panel.

Standard engine instruments include tachometer, oil temperature and pressure gages, boost pressure, fuel pressure and chronograph. Flight instruments

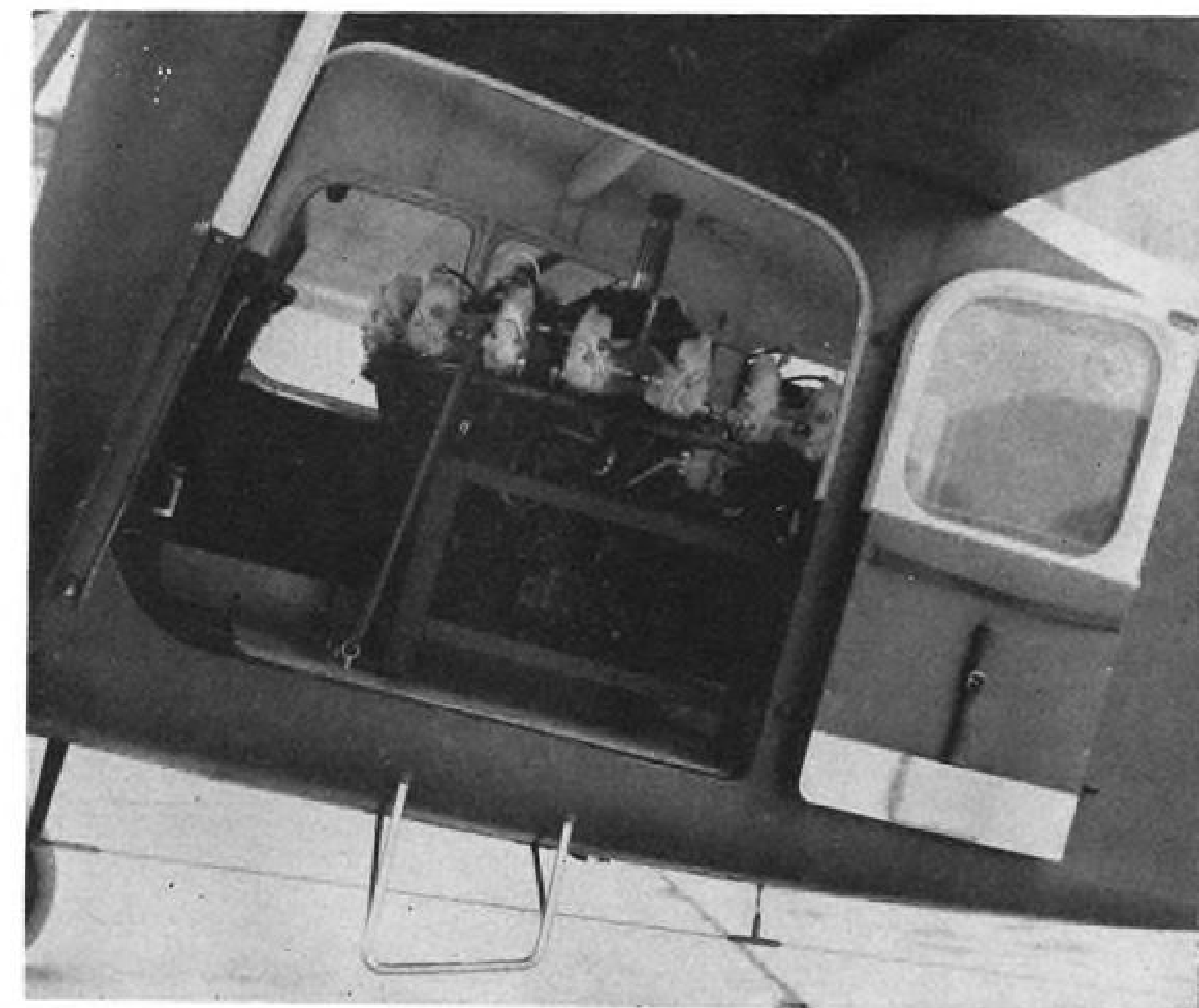
include artificial horizon, directional gyro, turn and bank, rate of climb, airspeed, altimeter, magnetic compass and vacuum feed. Electric control panel includes voltmeter, set of circuit breakers, engine fire extinguisher, battery and generator switches.

Elevator and rudder trim knobs sat on small center pedestal, directly below main panel. Aileron, rudder and elevator controls on the MH-1521 are composite (tubes and cables). Rudder is

operated by pedals hinged under the floor.

Engine fired up quickly and the Broussard was taxied to takeoff position. Nose sits a bit on the high side, and aircraft was S'd slightly during taxi run for visibility purposes. Large windshield is made from two symmetrical plastic glass sheets, assembled on frame by means of screws and rubber interposition.

Field elevation at Le Bourget is 180



BROUSSARD seats can be dismantled within one minute per unit, leaving a clear cabin floor for cargo or stretchers. Door measurement is 3.78 ft. x 4.2 ft.

Steady,
there!



Because his motor control system is inadequate to "orbital" conditions, the happy fellow above may well feel more than a little "out of this world". His old familiar muscles are incapable of providing the precise, reliable control he needs.

So it is with the new generation of high-speed air and space vehicles. More and more, hydraulic servomechanisms are giving way to a variety of *hot gas actuator systems*, relatively insensitive to high ambient temperatures and in many ways ideally suited to such requirements as space-age vector and vernier control.

Chandler Evans has been conducting a number of research and development programs in the field of high-pressure pneumatics. As a result of its extensive feasibility studies, CECO is now prepared to discuss with you the merits of systems which feature the use of chemically generated gases derived from either solid or liquid propellants.

CHANDLER EVANS CORPORATION WEST HARTFORD 1, CONNECTICUT

For a new folder on CECO hot gas actuator systems, address your request to Department 49.



MH-1521 Broussard

Specifications:

Span 45 ft.
Wing area 274 sq. ft.
Aspect ratio 7.5
Length 28.2 ft.
Cabin dimensions:
Length 10.15 ft.
Maximum width 4.1 ft.
Mean height 4.3 ft.
Door size 3.78 ft. x 4.2 ft.
Empty weight (one seat) 3,373 lb.
Gross weight 5,511 lb.
Maximum authorized weight 5,953 lb.
Wing loading 20.15 lb./sq. ft.
Power loading 4.94 bhp.
Fuel capacity 661 lb. (110 gal.)
Payload (pilot and max. range) 1,655 lb.

Performance:

Takeoff:
Ground run 607 ft.
Distance to clear 50 ft. 1,066 ft.
Landings:
Ground run 328 ft.
Distance after clearing 50 ft. ... 787 ft.
Rate of climb 1,082 fpm.
Level speeds:
Max. continuous (2,300 rpm.):
168 mph. (146 kt.)
Max. cruise (2,000 rpm.):
152 mph. (132 kt.)
Economical cruise (1,800 rpm.):
136 mph. (121 kt.)
Minimum speed 62 mph. (54 kt.)
Range (no wind) 745 mi.
Service ceiling 18,045 ft.

ft. Takeoff was made to the northeast, into a 14-kt. wind. Outside air temperature was 27C. Sea level pressure was 1,018 mb. Sixteen degrees of flaps were dropped.

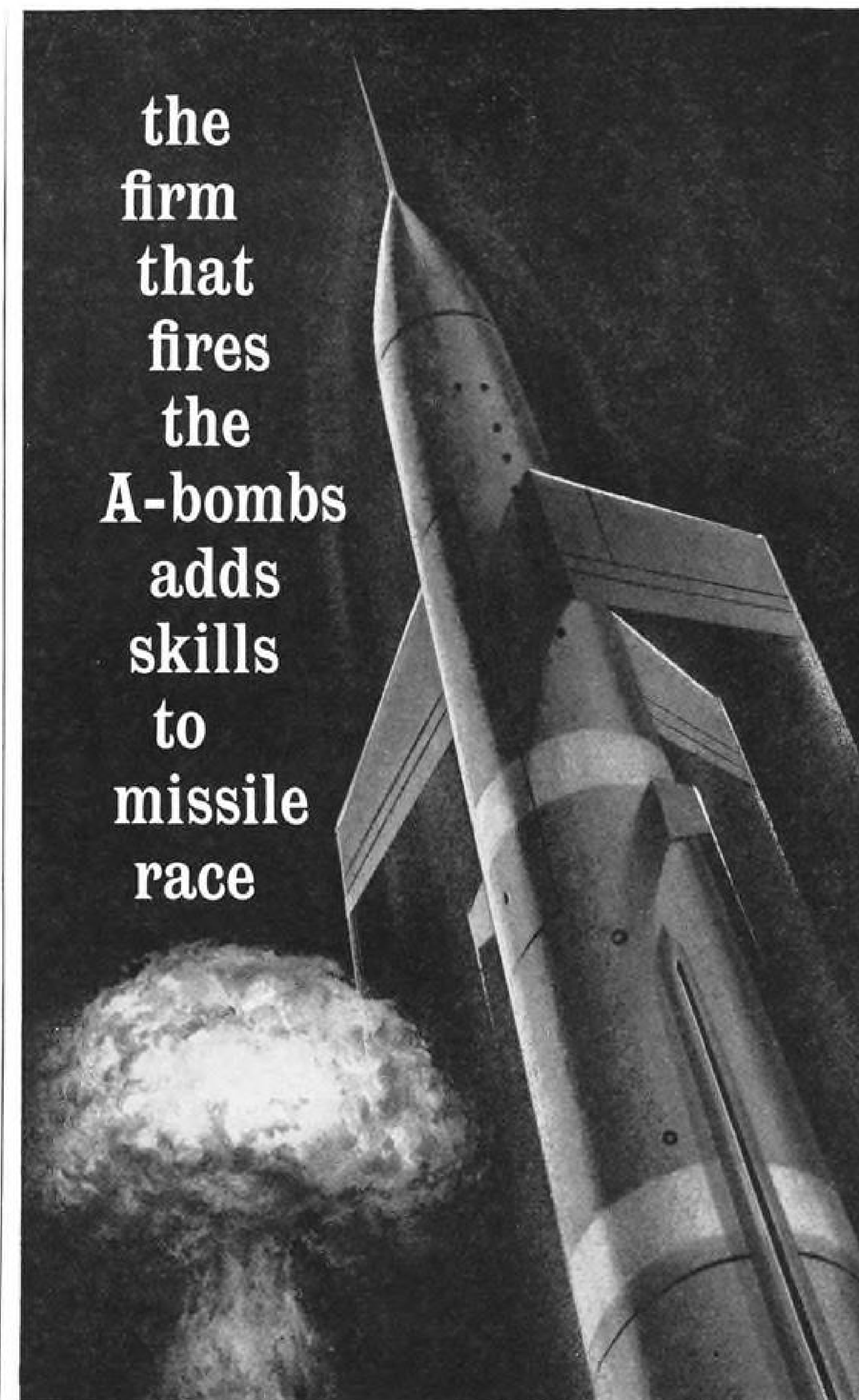
Full throttle was applied, generating 2,800 rpm., and the tail was off the ground shortly after airplane started to roll. Within 400 ft. we were airborne, climbing slightly nose high, 1,000 fpm., airplane indicating 60 kt. (69 mph.).

Nose was lowered slightly, and at 2,000 ft. airplane was ascending at 800 fpm., airspeed indicating 70 kt. (81 mph.). Visibility to the rear was no problem in level flight, but during moderate banks the high wing posed an obstruction. Feel of the airplane was good; response to small control pressures was immediate and positive.

At 4,000 ft., pulling 1,800 rpm., outside air temperature 20C, the Broussard indicated 100 kt., for a true airspeed of 109 kt. or 126 mph. At 5,500 ft., pulling 1,900 rpm., airplane held 100 kt. indicated for a true reading of 112 kt. or 129 mph. At maximum cruise—2,000 rpm.—the MH-1521 trues out at 152 mph.

Stability of the Broussard was evidenced during hands-off flight in tight turns. Snapping the stick forward, during level flight, would result in one

the
firm
that
fires
the
A-bombs
adds
skills
to
missile
race



In the timing, firing and instrumentation of nuclear devices, a single error in judgment or mistake in technical operation can lose a costly experiment or worse.

Yet Edgerton, Germeshausen & Grier, Inc., has helped to control, measure and photograph every nuclear test detonation for the Atomic Energy Commission. Its record — more than 100 shots in 10 years — and EG&G has never lost an experiment!

The unmatched capabilities proved by this remarkable record are applicable directly to the firing, instrumentation and tracking of missiles and satellites, as well as to other Space Age problems. Edgerton, Germeshausen & Grier, Inc. offers expert support to the missile man in:

Test facility operations • Test instrumentation systems • Nuclear warhead technology
Precise detonator timing • Flash systems for optical tracking • Technical field photography

Scientific and engineering positions, in physics and electronics are available. Additional information will be furnished upon request.

EDGERTON, GERMESHAUSEN & GRIER, INC.

160 BROOKLINE AVENUE, BOSTON 15, MASS. • 1622 SOUTH "A" STREET, LAS VEGAS, NEV.

LOW LEVEL INPUT AMPLIFICATION

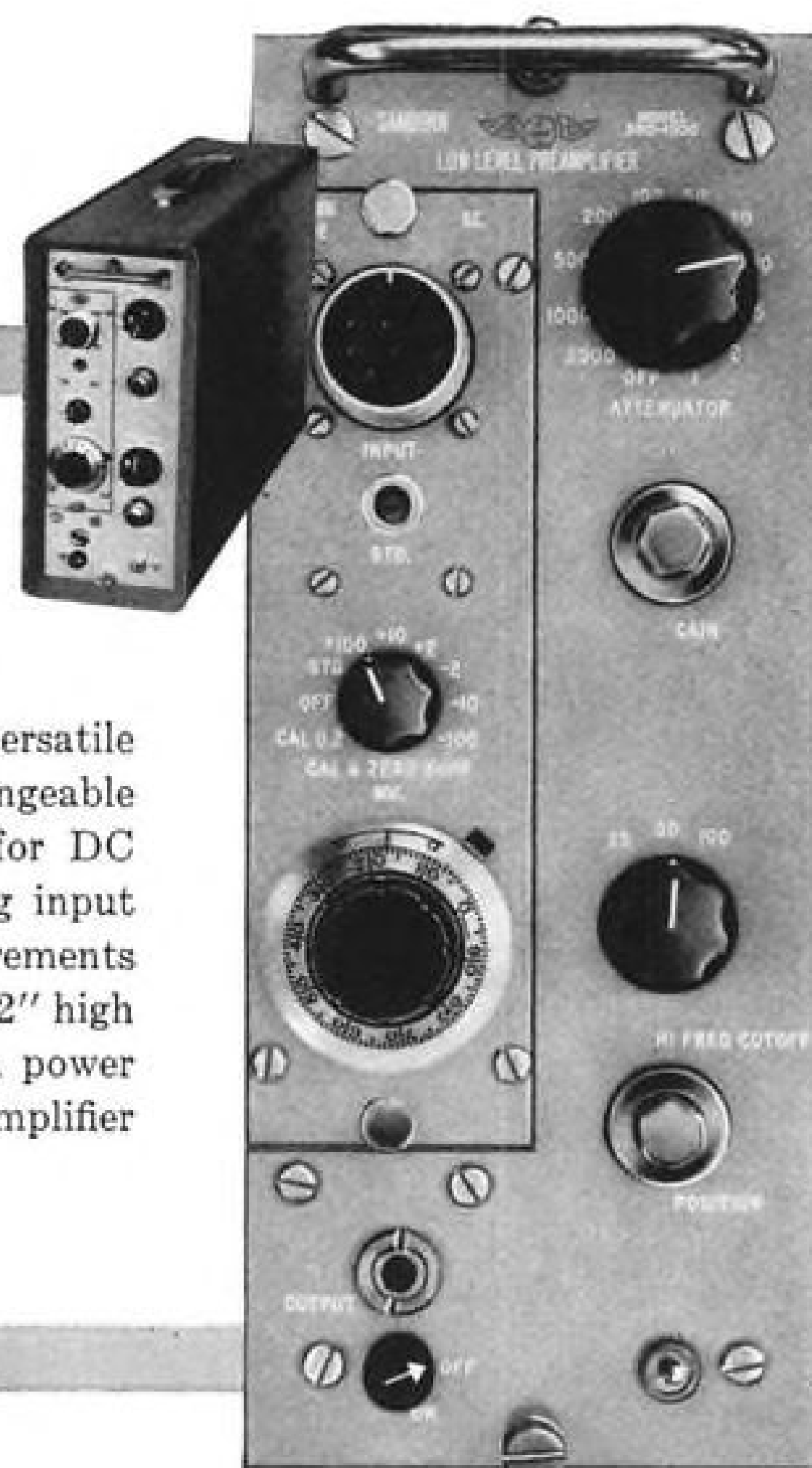
- 1,000,000:1 rejection ratio at 60 cps
- floating input
- isolated output

IN 2 NEW SANBORN CHOPPER AMPLIFIERS

INDIVIDUAL SET-UPS

portable, self-contained unit amplifier

The Model 350-1500 Low Level Amplifier provides extremely versatile measurement of low level signals through use of two interchangeable plug-in circuits — one for thermocouple applications, another for DC strain gage work (other plug-ins now in development). Floating input and isolated output make the 350-1500 useful when signal measurements are made in the presence of large ground loop voltages. The 10-1/2" high x 4-3/16" wide 350-1500 may be used individually with its own power supply to drive a 'scope, meter, optical element, etc. or as a preamplifier in 6- or 8-channel 350 series recording systems.



SPECIFICATIONS

| | 350-1500 | 850-1500A |
|-------------------------|---|---|
| Sensitivity | 20 uv input for 1 volt output, or 10 chart div. with Sanborn recorder; X1 to X2000 attenuator | 100 uv input for 1 volt output, or 10 chart div. with Sanborn recorder; X1 to X200 attenuator |
| Input | Floating, can be grounded | |
| Input Impedance | 100,000 ohms | 200,000 ohms |
| Output | Floating or grounded (independent of input) | |
| Output Impedance | 350 ohms | |
| Output Capabilities | ±2.5 volts across 1000 ohm load | |
| Bandwidth | DC - 100 cps (3db) | |
| Linearity | ±0.1% of full scale | |
| Common Mode Performance | 120 db for 60 cps and 160 db for DC with 5000 ohms unbalance in source | |
| Noise | 2 uv peak-to-peak over a 0 to 100 cps bandwidth | |
| Drift | ±2 uv for 24 hours | |
| Gain Stability | ±0.1% for 24 hours | |

Complete specifications and application data are available from Sanborn Sales-Engineering Representatives in principal cities throughout the United States, Canada, and foreign countries.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Mass.

MULTI-CHANNEL INSTALLATIONS

8-unit 7" high modules for "850" series direct writers

Compact Model 850-1500A Low Level Preamplifiers are economical, space-saving units for large installations such as aircraft and missile development and test facilities where many recording channels are used to monitor strain gage and thermocouple outputs. Required 440 cps chopper drive voltages can be supplied for up to 16 channels with the Model 850-1900 MOPA.



long oscillation before nose returned to neutral position.

Airplane has good safe-flight characteristics and is quite docile in stalls, power off and on, with and without flaps. With power on, prop turning 1,900 rpm., nose was pulled high until stick was all the way back. Airspeed held to 50 kt. (57.5 mph.), and the MH-1521 continued to fly along nose high, a bit on the sluggish side, but with no fall away or wing dropping.

The Broussard was then leveled off and full throttle applied. Pilots usually hold full throttle to get 115 kt. indicated, then throttle back to required power setting while airspeed holds constant. Retarding throttle, but holding just a bit of power, 50 deg. of flaps were dropped. Airplane again was flown nose high at 50 kt., stalled at about 45 kt. indicated (53 mph. true airspeed). Stall was quite docile. Nose would drop and as speed built up, airplane would porpoise up, then down again. In this manner airplane gently descended.

A small, grass strip on the outskirts of Paris was used to demonstrate the short-field capabilities of the Broussard during landing and takeoff. The MH-1521 was pulled off, with 16 deg. of flaps, within 500 ft., and was dropped in and stopped in about 200 ft.

Airplane is normally flown into pattern at initial speed of 80 kt. (92 mph.), with about 20 deg. of flaps lowered. On base (or during circular pattern) 30 deg. of flaps were lowered, and speed reduced to 75 kt. Final approach was flown at 70 kt., full flaps. The Broussard was brought over the fence about 60 kt. for a three-point landing, easily coming to a full stop after a short roll.

Both brakes and flaps are hydraulically operated. The FAA-approved R985 overhauled engine is supplied with generator, starter, vacuum pump and fuel pump. The 24-v. battery sits in a compartment located aft of the cabin, accessible through right side of aircraft.

Airplane has two jack points located forward, under the fuselage. A third is at the rear, adjacent to the tail wheel. Crane handling is via two fuselage rings, at wing attachment level.

Agricultural version of the Broussard has an empty weight of 3,373 lb.; maximum gross weight of 5,953 lb. Max Holste estimates that an hour's fuel would weigh 176.5 lb.; oil, 44 lb.; pilot, 165.5 lb. and special equipment, 194 lb. Available would be 2,000 lb. for payload.

Best speed of the sprayer-duster is specified at 81 mph. Capacity of the agricultural tank is 176 gal. and output is 11.6 gal. per min. Spread width is designated as 75 ft. Surface covered during the operation, 185 acres. Density of the spreading, 1.1 gal./acre.

**Breaking
Tradition
To Find
A Better
Solution—
Faster**



Practical and economical answers to fluid handling problems help you get your project out on time

Quite possibly, the solution to your fluid handling problem demands a completely new approach.

A lot of problems do.

That's why FRI engineers specialize in creative . . . imaginative thinking, as well as ordinary analytical methods of problem solving. This combination is utilized for you in finding a workable, practical solution . . . economically.

It may range from developing a complete system to merely adapting an existing piece of equipment. Either way, FRI knows from experience which way to go.

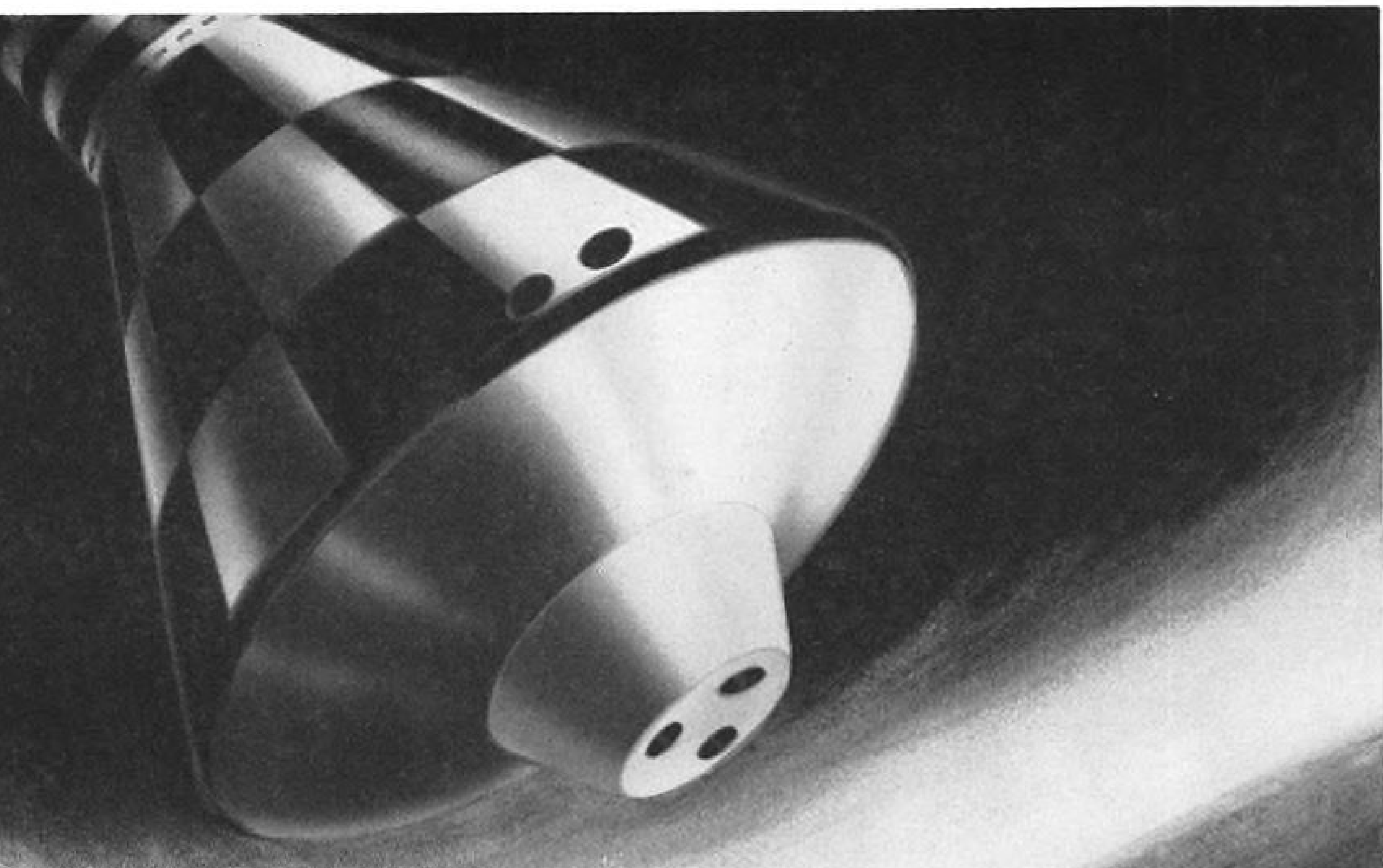
If your problem is in any way concerned with fast fluid transfer, you'll find it highly profitable to discuss it with FRI engineers. Why not write today for literature?



Flight Refueling, Inc.

FRIENDSHIP INTERNATIONAL AIRPORT • BALTIMORE 3, MD.

West Coast Representative: William E. Davis, Box 642, Inglewood, Calif.
Denver Representative: Price Engineering Sales Associates, Box 421, Littleton, Colorado



ALCOA AND BRUSH CREATE THE WORLD'S LARGEST BERYLLIUM FORGING TO BRING BACK THE MOST PRICELESS THING IN SPACE

ONE DAY, you'll know his name. You'll see it in the big, pulse-quickenning headlines: The man in NASA's "Project Mercury" capsule, flung into orbit on a spiral of fire . . .

AND, SUDDENLY, his life will become the most priceless thing in the black void that rings the earth. To bring him back, living, safe, unharmed—through the buffeting shock waves of the ionosphere; through the fiery heat of re-entry—this, so far, will be man's highest material achievement.

TO BRING him back safely, Alcoa has forged, on the gigantic 50,000-ton Air Force press at our Cleveland Works, the largest beryllium die forging ever turned out for any purpose. This forging, produced for

The Brush Beryllium Co. from their CMV hot pressed blanks, is a disk-shaped shield with an arc of 80 in. and a chord of 72 in.

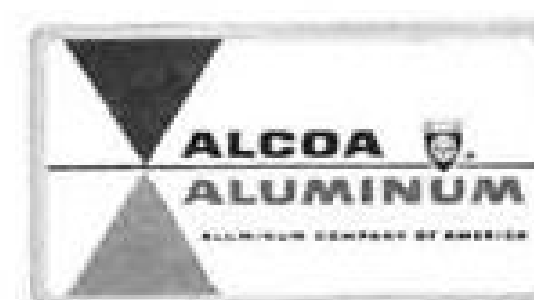
THIS BERYLLIUM forging is designed to be the base of a McDonnell Aircraft Corp. "Mercury" capsule. Beryllium is used partly to reduce weight, partly to withstand the shock of re-entry . . . but primarily to absorb, diffuse and dissipate the enormous heat of atmospheric friction—permitting the interior temperature of the space capsule to rise no higher than a safe, maximum 150°F.

ARE YOU mildly amazed to find Alcoa forging beryllium? You shouldn't be. For Alcoa possesses the nation's largest fabricating facilities along with certain know-how

which qualifies it fully for precision fabricating any lightweight metal.

FOR THE SOLUTION of your sophisticated metal-working problems—in beryllium, aluminum or what have you—Alcoa offers, in fact, facilities superior to any others, anywhere. For further information, please contact your nearest Alcoa sales office, or write: Aluminum Company of America, 2026-H Alcoa Building, Pittsburgh 19, Pa.

Your Guide to the Best in Aluminum Value

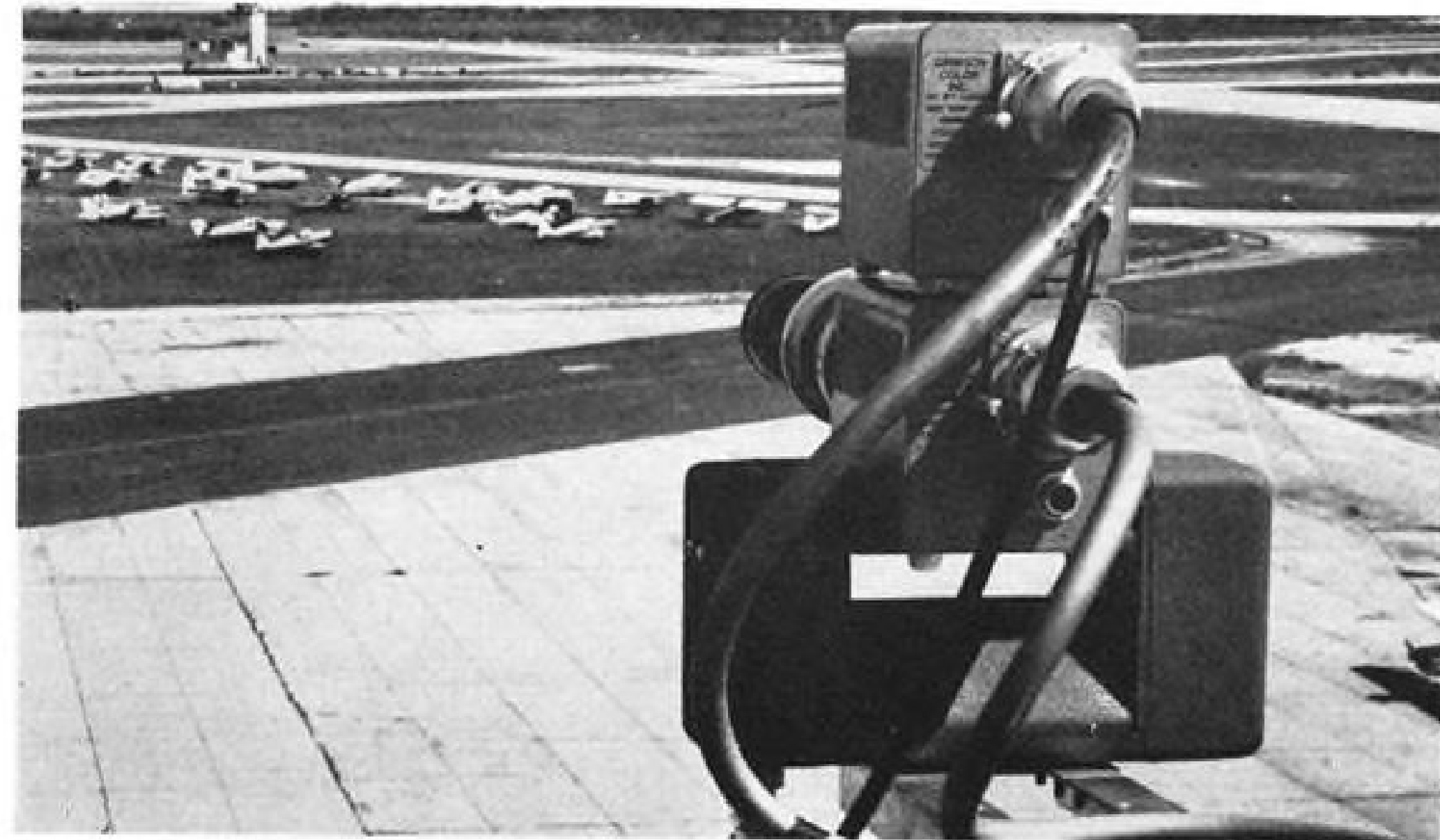


For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV



Airport Traffic Seen On Wide-Screen TV

Scanoscope wide screen 7x3 in. aspect screen in control tower at National Aviation Experimental Center, Atlantic City, N. J., is being used by Federal Aviation Agency in facilitating surveillance of runways and taxiways during airport traffic analysis programs being studied here by the agency. Control unit at bottom of monitor permits operator to work the 360-deg. pan and tilt head on which the two cameras are mounted some 60 ft. above the airport ramp; he can also switch from a 70-deg. wide angle lens unit to a 100-mm. telephoto lens, depending on whether he wants a general view of area or closeup. Monitor was developed by Grimson Color, Inc., N. Y. C.



work in the fields of the future at NAA



COUNTER- MEASURES ENGINEERS

Work on America's most advanced weapon systems.

At North American Aviation, such top-level projects as the B-70 and F-108 weapon systems have created unique careers with a tremendous engineering potential.

We have immediate openings for specialists and systems engineers in the field of electromagnetic and infrared countermeasures. Specialized areas include high power traveling wave tube analysis, receiver techniques, system logic, infrared systems design, and antenna and radome development. Experienced engineers are needed to establish requirements for countermeasures systems and to evaluate new components and techniques and their application to advanced systems.

Minimum requirements are actual experience in countermeasures plus B.S. degree in EE or Physics.

For more information please write to: Mr. A. H. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

**NORTH
AMERICAN
AVIATION, INC.**



LEWIS

SELECTOR SWITCHES

for

- Resistance Thermometers
- Thermocouple Thermometers

THERMOCOUPLE SWITCHES



Flanged Cases
in 2 inch
3 inch
4 inch dia.

Engineered to give years of service in test work as well as in permanent installations, LEWIS switches have heavy, low-resistance contacts; positive detent action and sturdy terminals for easy wiring.

The cases are splash proof and dust tight, of close fitting bakelite. Husky black-finished aluminum indexing knobs are used to turn the stainless steel shaft supporting the rotating brushes.

RESISTANCE BULB SWITCHES

A companion line of the same construction except that they are fitted with a common-terminal ring for three-wire bulb connections.

THE 9S SERIES THE SPACE SAVERS

FOR AIRCRAFT RESISTANCE THERMOMETERS

Small, sturdy, steel-cased switches 1 1/4 inches in diameter, 2-9/32 inches total shaft length, one hole mounting with 1/2-32 NS-2A threaded bushing. Designed especially for connecting two or more resistance temperature detectors to one instrument, now flying in the modern jets.

Write for our descriptive bulletin on Selector Switches

The LEWIS ENGINEERING CO.
Specialists In Temperature Measurement
NAUGATUCK, CONNECTICUT

AMC Contracts

Wright-Patterson AFB—Following is a list of unclassified contracts for \$25,000 and over as released by the Air Materiel Command:

Norair Division, Northrop Corp., facilities for assembly and testing of T-38 aircraft, (PR BI-9-F-9150), \$66,175.

Utah Division, Thiokol Chemical Corp., Brigham City, Utah, 88 ea., M-16E-1 rocket engines (for Mace missile program), Aerno, 36-1008, (PR's EP-9-39B-4400 and amendment No. 1 and EP-9-39B-4699), \$796,664.

Vertol Aircraft Corp., Morton, Pa., YHC-1Bs, mockup, spare parts, development and data, (PR 09897), \$6 million.

National Airlines, Inc., Miami, Fla., group A modification of contractor-owned L-1049H (Lockheed) aircraft to CRAF configuration, (PR EM-9-S-6378), \$28,041.

Research, Inc., Hopkins, Minn., runway overrun barrier webbing adapter test, (PR EM-9-RD-6253), \$48,137.

Lycoming Division, Avco Manufacturing Corp., Stratford, Conn., field maintenance and overhaul support of YT53-L-1 engines for H-43B pre-acceptance flight test, (PR EP-9-2810-4417), \$208,735.

Bell and Howell Co., Chicago, Ill., 72 ea., photographic accessory kit (LP-1), spare parts and data for: ground support equipment, (MIPR R02-99017 SC-01-23), IFB 33-600-59-171, \$64,683.

Emerson Radio and Phonograph Corp., Jersey City, N. J., transformer program, (PR 08803), \$79,659.

Special Projects Department, Monsanto Chemical Co., Boston, Mass., hydrocarbon fuels (two litres each of fifth) to be used for valuation purposes in small laboratory equipment to determine the suitability for use as advanced jet fuels, (PR EM-9-RD-6302), \$207,600.

Olympic Radio and Television Division, The Siegler Corp., Long Island City, N. Y., 1,765 ea., amplifiers, synchro signal compass, 400 cycle, type ME-1A, Aerno 60-3861, aircraft usage; P-84F modification program, (PR's MO-9-MAINT-27778, MO-9-MAINT-34742, MO-9-MAINT-941 and SM-9-05A-2528-1), \$691,738.

The Dow Chemical Co., Midland, Mich., 3,000 lb. of lubricant, Bis(phenoxyphenyl) ether, (PR EM-9-RD-6347), \$47,250.

The Dow Chemical Co., Midland, Mich., 2,000 lb. of lubricant, Bis(phenoxyphenoxy) benzene, (PR EM-9-RD-6324), \$62,100.

Topp Industries, Inc. (U. S. Science Corp.), Los Angeles, Calif., 2 ea., test sets, central air data computer output, engineering data and progress reports, (PR EA-9-RD-4632), \$58,816.

Melpar, Inc., Falls Church, Va., 11 ea., spectrograph analyzers, (PR's 911195-A, 913217-A and amend. No. 1), \$165,550.

Amoco Chemical Corp., Chicago, Ill., 19-118 ea., cartridges, starter, aircraft engine, type MXU-4/A for use on F-105 aircraft, (PR 00-9-1375-2787), \$625,158.

Grayston Corp., Dayton, Ohio, 2,409 ea., launchers, rocket, airborne, training, type MA2A, in accord with specification MIL-L-25157B (USAF) dated Mar. 28, 1958 and USAF drawing 57K22241 (for training purposes in launching of rockets), IFB 33-600-59-146, (PR's WR-9-FSC10-2014 and amendment No. 1 and WR-9-FSC10-3032), \$82,990.

Cook Electric Co., Chicago, Ill., 722 ea., controls, inverter changeover, type A-2, contractor's P/N 666-154 (used on miscellaneous aircraft), IFB 33-600-59-180 (PR SA-9-03C2-9216 and amendment No. 1), \$29,644.

Flight Propulsion Division, General Electric Co., Cincinnati, Ohio, 36 ea., J79-GE-2 turbojet aircraft engines, data and bill of materials for Navy, (MIPR R59-1943-48-NOas, partial), \$4,003,000.

Red Bank Division, Bendix Aviation, Eatontown, N. J., 107 ea., generators, 30 v.d.c., 200 amp., type MA-1, Aerno 42-2028, engineering and maintenance data for: Q-2C and H-37A aircraft, (PR EA-9-03C-4696), \$72,319.

Sylvania Electronic Systems, Waltham Laboratories, Sylvania Electric Products,

ADVANCED PRELIMINARY DESIGN ENGINEERS

The creation of the new Preliminary Design Department of our Solid Rocket Plant has led to several unusual and challenging positions for experienced engineers and scientists.

We are expanding:

into new fields of rocket propulsion and space technology, far beyond "classical" solid propellant rocketry. For this we are an internationally acknowledged leader.

We are looking for:

mature, experienced and highly versatile engineers, preferably over 30 years old. These men will be mechanical, aeronautical, or missile engineers. They may also be engineering-minded physicists or chemists. An M.S. degree is essential, a Ph.D. welcome. A high degree of proficiency in such fields as thermodynamics, aerodynamics, heat transfer, stresses, and physics is required, as well as a practical understanding of manufacturing fundamentals. Each of the men we are seeking must be capable of integrating the essentials of a new design, based on the more quantitative work of our several analytical groups.

Eight positions as "Technical Specialist" in our Preliminary Design Department are available. Each successful candidate will work on this team as an equal among equals. These top engineers will be given enough responsibility and freedom to work as they see fit. Excellent salaries are offered, commensurate with demonstrated ability and experience. The Sacramento, California, area offers a favorable, healthy climate and living conditions which are among the finest in the country, one and a half hours driving time from either the Sierra Nevada Mountains or San Francisco.

Please send your resume and direct any detailed questions to:

Mr. Emil L. Eckstein
Head, Department for Preliminary Design
Through:

Mr. E. P. James, Supervisor
Technical and Scientific Placement
AEROJET-GENERAL CORPORATION
Box 1947F
Sacramento, California

AEROJET-GENERAL CORPORATION

a subsidiary of
the General Tire & Rubber Company
Azusa & near Sacramento, California

Inc., Waltham, Mass., trainer attachments (ECM) to the AN/GPS-T2 radar target simulator trainers, spare parts, ground support equipment, data and installation services, (PR's PE-9-69-4120 and PE-9-6910-4180), \$485,452.

Pioneer-Central Division, Bendix Aviation Corp., Davenport, Iowa, 41 ea., develop and fabricate individual survival and emergency oxygen kit assemblies, Spec. MIL-S-26691 (USAF) and data, (PR DG-9-01A-7281), \$99,999.

North American Aviation, Inc., Los Angeles, Calif., 65 ea., rack assemblies, 1095-187-63026-31; 179 ea., rack assemblies, 1095-63026-32; 45 ea., rack assemblies, 1,200 lb., external store; 100 ea., bomb rack packages, 1095-187-63002-40, applicable to F-86 aircraft, (PR's WR-9-FSC10-2012 and amendments 1 and 2; WR-9-FSC10-2004 and amendment No. 1), \$427,653.

Ampex Corp., Redwood City, Calif., 1 ea., Ampex FR-100 recorder/reproducer and related equipment, (PR 916271-A), \$55,343.

Publication Development Division, American Society for Metals, Cleveland, Ohio, machinability of high strength steel program, (PR PB-9-MMP-9016), \$155,290.

Direct Current Motor & Generator Department, General Electric Co., Erie, Pa., 84 ea., 5901-6125-328-6204 amplitudes; 137 ea., 5901-6165-504-2009 motors (replacement spare components for AD, MD1, MD1A and MD4 fire control systems, B-47 and B-66 aircraft), (PR's WR-9-11E-964 and WR-9-11E-967), \$87,300.

Semiconductor & Materials Division, Radio Corp. of America, Somerville, N. J., transistor program (production refinement and pilot line production of low power, VHF, silicon, NPIN, intrinsic structure transistor), (PR BM-9-MMP-9088), \$321,558.

Sundstrand Aviation Division, Sundstrand Machine Tool Co., Rockford, Ill., 156 ea., shafts, interconnecting, 40 kva., 57 hp., Aerno 48-0575; 156 ea., transmission and governor assemblies, Aerno 48-0576; 156 ea., flanges, mounting, input, Aerno 48-0762; 158 ea., frequency and load controllers, Aerno 48-0591; 156 ea., transformers, current, 40 kva., Aerno 48-0838 and spare parts for: support of B-52G aircraft, (PR's EA-9-03C-4581 and EA-9-031-4582 and amendment No. 1), \$993,988.

Systems Research Laboratories, Inc., Dayton, Ohio, 15 ea., data reduction consoles (spec. AFCIN-4C 352101-2 dated Jan. 15, 1959, designated as exhibit "A"), (PR 913206-A and amendment No. 1), \$480,000.

Radiant Manufacturing Corp., Morton Grove, Ill., 1,862 ea., SNR screens, projection, BM-10, portable, spring roller mounted, spec. CG-S-172a dated April 21, 1958, type IV, and drawings, IFB 33-600-59-135, (MIPR R59-22224-SC-24 and amendment No. 1), \$55,226.

Westinghouse Electric Corp., Dayton, Ohio, 179 ea., panel controls, generator, 28 v.d.c., type B3, Aerno 42-730, engineering and maintenance data, IFB AF-33-600-59-164, (PR SA-9-03C-8349), \$58,802.

Schwien Engineering, Inc., Los Angeles, Calif., barometers, absolute pressure, standards in a/w exhibit WCLCI-2-16 dated Sept. 18, 1956, for: service test, (PR IME-9-ST-4455), \$59,140.

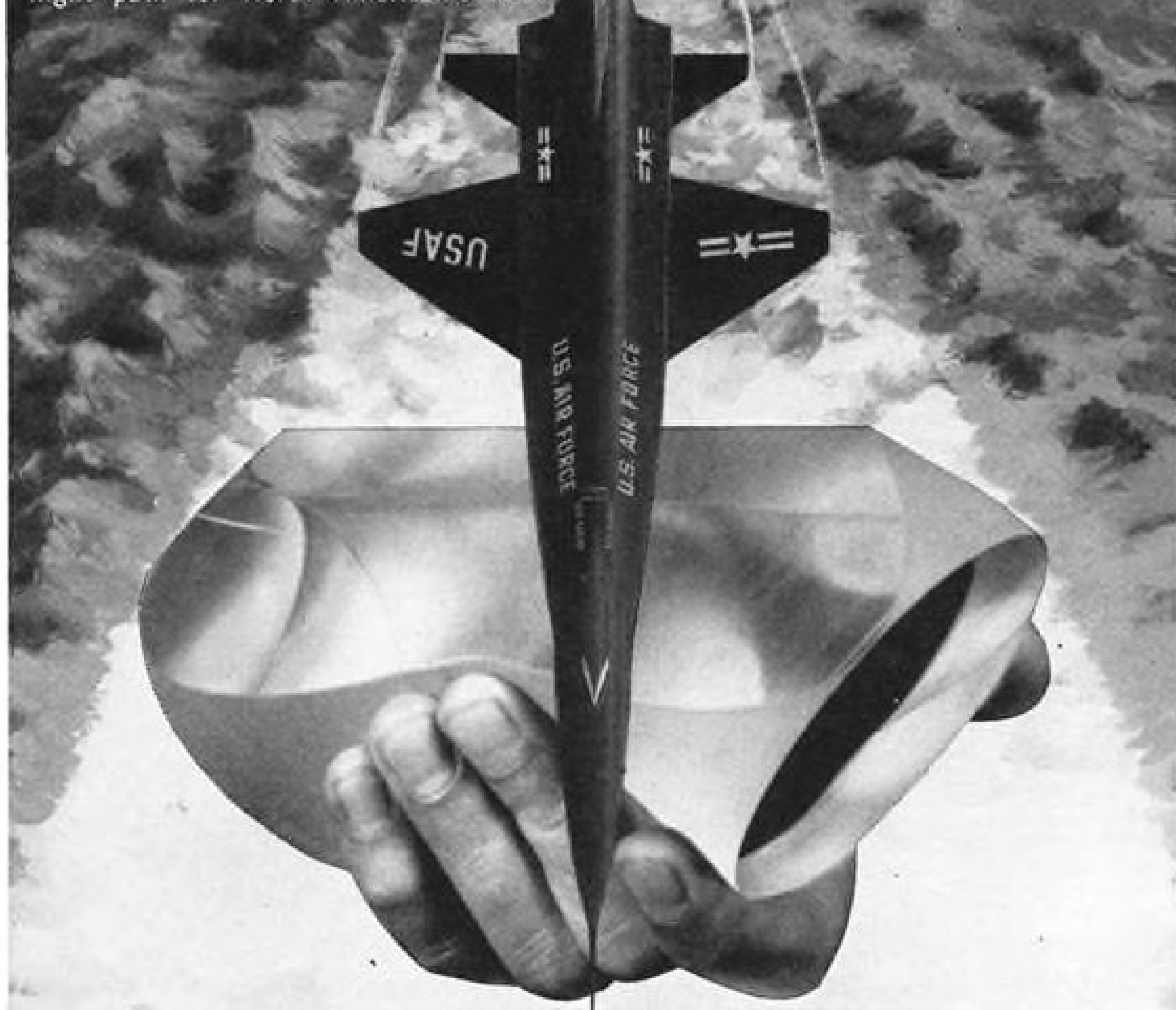
General Electric Co., Erie, Pa., 4 ea., generators, aircraft, 30 v.d.c., 300 amp. "VQAD," GE P/N 2CM75G1, including clamps, adapters and data, product improvement program) for: B-50, B66, C-54, C-97, C-119, C-123, C-124 and C-121 aircraft, (PR EA-9-03C-4903), \$55,450.

Propeller Division, Curtiss-Wright Corp., Caldwell, N. J., 111 ea., blade fairing and heating element assemblies, de-icing (spares for C-124C aircraft), (PR R-9-1610-4323), \$575,556.

Benson-Lehner Corp., Los Angeles, Calif., 4 ea., film readers, OSCAR model E (GS1026E); 4 ea., OSCAR projectors (GS 1095); 4 ea., decimal converters, model E (GS 1020D); associated data and equipment, (PR 913226-A and amendment No. 1), \$68,295.

Aeroproducts Operations of Allison Division, General Motors Corp., Dayton, Ohio, design, development and fabrication of a controllable pitch propeller compatible with the Allison T61 turboprop engine, (PR EA-9-03A-4548), \$1 million.

Texas Instruments roof prism—viewer for photographic system used in the Douglas A3D-2P—helped photo map the landing flight path for North American's X-15



ROAD MAPPER FOR THE X-15

Texas Instruments roof prisms share a vital role in mapping a safe landing course for the first manned space craft. Installed in a photographic system aboard a Douglas A3D-2P, these prisms recorded landmarks that will guide the X-15 pilot in his return to earth. Accurate photo mapping at 600 miles per hour requires exceptionally high quality optical components. This roof prism, for example, has angles that must be held within seconds of arc. Difficult to manufacture? Not for TI craftsmen... tolerances such as these are met everyday at TI in production quantities.

Leading designer and producer of silicon, germanium, quartz and other optics for military and commercial uses, TI has intimate familiarity with unusual materials suited to specific portions of the spectrum. In one of the nation's best equipped facilities, TI craftsmen grind, polish and coat precision optics with the same care that goes into a "road mapper" prism. This team — backed by a full-time engineering service and high-speed computers — can meet your requirements in any quantity from idea to completion. For detailed information about this technology, send for booklet "Precision Optics at Texas Instruments" or contact SERVICE ENGINEERING:

TEXAS  **OPTICS DEPARTMENT
INSTRUMENTS
INCORPORATED**
6000 LEMMON AVENUE
DALLAS 9, TEXAS

Checking Einstein with



Purity Plus—Hughes Products Division engineer checks semiconductor materials to insure purity.



Exit cones capable of withstanding temperatures of 6000° F. represent one example of advanced engineering being performed by the Hughes Plastics Laboratory.

an atomic clock in orbit

To test Einstein's general theory of relativity, scientists at the Hughes research laboratories are developing a thirty pound atomic maser clock (*see photo at left*) under contract to the National Aeronautics and Space Administration. Orbiting in a satellite, a maser clock would be compared with another on the ground to check Einstein's proposition that time flows faster as gravitational pull decreases.

Working from the new research center in Malibu, California, Hughes engineers will develop a MASER (Microwave Amplification through Stimulated Emission of Radiation) clock so accurate that it will neither gain nor lose a single second in 1000 years. This clock, one of three types contracted for by NASA, will measure time directly from the vibrations of the atoms in ammonia molecules.

Before launching, an atomic clock will be synchronized with another on the ground. Each clock would generate a highly stable current with a frequency of billions of cycles per second. Electronic circuitry would reduce the rapid oscillations to a slower rate in order to make precise laboratory measurements. The time "ticks" from the orbiting clock would then be transmitted by radio to compare with the time of the clock on earth. By measuring the difference, scientists will be able to check Einstein's theories.

In other engineering activities at Hughes, research and development work is being performed on such

projects as advanced airborne systems, advanced data handling and display systems, global and spatial communications systems, nuclear electronics, advanced radar systems, infrared devices, ballistic missile systems...just to name a few.

The variety and advanced nature of the projects at Hughes provides an ideal environment for the engineer or scientist who wishes to increase his professional stature.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

| | |
|---------------------|---------------------------|
| Communications | Environmental Engineering |
| Thin Films | Logical Design |
| Electron Tubes | Radar Circuit Design |
| Field Engineering | Material & Component Eng. |
| Semiconductors | Systems Analysis |
| Test Equipment Eng. | Nuclear Electronics |

*Write in confidence to Mr. Don Eikner,
Hughes General Offices, Bldg. 6-A8, Culver City, Calif.*

© 1959. H. A. C.

The West's leader in advanced ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach,
Malibu and Los Angeles, California;
Tucson, Arizona

SUPPORT!

Solar skills and capabilities cover full range of support equipment



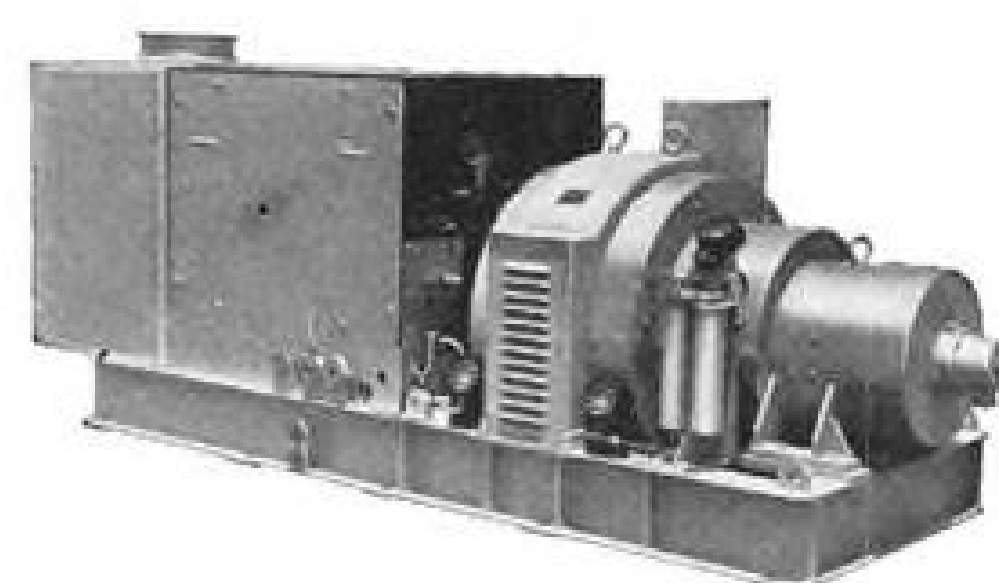
WHEELED VEHICLES: Solar's GSE capabilities include the design, development and manufacture of specialized powered and towed vehicles—including large trucks and semi-trailers—for missile transport, ground handling and other important support applications.



ELECTRONIC EQUIPMENT: Electronic Systems Development Corp., a Solar subsidiary, has broad experience in electronic systems for airborne, shipboard and ground installations—including missile checkout, data processing, communications, ground test and others.



MULTI-PURPOSE SERVICING UNITS: Support equipment is a natural outgrowth of Solar's early experience in fabricating advanced metal structures for specialized applications. Current units include dolly- and truck-mounted starting and servicing units for advanced military and commercial jets.



POWER PACKAGES: Solar emphasizes reliability in all of its support equipment. Among the more than 2000 major units of support equipment produced by Solar are reliable, lightweight gas turbine-driven generators for important ground, airborne and shipboard applications.

Underlying Solar's support equipment capabilities is a weapon systems team of selected scientists and engineers with years of active experience in the GSE field. For detailed information write today to Dept. G-137, Solar Aircraft Company, San Diego 12, California.



ENGINEERS WANTED! Challenging projects, unlimited opportunities with Solar.

NEW AVIATION PRODUCTS

Reflective Runway Markings

Reflective aggregate available in white or yellow is designed to make runway and taxi strips more readily visible at night. Aircraft landing lights will make unlighted runway markings visible from two miles out at an altitude of 500 ft.

The aggregate, tested at Air Force and Navy facilities, is bonded at 60F temperatures to dry concrete or asphalt treated with a binder. Compound, used with a conventional pavement striping machine, is applied at a rate of 4 lb. per gallon of recommended binder, each gallon covering 80 sq. ft.

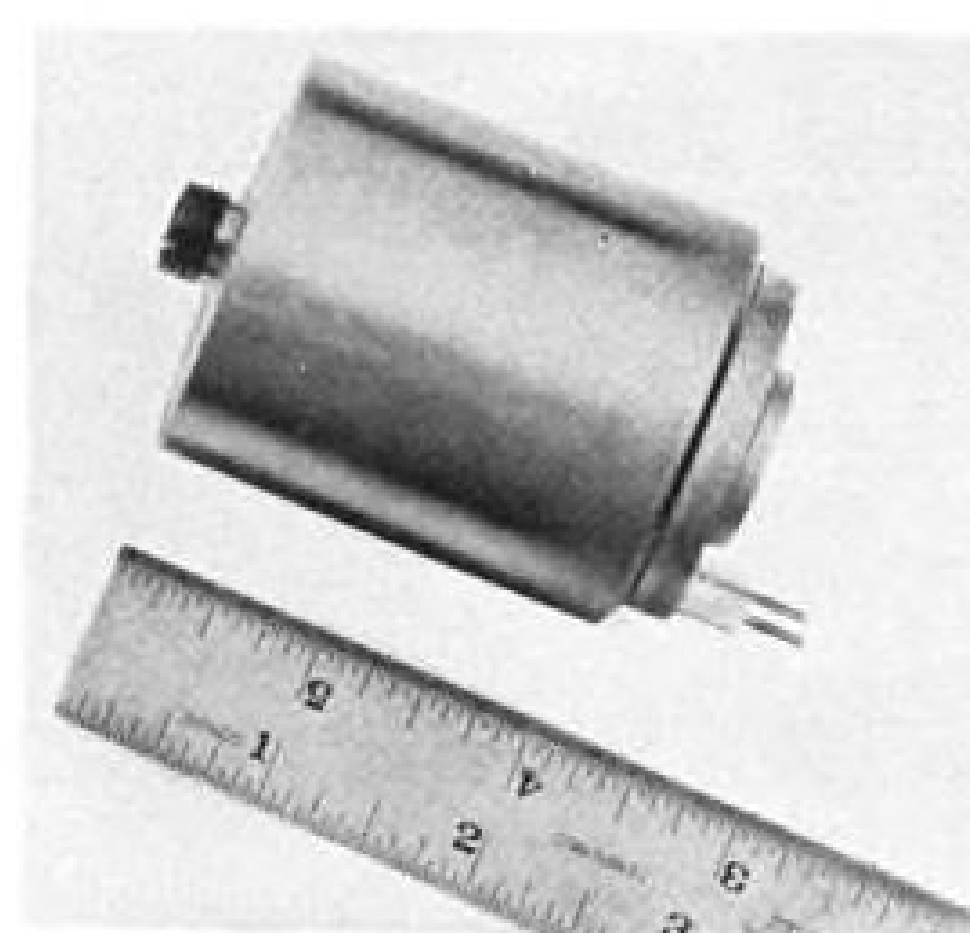
Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minn.

Time Delay Relay

Transistorized time delay relay is intended for remote control operations in missiles and satellites, such as closing destruct circuits and deploying drag chutes.

Relays, available in Models 9349 and 9350, meet military specification MIL-R-6106C. Both the 9349 (time delay on pickup) and the 9350 (time delay on dropout) operate crystal can relays inside the package through a transistorized network which determines the time delay. Specifications include: ambient temperature range from -55 to +120C, nominal time delay from 0.1 sec. to 3 min., operating voltage range 18 to 30 v.d.c., maximum weight 0.35 lb., maximum size 1.531 in. square by 1.812 in. high.

Leach Corp., Relay Division, Los Angeles, Calif.



Missile Solenoid

Solenoid, designed to operate in high temperature areas of missiles and aircraft, can operate continuously in temperatures of 1,000F.

Stroke of the unit is from .010 in. to .060 in. At .010 in. stroke the solenoid will operate a minimum force of 15 lb. Required power source is from 18 to



X-15 Nose Wheel Equipped With Fabric-Tread Tires

Fabric tread tires designed for the nose wheel of the X-15 are compared following landing of the North American research aircraft. Developed by the B. F. Goodrich Co., the tire incorporates multiple plies of nylon cord in the tread to better bind tread and carcass and prevent the tire from throwing its tread during the aircraft's high-speed landings.

30 v. d.c.; coil resistance at 1,000F is 35 ohms. Diameter is 1 1/8 in. and weight is 1.3 lb.

Rocker Solenoid Co., 140 N. Marine Ave., Wilmington, Calif.

Hot Gas Motorpump

Hot gas motorpump or auxiliary hydraulic power on missiles utilizes either solid propellant generators or gas bled from the main propulsion system.

The motor, a modified axial piston-type hydraulic motor, provides auxiliary power throughout a range of 0.5 hp. at 1,500 psi. to 66 hp. at 3,000 psi. Speed ratings for the integral units range from

18,200 rpm. for the 0.095 cu. in./rev. size to 6,500 rpm for the 2.35 cu. in./rev. size. Motors have been tested at temperatures to 5,000F. Motors, running on solid propellants at temperatures of 2,300F, average one minute endurance.

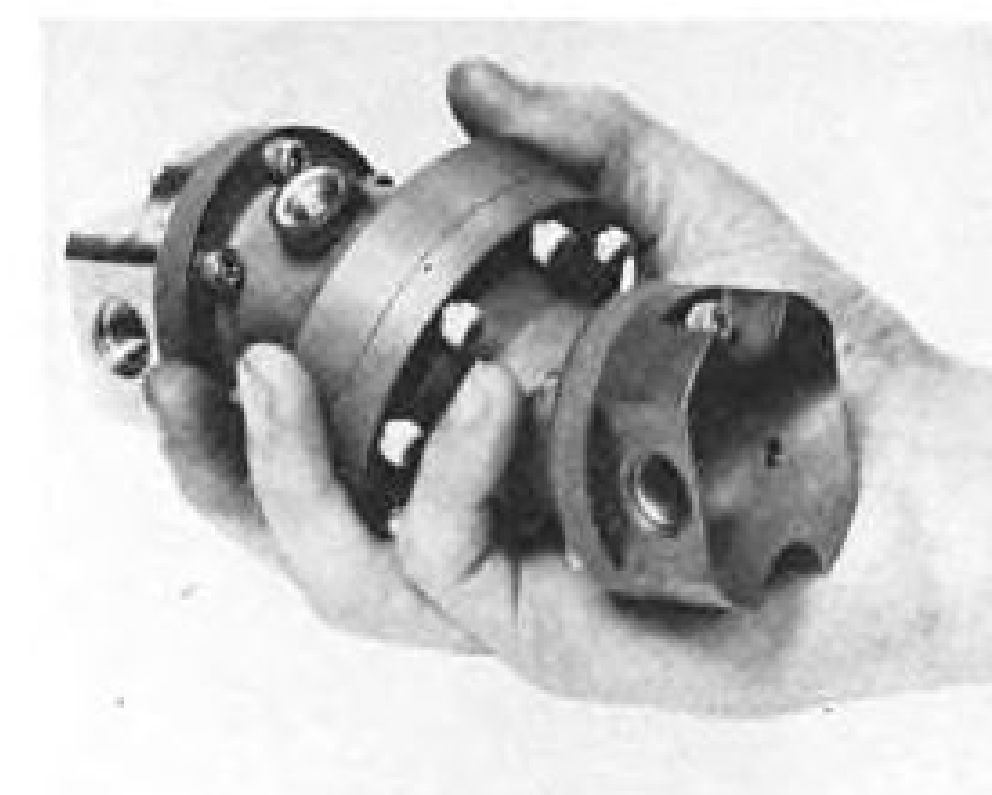
Vickers, Inc., Detroit 32, Mich.



Solid State Inverter

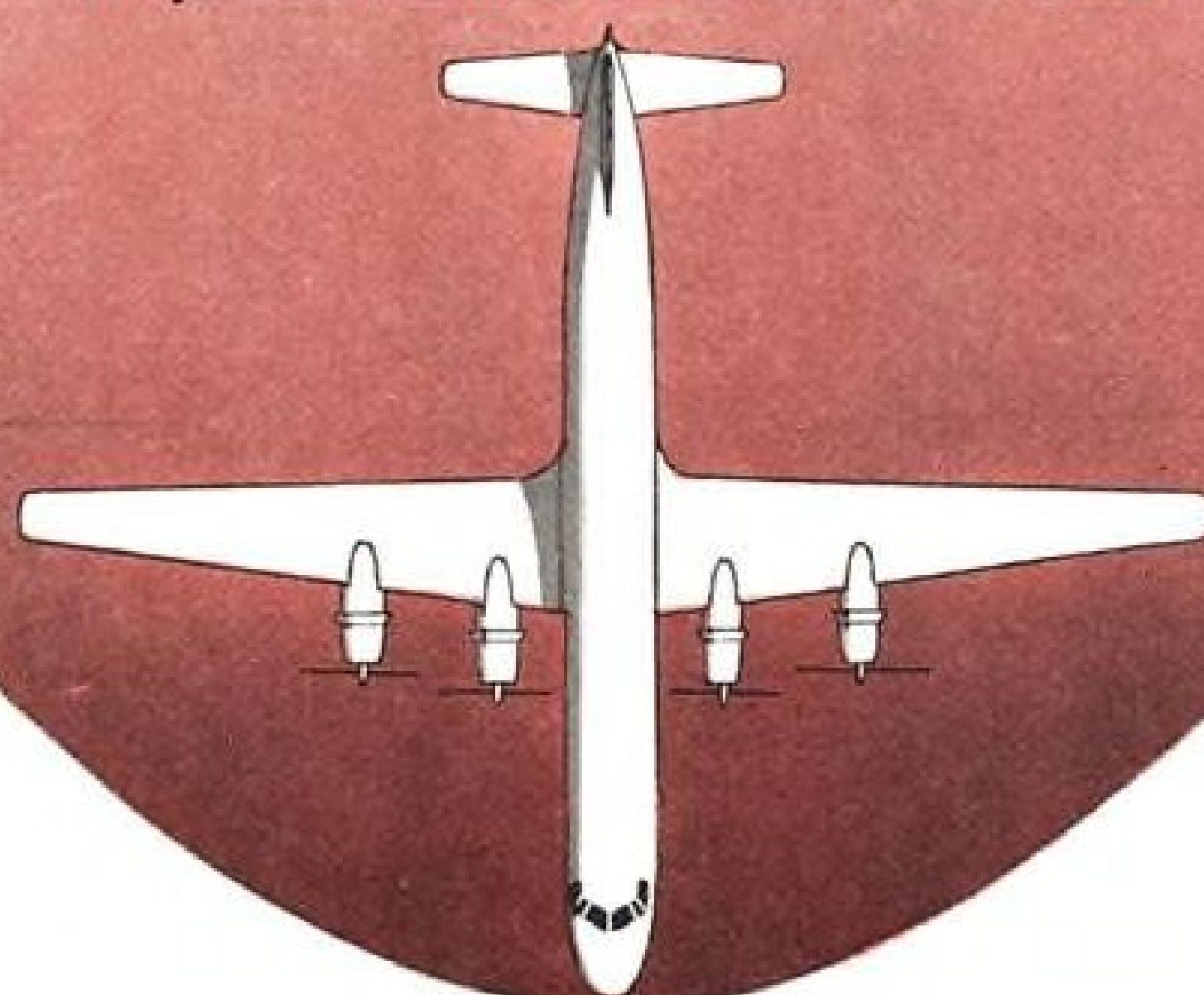
Solid state power inverter is used to energize either or both General Electric J85 turbojet engines on the Northrop T-38 jet trainer. Inverter replaced vibrator type equipment.

Power inverter, Model No. SIS-W41251, for ground or inflight starting,



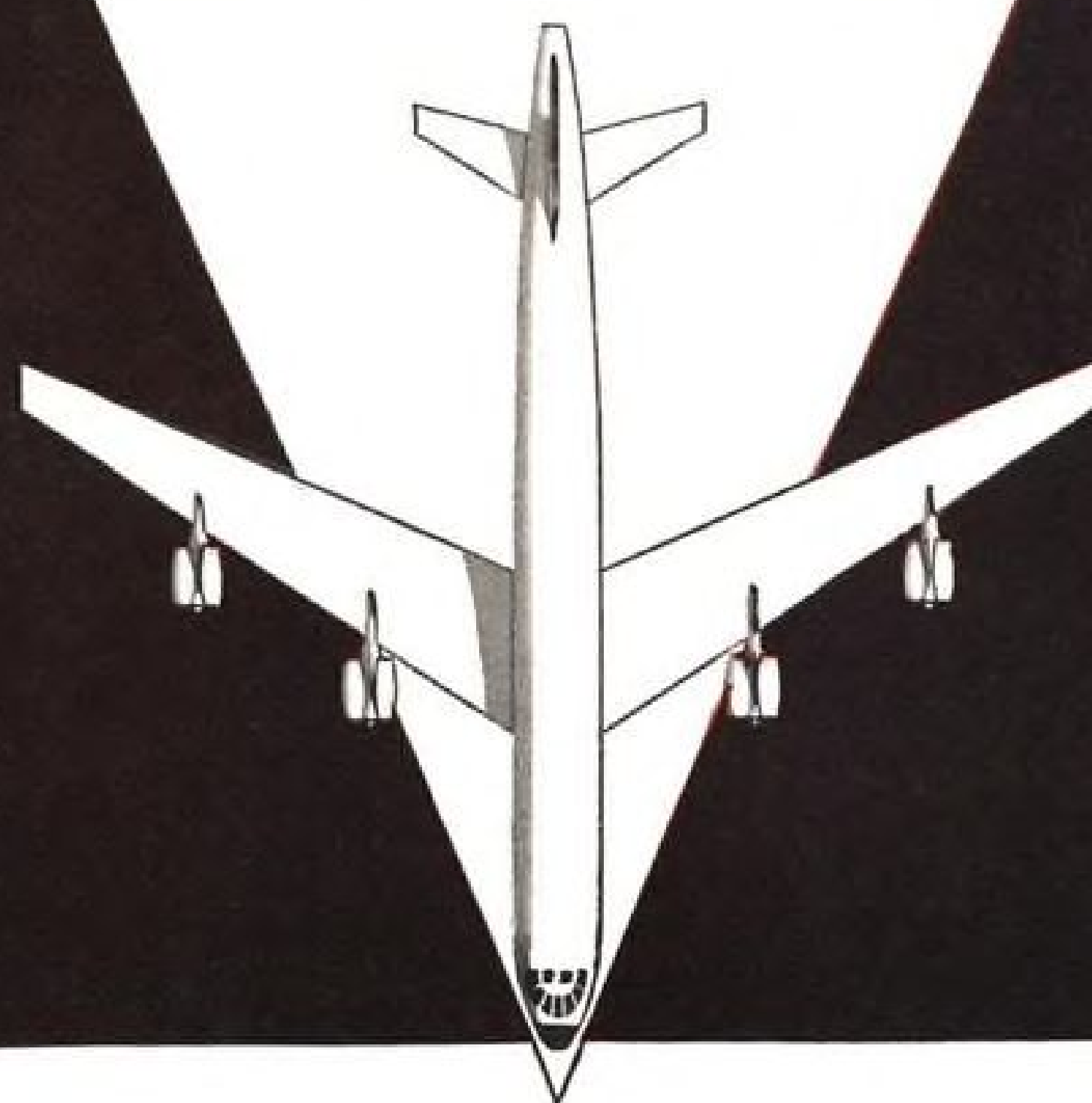
Sinclair

supplies 45% of the aircraft oil used by major scheduled airlines in the U.S.



Sinclair

aircraft oil is also used to lubricate the mighty engines of commercial and military jets



You can depend on

Sinclair



Aircraft Oils

Sinclair Refining Company, Aviation Sales, 600 Fifth Avenue, New York 20, N. Y.

converts 18-24 v.d.c. to 100-145 v. square wave, 320-360 cps. a.c. power. Output and voltage frequency are proportional to input voltage. Rated load of the inverter is 125 volt amp. with a 3 amp. surge. Weight is 3½ lb. and the inverter measures 5 x 5 x 3½ in. Unit meets MIL-E-5400 and MIL-E-5272A. Magnetic Amplifiers, Inc., New York 55, N. Y.

Petroleum Contracts

Washington—Following is a list of unclassified contracts for \$25,000 and over as released by the Military Petroleum Supply Agency:

The American Oil Co., New York, Avgas, 91/96, (IFB 59-108), 10,502,000 gal., \$1,264,000.

The California Oil Co., Perth Amboy, N. J., Avgas, 115/145, (IFB 59-108), 7,350,000 gal., \$1,156,890.

O. F. Collinge Co., Los Angeles, Avgas, 115/145, (IFB 58-108), 8,087,000 gal., \$1,417,420.

Cities Service Oil Co., New York, Avgas, 115/145, (IFB 59-108), 12,247,000 gal., \$12,418,676.

Continental Oil Co., Houston, Tex., Avgas, 115/145, (IFB 59-108), 7,220,000 gal., and Avgas, 100/130, (IFB 59-108), 880,000 gal., \$1,163,251.

D-X Sunray Oil Co., Tulsa, Okla., Avgas, 100/130, (IFB 59-108), 5,464,000 gal., and Avgas, 115/145, (IFB 59-108), 26,112,000 gal., \$4,483,918.

Esso Standard Oil Co., New York, Avgas, 115/145, 66,582,000 gal., Avgas, 100/130, 3,970,000 gal., Avgas, 91/96, 717,000 gal., Avgas, 80/87, 377,000 gal., (IFB 59-108), \$10,825,002.

General Petroleum Corp., Los Angeles, Avgas, 115/145, 4,200,000 gal., Avgas, 100/130, 7,782,000 gal., (IFB 59-108), \$1,941,965.

Gulf Oil Corp., Pittsburgh, Pa., Avgas, 100/130, 25,000 gal., Avgas, 91/96, 604,000 gal., (IFB 59-108), \$95,866.

Humble Oil & Refining Co., Houston, Tex., Avgas, 115/145, 20,250,000 gal., Avgas, 100/130, 3,890,000 gal., Avgas, 80/87, 1,022,000 gal., (IFB 59-108), \$3,749,010.

Magnolia Petroleum Co., Dallas, Tex., Avgas, 115/145, 12,000 gal., Avgas, 100/130, 3,660,000 gal., Avgas, 91/96, 750,000 gal., Avgas, 80/87, 158,000 gal., (IFB 59-108), \$680,986.

Phillips Petroleum Co., Bartlesville, Okla., Avgas, 115/145, 2,850,000 gal., Avgas, 100/130, 3,897,000 gal., Avgas, 91/96, 122,000 gal., Avgas, 80/87, 319,000 gal., (IFB 59-108), \$1,107,193.

Richfield Oil Corp., Los Angeles, Avgas, 115/145, 67,513,000 gal., (IFB 59-108), \$11,438,581.

Shamrock Oil & Gas Corp., Amarillo, Tex., Avgas, 115/145, 4,160,000 gal., Avgas, 100/130, 3,455,000 gal., Avgas, 91/96, 345,000 gal., (IFB 59-108), \$1,201,668.

Shell Oil Co., New York, Avgas, 115/145, 27,541,000 gal., Avgas, 100/130, 10,849,000 gal., Avgas, 91/96, 3,972,000 gal., Avgas, 80/87, 315,000 gal., (IFB 59-108), \$6,933,892.

Sinclair Refining Co., New York, Avgas, 115/145, 31,371,000 gal., (IFB 59-108), \$4,720,392.

Socony Mobil Oil Co., New York, Avgas, 115/145, 735,000 gal., Avgas, 91/96, 1,482,000 gal., (IFB 59-108), \$345,680.

Western Operations, Inc., Standard Oil Company of California, San Francisco, Calif., Avgas, 115/145, 4,060,000 gal., Avgas, 100/130, 2,050,000 gal., Avgas, 91/96, 3,440,000 gal., (IFB 59-108), \$1,693,516.

Standard Oil Co. (Indiana), Chicago, Avgas, 115/145, 2,150,000 gal., Avgas, 100/130, 3,816,000 gal., (IFB 59-108), \$911,157.

Standard Oil Co. (Kentucky), Louisville, Ky., Avgas, 115/145, 780,000 gal., Avgas, 100/130, 2,060,000 gal., Avgas, 91/96, 1,470,000 gal., Avgas, 80/87, 2,740,034 gal., (IFB 59-108), \$1,125,343.

The Standard Oil Co. (Ohio), Cleveland, Ohio, Avgas, 100/130, 3,120,000 gal., Avgas,

without E-W dehumidifiers, the Jupiter would drown in its own sweat!



Jupiter missile developed by the Army Ballistic Missile Agency for operational use by the U. S. Air Force. Photo courtesy U. S. Army.

Vital equipment in this Jupiter missile is protected 24 hours a day, month after month, by a specially designed Ellis and Watts refrigerated-type Dehumidifier. In the various compartments of the Jupiter missile this E-W Unit constantly maintains perfect environment conditions during long periods of standby and storage. Without this specialized Dehumidification Unit, moisture and condensation could cause deterioration of vital equipment and one of our most important weapons would never even get off the ground!

Designing and building specialized dehumidification units for electronic or mechanical gear is our business at Ellis and Watts. Units of any capacity, configuration, control requirements or functions can be designed and built to any applicable military or commercial specifications.

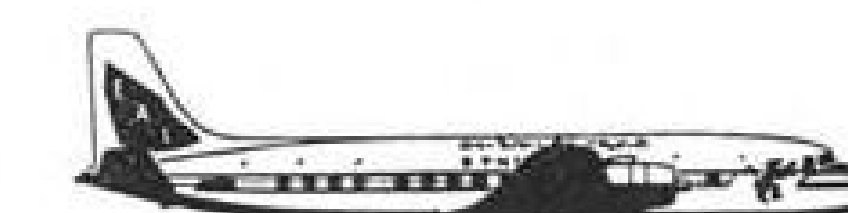
And, Ellis and Watts units will function perfectly in any climate conditions on earth.

For additional information on specialized dehumidification units for electronic or mechanical gear, write for bulletin 135-A.



ELLIS AND WATTS PRODUCTS, INC.
P. O. Box 33-AA Cincinnati 36, Ohio

FLY THE GATEWAY ROUTE TO THE "HEART" OF HISTORIC AFRICA



Fly the route of history via Ethiopian Airlines! See Cairo . . . the Red Sea . . . and Ethiopia, Land of the Queen of Sheba. Africa offers today's greatest business potential, newest travel adventure. Fly overnight in luxurious DC-6B's

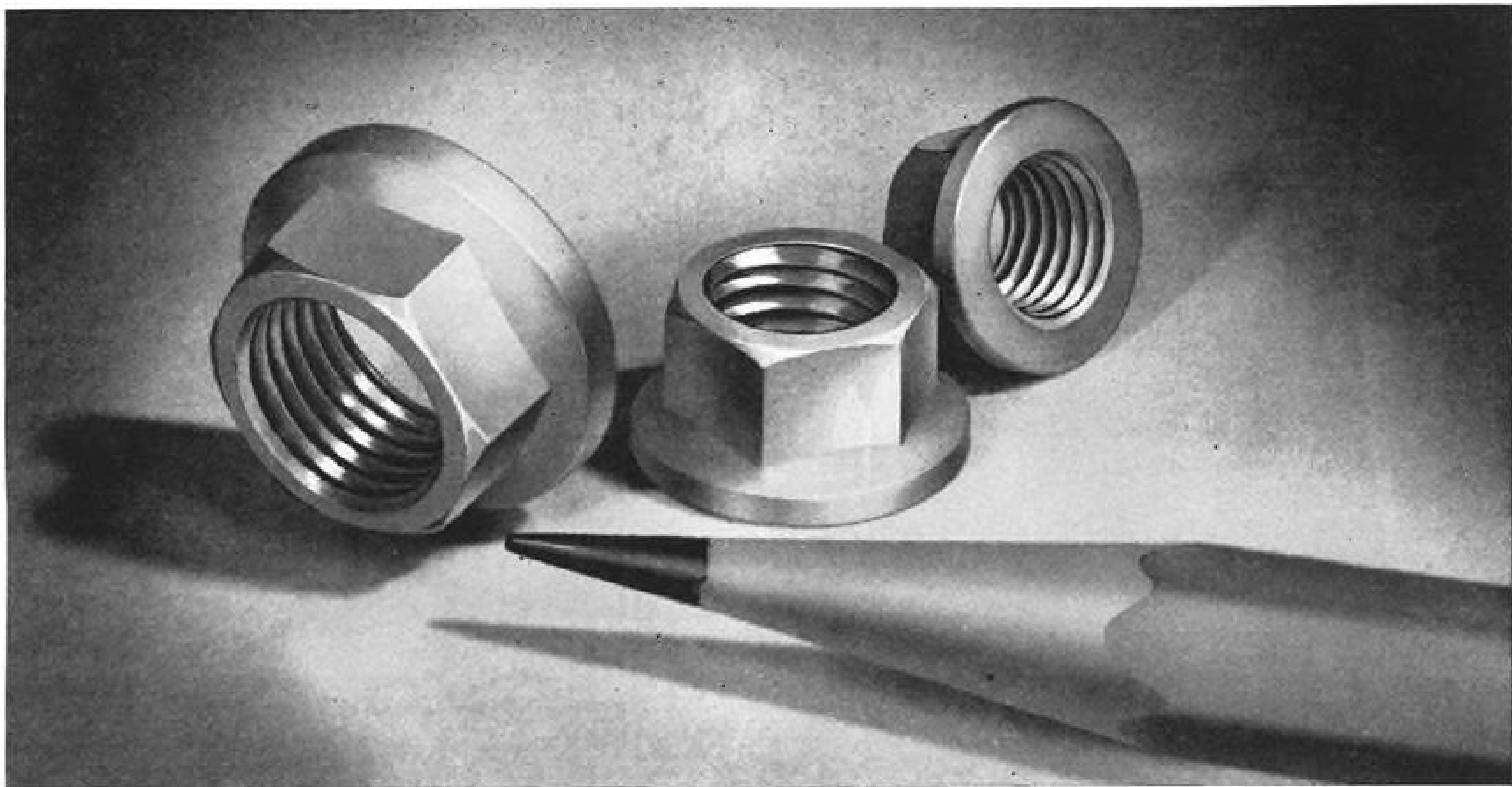
from Frankfurt (now 4 flights weekly) to Greece, Egypt, Sudan, Ethiopia and Kenya. Incomparable service.

Visit one of our 5,000 offices in the United States and Europe—YOUR TRAVEL AGENT.

የኢትዮጵያ አየር መንገድ
ETHIOPIAN AIRLINES
THE WONDERLAND ROUTE

Meets new NAS 1291

SPS FN-12 Featherweight locknut replaces NAS 679 and equivalents*—saves up to 72% in locknut weight



SPS FN-12 Series Featherweight locknut was the first to meet new NAS 1291 calling for a lighter weight replacement for NAS 679 sheet metal nuts. New forged featherweight offers major weight savings, superior performance, high reliability; also permits secondary weight reductions through use of narrower bolting flanges.

Here is one of the few nuts that meet new NAS 1291 standard calling for a lighter weight locknut interchangeable with NAS 679 sheet metal nuts. The new SPS FN-12 weighs 12-60% less than its NAS 679 counterparts . . . and 12-72% less than equivalent MS or AN types. Yet it sacrifices none of the static or dynamic properties of these larger, heavier nuts. It provides 160,000 psi tensile strength on a 180,000 psi bolt and gives greater bolt tension-tension fatigue strength than any other lightweight locknut tested.

The FN-12 saves weight in another way also. Because of its new configuration, it can be installed closer to vertical bulkheads than any other aircraft nut now in use. This allows a narrower bolting flange, with consequent reductions in aircraft weight.

You can specify FN-12 Series Featherweight locknuts in 11 sizes—#4 through 5/8 inch. All sizes are available for immediate delivery. From #4 to 5/16", FN-12 locknut prices are practically the same as NAS 679 locknuts. In the size range including 3/8" and above, prices are considerably lower.

For more information, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium. Request Bulletin 2426.

| ACTUAL WEIGHTS OF FN-12 AND COMPARABLE LOCKNUTS | | | | | |
|---|-------|----------|-------------------------|------------|-------------------------|
| All Weights Expressed as Pounds per 1000 Pieces | | | | | |
| Size | FN-12 | NAS 679† | % Weight Saved by FN-12 | AN Series‡ | % Weight Saved by FN-12 |
| # 4-40 | 0.4 | 0.8-1.0 | 50%-60% | 1.3 | 69% |
| # 6-32 | 0.7 | 1.3-1.7 | 50%-60% | 2.5 | 72% |
| # 8-32 | 1.2 | 2.1-2.5 | 43%-52% | 4.2 | 71% |
| # 10-32 | 1.6 | 2.5-2.8 | 40%-47% | 4.6 | 67% |
| 1/4-28 | 3.5 | 3.9-4.7 | 12%-26% | 8.5 | 59% |
| 5/16-24 | 5.4 | 6.4-7.2 | 16%-25% | 11.8 | 54% |
| 3/8-24 | 7.3 | 9.3 | 21% | 19.5 | 63% |
| 7/16-20 | 14.7 | 16.0 | 8% | 22.6 | 35% |
| 1/2-20 | 21.0 | — | — | 43.5 | 51% |
| 5/8-18 | 24.4 | — | — | 71.5 | 66% |
| 3/4-18 | 33.8 | — | — | 87.3 | 61% |

†Range of four most commonly used sheet metal nuts of NAS 679 type

‡Range for AN 363, 364, 365

*MS 20364, MS 20365; NAS 1021, NAS 1022; AN 363, AN 364, AN 365 and AN Plain Nuts

AIRCRAFT / MISSILE Division **SPS**

JENKINTOWN 3, PENNSYLVANIA • SPS WESTERN, SANTA ANA, CALIF.

91/96, 450,000 gal., Avgas, 80/87, 40,000 gal., (IFB 59-108), \$586,998.
Tidewater Oil Co., Los Angeles, Calif., Avgas, 115/145, 15,330,000 gal., Avgas, 100/130, 5,635,000, (IFB 59-108), \$3,575,738.
Utah Oil Refining Co., Salt Lake City, Utah, Avgas, 115/145, 1,620,000 gal., Avgas, 100/130, 3,260,000 gal., Avgas, 91/96, 10,000 gal., (IFB 59-108), \$853,869.
Asiatic Petroleum Corp., New York, Avgas, 115/145, 10,500,000 gal., (IFB 59-108), \$1,569,750.
Eastern States Petroleum & Chemical Corp., Houston, Tex., Avgas, 115/145, 44, 100,000 gal., (IFB 59-108), \$6,392,736.
Republic Oil Refining Co., Division of Plymouth Oil Co., Pittsburgh, Pa., Avgas, 115/145, 18,900,000 gal., (IFB 59-108), \$2,829,330.
Sky Harbor Air Service, Cheyenne, Wyo., Avgas, 115/145, 70,000 gal., Avgas, 100/130, 335,000 gal., Jet fuel 4, 200,000 gal., Lube oil 1100, 7,000 gal., Lube oil 1010, 20 gal., (IFB 59-117), \$129,121.
Standard Oil Co. (Kentucky), Louisville, Ky., Avgas, 100/130, 30,000 gal., Avgas, 91/96, 90,000 gal., Lube oil 1100, 300 gal., (IFB 59-117), \$28,458.
Shell Oil Co., New York, Avgas, 115/145, 1,165,000 gal., Avgas, 100/130, 2,975,000 gal., Avgas, 91/96, 446,000 gal., Avgas, 80/87, 5,000 gal., Jet fuel 4, 400,000 gal., Lube oil 1010, 15 gal., Lube oil 1100, 55,000 gal., (IFB 59-117), \$1,117,388.
Esso Standard Oil Co., New York, Avgas, 115/145, 80,000 gal., Avgas, 100/130, 530,000 gal., Avgas, 91/96, 50,000 gal., Avgas, 80/87, 1,000 gal., Jet fuel 4, 36,000,000 gal., (IFB 59-117), \$671,302.
The Texas Co., New York, Avgas, 115/145, 60,000 gal., Avgas, 100/130, 380,000 gal., Jet fuel 4, 1,800,000 gal., Lube oil 1100, 2,600 gal., Lube oil 1010, 20 gal., (IFB 59-117), \$350,095.

Navy Contracts

Following is a list of unclassified contracts for \$25,000 and over as released by U. S. Navy contracting offices:

DEPARTMENT OF THE NAVY, BUREAU OF AERONAUTICS, Washington 25, D. C.

Chance Vought Aircraft Co., Dallas, Tex., research and development of integrated flight capsule design for F8U-1 aircraft, NOas 59-6150-c(AE-52-4744-59), \$1,055,701.

Texas Instruments, Inc., Dallas, Tex., AN/APS-80 radar sets and components, in accordance with Spec. MIL-R-21113(Aer) with exceptions thereto dated Oct. 15, 1958, letter contract NOas 59-0282(PD-31-1827-59 and Revision A thereto), \$9,373,728.

Goodyear Aircraft Corp., Akron, Ohio, conduct a study of terrain radar return, NOas 59-6186-c(PH-40-3401-59), \$136,836.

Canoga Division, Underwood Corp., Van Nuys, Calif., fabricate and furnish six automatic frequency control (AFC) modification kits for AN/MPS-26 radar set, NOas 59-6149-c(AV-31-2893-59), \$80,683.

Research Division, Aeronca Manufacturing Corp., Baltimore, Md., 10 automatic data loggers for missile tactical telemetry, NOas 59-4186-f(AV-31-2927-59), \$26,869.

Arinc Research Corp., Washington, D. C., a study to determine the capabilities, projected military and commercial requirements, and industrial capabilities for complex electronic circuit packages and severe environment receiving tubes, NOas 59-4180-c(IP-43-4402-59), \$79,922.

Pan American World Airways, Inc., New York, services and materials necessary for the orderly transition from government to contractor operation of the furnishing of en route aircraft support for government designated transient transport aircraft, NOas 59-4239-c(SE-30-3896-59), \$73,000.

Aircraft Radio Corp., Boonton, N. J., 301 AN/ARC-39 transceiver equipment, each consisting of one RT-427/ARC-39, receiver; MT-605A/APR-9 mounting; C-2241/ARC-39 control furnished in accordance with specification MIL-R-19506(Aer), NOas 59-0246-1(PD-31-1709-59), \$687,597.

New Jersey Division, Kelsey Hayes Co., Clark, N. J., materials and services necessary to disconnect, prepare for shipment, re-

CHEMELEC

COPPER CLAD TEFLON[†]

Unequaled for printed circuits, cable strips

You can't go wrong with Chemelec Copper Clad TEFLON for printed circuits and cable strips. Here's why: TEFLON's dielectric constant is exceptionally low and uniform, water absorption is zero, no delamination is possible. TEFLON is chemically inert and unaffected by 500° F solder. Its bond strength is greater than 7 lbs/in. Copper Clad TEFLON Sheet (upper right) is available 18" wide, 36" long, and in TEFLON thickness to 3/16" with 1 or 2 oz. copper on both sides. Copper Clad Tape (upper left) comes 12" wide, 36" or 150" long, up to .060" thick, with 1, 2, or 3 oz. copper on one or both sides. Heavier copper is available on request.



*Registered Trademark
†DuPont Trademark

TEFLON Spaghetti Tubing now comes in three grades

Realize tremendous cost savings with TEFLON Spaghetti. Eliminate purchase of excess weight tubing by specifying exactly what you want from a choice of three grades and ten colors. In all sizes, Chemelec Spaghetti Tubing retains the superb features of TEFLON; in addition, it is flexible and free from leaks due to cracks or perforations. Available grades include *thin wall* (wire gauge from 30 to 0, wall thickness from .009 to .015), *standard wall* (wire gauge from 24 to 0, wall thickness from .012 to .020), *heavy wall* (wire gauge from 22 to 5, wall thickness from .016 to .032). Standard RMA colors.

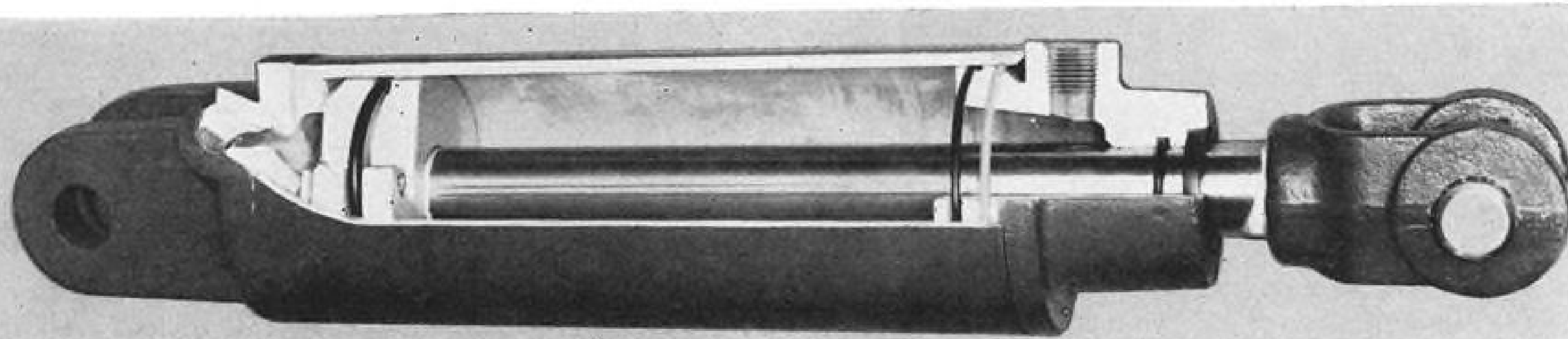
For further information, write for Catalog EC-358.
FLUOROCARBON PRODUCTS, INC.,
division of United States Gasket Co., Camden 1, New Jersey.

Fluorocarbon Products Inc.

There's a HOLE lot of sense in this use of mechanical tubing

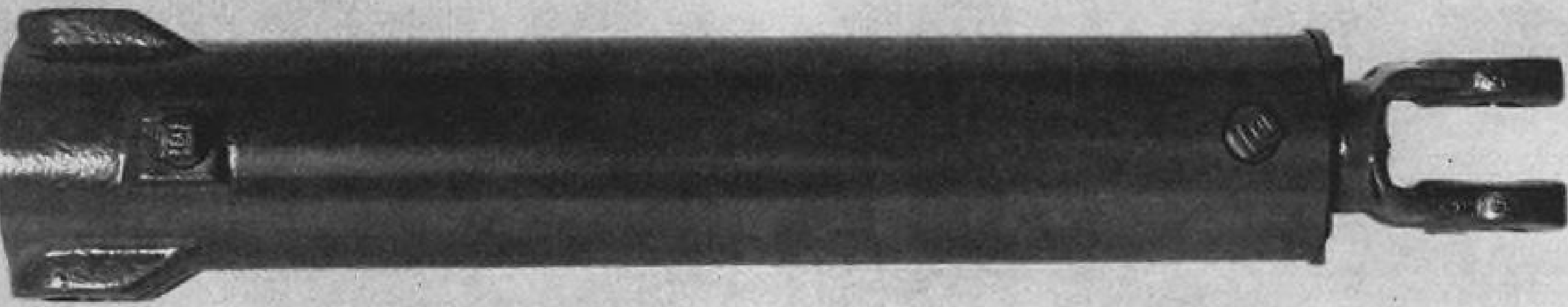
What we're talking about is USS Shelby Seamless Mechanical Tubing. Here's how Industrial Hydraulics Division, Cessna Aircraft Company uses it to boost life, simplify manufacture and lower costs in the hydraulic cylinders they supply to agricultural equipment builders. We quote from their letter to us:

"The cut-away cylinder is a unit we furnish to one of our many customers. This is a 3½" diameter, double-action cylinder used for mounting on pull-behind tools



such as plows, cultivators, and disc harrows. This cylinder uses your Shelby Seamless Mechanical Tubing with the I.D. bored to size and roller burnished to a finish of approximately six to eight RMS. The expected life of this cylinder is in excess of 300,000 cycles, operating at 1,500 psi hydraulic pressure.

"The other cylinder is furnished to another one of our customers, and is a 3¼" I.D. double-action cylinder with a 13" stroke. Used to raise and lower the platform of their self-propelled combine, it is similar to the cut-away cylinder



with respect to finish requirements and material for the barrel. The operating pressure is approximately the same and so is the expected service life of five years, or 300,000 cycles. Generally these cylinders may be serviced for additional use by merely replacing the seals.

"The severe field conditions these cylinders are subjected to are some of the most extreme to which cylinders could be exposed."

In critical mechanical applications like these, and in an almost endless number of fabrications that are essentially tubular in character, Shelby Seamless will ensure improved performance, finer appearance and economical production.

For Shelby Seamless offers more than just a pre-bored hole. It not only combines to an exceptional degree the qualities of strength, uniformity and dimensional accuracy but, in addition, is readily workable and has excellent machining properties. If you want to find out how it can be most effectively applied to your designs, contact your nearby Shelby Distributor.

And remember—USS Shelby Tubing is made by the world's largest and most experienced manufacturer of tubular products.

USS and Shelby are registered trademarks

National Tube
Division of



United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division • United States Steel Export Company, New York

move and load on rail cars or over-the-road trailers, machine tools and equipment, NOas 59-0024-c(IP-33-4411-59), \$120,000.

Columbus Division, North American Aviation, Inc., Columbus, Ohio, 90 airplanes, model T2J-1 in accordance with detail specification SD-524-1-1(s), letter contract NOas 59-0163(PG-22-1277-59), \$19,350,000.

The Transport Company of Texas, Corpus Christi, Tex., services and materials necessary to furnish logistic support to government installations on Kwajalein Island, NOas 59-4176-c(SE-31-3889-59), \$25,000.

AVIATION SUPPLY OFFICE, 700 Robins Avenue, Philadelphia 11, Pa.

Lear, Inc., Grand Rapids, Mich., synchronizers, for automatic directional indicators on HSS-1-1N aircraft, N383-59908A (383/216697/59), 92 ea., \$32,148.

Phaikins, Inc., New York, sustenance kits, container, back pad, parachute harness, N383(MIS)60206A(IFB-383-830-59), 2,000 ea., \$33,440.

Sancor Corp., El Segundo, Calif., parts kits, to support aviation jacks, ground servicing equipment, N383-59769A(383/261278/59), \$37,717.

AIResearch Manufacturing Corp. of Arizona Division, the Garrett Corp., Phoenix, Ariz., starters, air turbine to support F11F aircraft, N383-59937A(IFB-383-674-59), 59 ea., \$110,701.

Sperry Rand Corp., action through Sperry Gyroscope Co. Division, Great Neck, N. Y., amplifier and generator assemblies, to support engine analyzers, N383-59862A(383/232830/59), \$55,430.

Bendix Filter Division, Bendix Aviation Corp., Royal Oak, Mich., filter element assemblies, to support fuel systems on F4D-1 aircraft, N383-59928A(383/214485/59), 6,070 ea., \$17,385.

Hazard Wire Rope Division, American Chain & Cable Co., Inc., Wilkes Barre, Pa., bridles, for launching F4D-1 aircraft, N383-59721A(383-263161/59), 900 ea., \$59,238.

Piqua Engineering, Inc., Piqua, Ohio, grip assemblies, to support FJ4 aircraft, N383-59899A(383/234928/59), 212 ea., \$35,913.

Henry Spen & Co., Inc., Brooklyn, N. Y., valve and hose assemblies, to support regulators on oxygen and nitrogen trailers, N383-59754A(383/261248/59), \$65,288.

Raymond Engineering Laboratory, Inc., Middletown, Conn., clutches, to support radar equipment, N383-59520A(383/233425/59), 72 ea., \$44,148.

Leland Airborne Products Division, American Machine & Foundry Co., Vandalia, Ohio, inverters, to support electrical systems in T2V-1, F11F-1 aircraft, N383-59890A(383/234711/59), 47 ea., \$29,295.

Aeronautical Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., amplifiers, liquid oxygen for various aircraft, N383-59909A(383/216660/59), 190 ea., \$36,100.

AC Spark Plug Division, General Motors Corp., Milwaukee, Wis., levers and springs, to support turbosupercharger regulators for AD-7 aircraft, N383-58908A(383/213114/59), \$35,777.

Model Engineering & Manufacturing, Inc., Huntington, Ind., signal generators, to support various aircraft and missiles, N383(MIS)-59540A(MIPR 33-604-9-17C-0123), 204 ea., \$153,000.

General Electric Co., Philadelphia, Pa., relays, 3 amp, 4 pole double throw, sealed, panel mounting, N383-59537A(IFB-383-606-59), 9,330 ea., \$40,864.

M. Steinthal & Co., Inc., New York, parachute assemblies, personnel, chest type, N383-59787A(IFB-383-725-59), \$311,977.

Friden, Inc., San Leandro, Calif., driftmeters, electrically driven gyro stabilized, for WV-2 and -3 aircraft, N383(17-383)-59416A(PREN 11-2361/59-383/216369-59), 127 ea., \$362,585.

Grimes Manufacturing Co., Urbana, Ohio, anti-collision beacons, to support various aircraft, N383-60053A(383/235004/59), 699 ea., \$54,340.

Rubber Fabricators, Inc., Grantsville, W. Va., life preservers, yoke CO₂ inflatable with pouch, N383(219)-59761A(219/7001/59), 5,400 ea., \$118,683.

The Goodyear Tire and Rubber Co., Akron, Ohio, brake linings, to support brake assemblies on various aircraft, N383-59834A(383/211426/59), 58,272 ea., \$58,563.

Engineering and management
opportunities in

RCA SYSTEMS SUPPORT PROJECTS

RCA offers expanding opportunities in Weapon Systems Support projects. This work involves program planning, advanced operations analysis, systems analysis, equipment development and design, and systems integration. Experience is desired in the many areas of systems support—checkout and test equipment, logistics, and training.

Exceptionally fine professional and management positions are available to EE's, ME's Mathematicians, and Physicists with at least five years of experience.

Salaries are excellent; opportunities for advancement, unlimited. Benefits are among the best in the industry.

Several current Systems Support Project areas are:

- Aircraft electronic systems
- Military and civil digital communications systems
- Missile systems
- Space vehicles and space stations

FOR INTERVIEW WITH ENGINEERING MANAGEMENT:

Please send complete resume to:

Mr. C. B. Gordon
RCA, Box Z-13H
Professional Employment
Building 10-1
Camden 2, N. J.



RADIO CORPORATION OF AMERICA
Defense Electronic Products



EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED

The advertising rate is \$45.00 per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.

An Advertising inch is measured 3/4" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

Send NEW ADS to Classified Advertising Div. of AVIATION WEEK, P. O. Box 12, N. Y. 36, N. Y.

RATES

\$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Position Wanted Ads are 3/4 of above rate.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

UNDISPLAYED

the specialty: ELECTRONICS
the field: HELICOPTERS
the openings: AVIONICS INSTRUCTORS
FIELD SERVICE REPRESENTATIVES

World's foremost designer and builder of helicopters now has openings for two types of specialists in the field of electronics.

AVIONICS INSTRUCTOR—Good opportunity for advancement available to men with a minimum of four years' experience in electronics and aircraft maintenance. Teaching background or a sincere desire to teach is essential.

Positions entail instruction of commercial and military customers in helicopter stabilization systems, Doppler radar, servo-mechanisms and electrical systems. Of paramount importance is a thorough understanding of flight controls, hydraulics, mechanics and electronics.

Occasional travel is required of men in these positions.

ELECTRONIC FIELD SERVICE REPRESENTATIVES—Unusually interesting work here for men with advanced electronics training and experience.

Though not essential, previous helicopter experience is desirable.

Assignments require the ability to check circuitry and effect repairs, along with the further ability to make suggestions which can lead to design improvements. Work involves use of all types of electronic test equipment.

If you feel you qualify fully for either type of position outlined above, please send your resume to Mr. James L. Purfield.

SIKORSKY AIRCRAFT

One of the Divisions of United Aircraft Corporation

Stratford, Connecticut

EXECUTIVE PILOT FOR TWIN BEECH AIRCRAFT

Minimum flying time 7000 hours, with substantial multi-engine, instrument time and ATR. Age range 32-40 years. Ex-service Pilots with VIP flying experience considered. Congenial people, good salary and benefits including free insurance and paid vacations. Write for interview, giving experience resume, to Director of Personnel.

The Mason and Dixon Lines, Inc.
P. O. Box 231, Kingsport, Tennessee

AIRLINE REGIONAL SALES EXECUTIVES AIRLINE DISTRICT SALES EXECUTIVES

A leading international airline is expanding its sales force and require a Sales Manager of outstanding creative ability, as well as a number of area Sales Managers, all of proven success in airline sales work and capable of assuming duties without a formal training period. Thorough knowledge of both English and Spanish is essential.

The Sales Manager will be given the opportunity of increasing sales now amounting to some twenty million dollars annually. Sales Manager candidates will be considered for area jobs if not selected as suitable for the major one.

Salary open to discussion. Replies held strictly confidential. Send resume with background to

P-2303, Aviation Week

Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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; 530 N. Michigan Ave.
SAN FRANCISCO 4; 68 Post St.

POSITIONS VACANT

Wanted Captain DC-4 aircraft, ATR-Instructors—Check Pilot Ratings & Experience Temporary or Permanent Contract. Send full details, resume and experience and salary required, to: Trans Mediterranean Airways, P. O. B. 3018, Beirut, Lebanon. Att: Mr. C. V. Richmond.

Flight Instructors; Age 26-38 with commercial, instructor and instrument ratings. Minimum 2000 hours or military rating. Air Force contract school, many fringe benefits. Personnel Manager, Anderson Air Activities, Malden Air Base, Missouri.

POSITIONS WANTED

ATR Pilot Age 37—10,000 hrs. Recently completed scheduled international contract. DC-3 DC-4 C-46 Desires flying position. PW-2164, Aviation Week.

ATR Pilot, age 39—11,500 hours, no accidents, domestic and international airline experience. Experienced in light planes, DC-3, C-46, and DC-4. College background, also, Flight Instructor and A&E certificates. Desires permanent flying position. PW-2192 Aviation Week.

ATR Pilot age 30, 3800 hrs. no accidents. Domestic and international airline experience. Experienced in Lt. planes DC-3, DC-4, M-404, & Constellations. College background. Desires permanent flying position. PW-2229, Aviation Week.

Need jet experience? Ex- B-47 instructor 1600 hrs. B-47, 11000 total. ATR (DG-4), SMEL, CFL. Prefer jet pilot or instructor. Consider any interesting job. PW-2236, Aviation Week.

Pilot with 7 years of experience in Multiple Engine Jet Operator. 1000 hours jet front seat time including electronic test. Desires employment consistent with experience. Resume on request. Available 30 November 1959. PW-2288, Aviation Week.

British Test Pilot, 22 years in the industry. wishes to represent American company, not necessarily aviation, U. K. or abroad, anything considered. PW-2293, Aviation Week.

OFFICE SPACE TO RENT

Office Space—East Hartford, Conn., Opposite Pratt & Whitney. Ideal location for United Aircraft Suppliers. Alex Z. Perlstein, 252 Asylum Street, Hartford, Conn.

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.

WE'RE LOOKING
FOR A MAN
LIKE Archimedes



$$W_f = W_e - II_f V$$

—WITH A MODERN TURN OF MIND

Archimedes went underwater to find an answer.

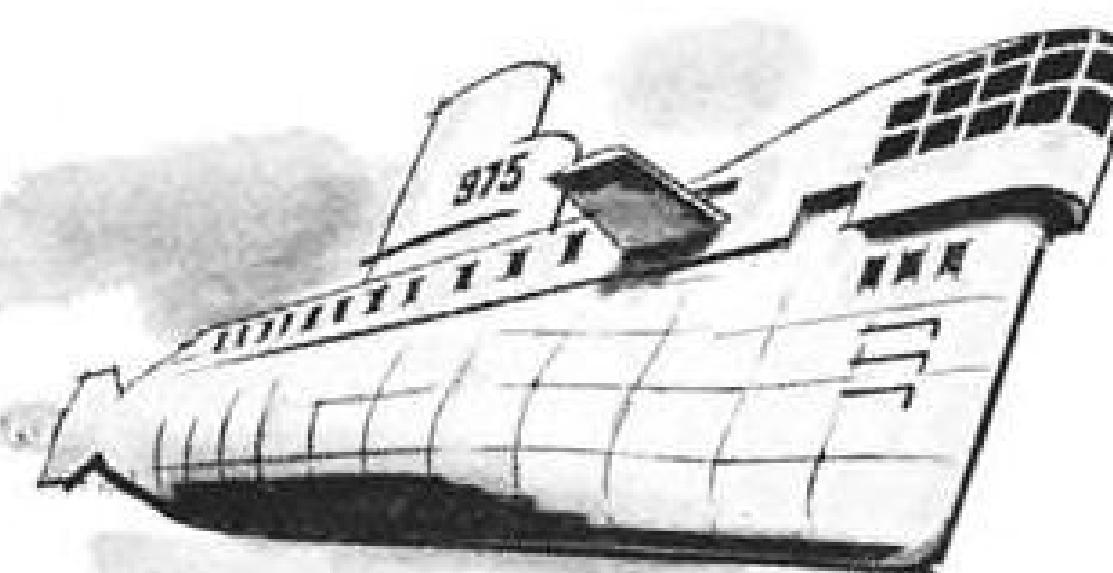
The resultant shout of "Eureka!" signaled standout scientific progress.

At Goodyear Aircraft we have SUBROC, the underwater antisubmarine missile program,* for modern-day application of such talents.

If you're of the turn of mind to launch a future of real substance—

We invite you to join us. *The water's fine!*

Write: Mr. Charles Jones, Director of Technical & Scientific Personnel, Goodyear Aircraft Corporation, Akron 15, Ohio.



*Also programs in rocket propulsion, interplanetary guidance, ground support systems for missiles, nose cones, radar structures, advanced black boxes and structures engineering, outer space escape capsules.

GOODYEAR AIRCRAFT

What is your problem?

Competent men for your staff? . . . employment? . . . or are you looking for—or offering—a business opportunity of special interest to readers of this publication? You can get their attention—at small cost—through an advertisement in the Employment Section of AVIATION WEEK.

OPEN POSITIONS IN SYSTEMS RESEARCH

Continuing expansion of our research programs, particularly in systems research, has created a need for additional members of our staff. Unusually interesting immediate and long-range assignments await those whose backgrounds and interests match our needs.

TYPE OF WORK

Space Systems Research • Surveillance Systems Research
Weapons Systems Research • Transportation Systems Research
Air Traffic Control Systems Research

Plus independent, advanced studies in electronics, aerodynamics, propulsion, and computer logic in support of systems research programs. Customers include Department of Defense, FAA, NASA and industry.

PROFESSIONAL NEEDS: The following list of current openings is not exclusive. The Laboratory is always pleased to investigate employment possibilities with scientists and engineers of ability and imagination.

SENIOR ENGINEERS AND SCIENTISTS

with experience in large systems design and analysis. Physics, E.E. or A.E. background as project leaders for systems design.

QUALIFIED PHYSICISTS AND E.E.'s

for work on radar, communications, navigation data processing, control systems.

QUALIFIED A.E.'s AND M.E.'s

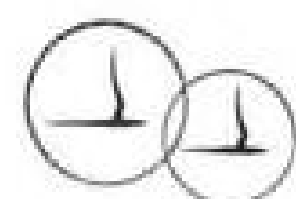
for missile design, applied aerodynamics, air transportation research.

THE ORGANIZATION

Cornell Aeronautical Laboratory is a not-for-profit corporation wholly owned by Cornell University. It is financially self-supporting and operated for the sole purpose of advancing and enlarging scientific and engineering knowledge. Current research volume is about 14 million dollars per year with slightly more than 1000 employees.

DESIRABLE EMPLOYMENT FEATURES

VARIETY—the more than 400 engineers and scientists at CAL are working in 13 technical departments on about 150 different projects, large and small. **INDIVIDUAL RECOGNITION**—the high ratio of contracts per engineer coupled with the Laboratory's practice of using small research teams, allows the recognition of every man's individual contribution. To guarantee this recognition, each man's progress is reviewed every 6 months. **SALARY**—CAL recognizes its need for above-average professionals, and appreciates that such individuals must be compensated accordingly, consequently it has established liberal salary scales which invite comparison not only with other research laboratories, but also with the entire aircraft industry. **LOCATION**—fine suburban area.



CORNELL AERONAUTICAL LABORATORY, INC.
OF CORNELL UNIVERSITY

J. V. Rentschler

CORNELL AERONAUTICAL LABORATORY, INC.
Buffalo 21, New York

Please send me a copy of "A Community of Science."

Name _____

Street _____

City _____

Zone _____

State _____

FOOD SERVICE MANAGER

Attractive opening in Miami, Florida, for food service specialist, combining complete knowledge of food service field with proven managerial ability to administer staff of some 350 persons.

Background in hotels, restaurants, airlines, considered equally. Replies held in confidence. Address resume, stating minimum salary acceptable, with detail of background experience, to

P-2304, Aviation Week
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

FOR ADDITIONAL INFORMATION

About Classified
Advertising,

Contact
The McGraw-Hill
Office Nearest You.

ATLANTA, 3
1301 Rhodes-Haverty Bldg.
JACKSON 3-6951

R. POWELL

BOSTON, 16—350 Park Square
HUBBARD 2-7160
D. J. CASSIDY

CHICAGO, 11
520 No. Michigan Ave.
MOHAWK 4-5800
W. HIGGINS—E. S. MOORE

CLEVELAND, 13
1164 Illuminating Bldg.
SUPERIOR 1-7000
W. B. SULLIVAN—T. H. HUNTER

DALLAS, 2—1712 Commerce St.,
Vaughan Bldg.
RIVERSIDE 7-5117
GORDON JONES—F. E. HOLLAND

DETROIT, 26—856 Penobscot Bldg.
WOODWARD 2-1793
J. R. PIERCE

LOS ANGELES, 17—1125 W. 6th St.
HUNTLEY 2-5450
P. M. BUTTS

NEW YORK, 36—500 Fifth Ave.
OXFORD 5-5959
H. T. BUCHANAN—R. P. LAWLESS
T. W. BENDER

PHILADELPHIA, 3
Six Penn Center Plaza
LOCUST 8-4330
H. W. BOZARTH—T. W. McCLURE

ST. LOUIS, 8—3615 Olive St.
JEFFERSON 5-4867

SAN FRANCISCO, 4—68 Post St.
DOUGLAS 2-4600
S. HUBBARD

ENGINEERS • SCIENTISTS

THE
MITRE
CORPORATION

Invites You to Investigate the PROFESSIONAL OPPORTUNITIES AVAILABLE in Integrated System Engineering

MITRE, a research and development organization, is responsible for providing engineering solutions to the problems involved in integrating the many varied Air Defense systems. Formed under the sponsorship of the Massachusetts Institute of Technology, this independent non-profit corporation has undertaken a long-range work program which requires a spectrum of skills in engineering and the physical sciences.

These skills are utilized in the design, development and evaluation of the diverse components, equipments and subsystems from which evolve total systems. These subsystems consist of detection systems, communications, data links, computers, data processing systems, and defensive weapons. This continuing system engineering function takes cognizance of the immediate and long-term threat, the total defense technology—both present and projected—and the complex logistics of air defense with a programmed methodology that insures the best possible defense system, at minimum cost, for any given time period.

Technical Staff appointments are currently being made in the following areas:

- | | |
|--------------------------------------|--------------------------------|
| • SYSTEM DESIGN | • WEAPONS SYSTEM INTEGRATION |
| • COMPONENT RESEARCH and DEVELOPMENT | • HUMAN ENGINEERING |
| • REAL-TIME COMPUTER CONTROL SYSTEMS | • COMMUNICATIONS SYSTEMS |
| • DETECTION TECHNIQUES | • ELECTRONIC WARFARE |
| • OPERATIONS ANALYSIS | • INTEGRATED SYSTEM EVALUATION |

The above openings are available at all three MITRE locations
—suburban Boston, Massachusetts—Fort Walton Beach, Florida
—and Montgomery, Alabama

To arrange an immediate confidential interview, send resume to
Dana N. Burdette, Personnel Director

THE MITRE CORPORATION

244 WOOD STREET—LEXINGTON 73, MASSACHUSETTS

A brochure more fully describing MITRE and its activities is available on request.

Computer Applications

SENIOR STAFF SPECIALIST

HONEYWELL'S Aeronautical Division
invites qualified candidates to consider
this Senior staff appointment

POSITION Senior Staff Specialist for computer applications. Will operate independently with minimum guidance, must plan own activities and will be responsible for constructive relevant and technically sound recommendations. Opportunity to pursue appropriate advanced technical ideas.

RESPONSIBILITIES Recommendations regarding new techniques and technical trends, participation in concept and design reviews, liaison with military customers, other companies, and other divisions and departments within Honeywell. General top level technical consultation, program recommendations, evaluation of technical support requirements. Seminars in advanced problems of computer application.

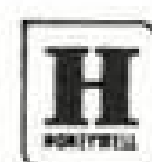
REQUIREMENTS Strong background in analog and digital computer design through fire control, bombing, navigation and/or data processing system development. First hand computer circuit and control system design experience. Technical project direction with emphasis on system engineering

If interested in this staff opportunity, write
J. R. Rogers, Chief Engineer, Preliminary Development Staff

Honeywell

AERONAUTICAL
DIVISION

Dept. M-6, 2600 Ridgeway Road,
Minneapolis, Minn.



MANAGER FLIGHT LABORATORY

A leading airborne electronic equipment manufacturer is looking for an experienced man to manage its East Coast flight laboratory.

To qualify, you should have at least three years of management background and extensive experience in at least two of the following areas:

Aircraft Operations
Flight casting A/C Equipment
Development and Testing of Electronic Equipment

Experience as a pilot is desirable but not essential.

In this position, you will plan and direct the operation of the flight laboratory, and be responsible for aircraft operations, maintenance, modification, and flight test engineering.

For further information and to arrange personal interview, send resume to Box

P-2266, Aviation Week
Class. Adv. Div., P. O. Box 12, N. Y. 36, N. Y.

SALES ENGINEERS

Excellent opportunities for Sales Engineers with experience in propulsion, missile, or space systems and components.

Openings exist in South Bend, Ind. for men of proven capability with sales experience and technical background in the mechanical, electrical, and/or electronic fields. Assignments require knowledge of current propulsion, airframe and missile/space programs and will involve contacting industry and missile agencies.

Send complete resume to:

J. P. Makielski
Administrative Engineer
BENDIX PRODUCTS DIVISION
BENDIX AVIATION CORP.
SOUTH BEND, INDIANA

SALES ENGINEER WANTED

For Fort Worth, Texas

Prefer Electrical Engineer with electronic background, between ages of 26 and 30, to do application and sales work on aircraft electronic components. Excellent opportunity for right man.

Write Mr. H. E. Beane, Vice President

THE BRISTOL COMPANY
Waterbury, Connecticut

ADVERTISING MANAGER

One of the country's best-known firms is seeking a veteran advertising manager, who combines creativity and sound judgment, for administration of a division advertising program slanted at Latin America.

Thorough knowledge of both English and Spanish is essential. Industry horizons are unlimited and base location is unsurpassed.

Replies held strictly confidential. Send resume of experience, background, and statement of minimum acceptable salary to

P-2302, Aviation Week
Class. Adv. Div., P. O. Box 12, N. Y. 36, N. Y.

IN ALL INTERESTS OF AVIATION
If You're important, you either read

AVIATION WEEK
or you advertise in it, or both

Experienced PRELIMINARY DESIGN ENGINEERS

If you have a B.S. or M.S. degree in engineering or physics, plus broad experience in the aircraft/missile field, Boeing can offer you an unusually rewarding long-range career. Assignments are with Boeing's Product Research Office, which evaluates and analyzes both aircraft and missile systems for the purpose of identifying prospective new product areas for the company.

These assignments are extremely interesting, and offer you the scope and opportunity you need to realize your career potential to the fullest possible degree.

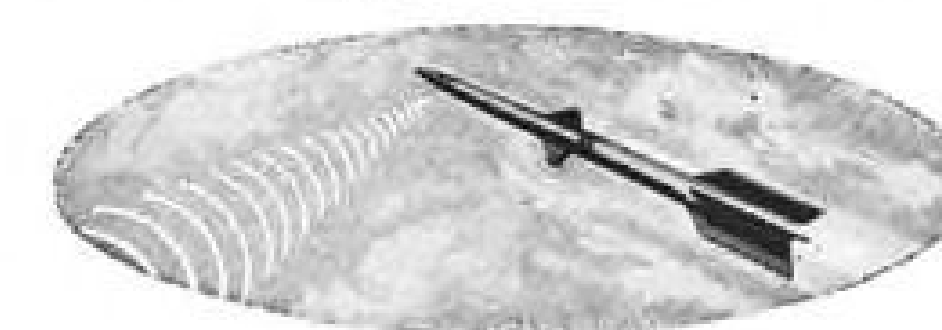
Send your resume, today, to:

Mr. B. F. Ruffner
Director of Product Research
Boeing Airplane Company
P. O. Box 3822 - AVJ
Seattle 24, Washington

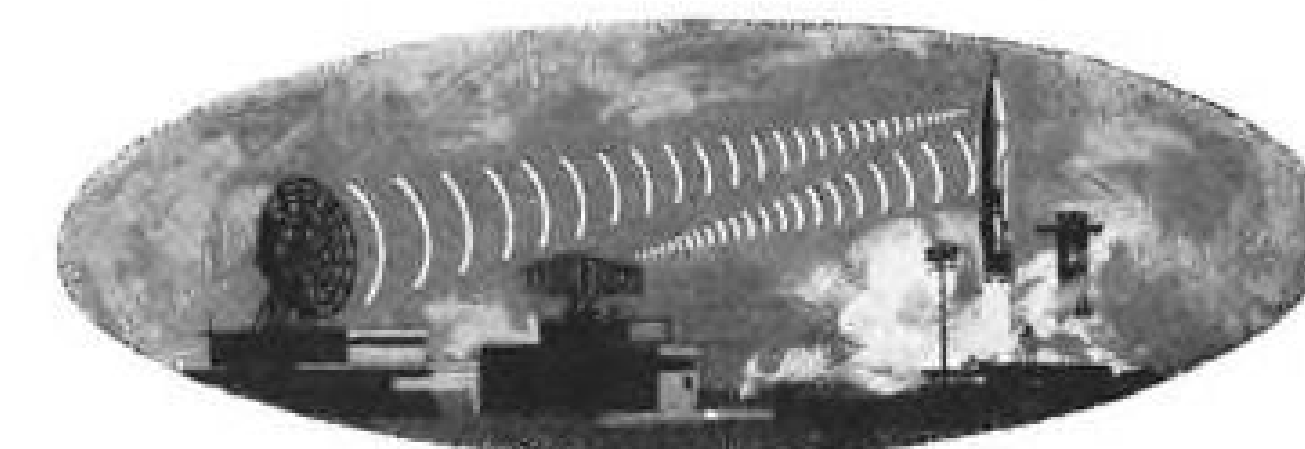


BOEING
...environment for
dynamic career growth

Interested in Systems Engineering?



There are systems



...and systems

...and **TOTAL** systems
in which the big bird and support
equipment may rank only
as a component.

This difference between systems can make
a big difference in your career

IF YOU ARE QUALIFIED and interested in contributing to programs of "total" scope, it will be of value to you to investigate current opportunities with General Electric's DEFENSE SYSTEMS DEPT., whose work lies primarily in providing *total* solutions to large scale defense problems of the next 5, 10 and 20 years.

The work here lies almost entirely in the areas of systems engineering and systems management.

Inquire about these positions:

| | |
|-------------------------------|-----------------------------------|
| Guidance Equation Engineers | Systems Test Evaluation Engineers |
| Systems Logistics Engineers | Engineering Psychologists |
| Electronic Systems | Radar Equipment Engineers |
| Management Engineers | Weapons Analysis Engineers |
| Operations Analysis Engineers | Weapons Systems Integration |
| Systems Program Engineers | Engineers |
| Data Processing Engineers | Engineering Writers |

Forward your confidential resume at an early date.

Whereas the growth potential is evident — both for DSD and the engineers who join us — the positions we fill during these early months will carry significant "ground-floor" benefits.

Write fully to Mr. E. A. Smith, Room 8-B.



DSD DEFENSE SYSTEMS DEPARTMENT

A Department of the Defense Electronics Division

GENERAL ELECTRIC

300 South Geddes Street, Syracuse, N. Y.

Explore new areas at IBM in

MECHANICS

At IBM, engineers are applying the principles of mechanics in radically new ways in order to keep pace with recent scientific advances. One project, for example, involves the design of mechanical and electromechanical devices and servos in the 5-10 millisecond range that will insure minimum noise, vibration, and wear. In another project, new concepts of magnetic recording systems are being sought that will enable great quantities of data to be stored in highly miniaturized "memory" devices. Also under development are extremely fast, extremely small output mechanisms that will open a new era in office equipment design. For assignments like these, IBM is seeking engineers who can solve the unusual mechanics problems posed by recent technological break-throughs.

SOME ASSIGNMENTS NOW OPEN

Development of nonconventional devices that accurately measure the effects of gear-tooth wear on angular precision; design of gears for miniaturized electromechanical devices; analysis of problems involving the organization and design of high-speed mechanical and electromechanical devices. Experience required in gearing problems arising from information transmission applications.

Theoretical and experimental analysis of dynamic elastic systems; of stability, self-acting, and experimental pressure gauges; of liquid journals and thrust bearings; of solutions to partial differential equations of the elliptical type for various boundary conditions in lubrication problems.

Mechanical movements—study of their addition and communication by fluid-column linkages, and solution of problems in elastic properties of members; investigation of means of storing and handling mechanical "memory" media stored in densely packed bin array.

Thermodynamics problems in aircraft installation and cooling work. Knowledge of heat transfer, packaging, and aircraft structures necessary.

Applied research in noise-generating phenomena in data processing equipment. The work includes analyses of intricate electronic or electromechanical components, measurement of physical effects in noise production, and application of data to the optimization of design parameters for minimum machine-noise output.

Study of the behavior of transient systems, pulse behavior and nonlinear response of mechanical systems; analyses of impact loads on mechanical systems and transducing of energy into and out of mechanical systems.

Research—through photoelasticity—of propagation, reflection and diffraction of stress waves in birefringent materials; study of dynamic stress-optic laws. Experience required in field of applied mechanics or photoelasticity.

CAREERS AVAILABLE
IN THESE AREAS

| | |
|-------------------------|--------------------------|
| Acoustics | Gear design |
| Applied mathematics | Mechanical analysis |
| Dynamic elastic systems | Servomechanisms |
| Electromechanics | Systems design |
| Fluid-column linkage | Vibration & wear control |

QUALIFICATIONS: B.S., M.S., or Ph.D. in Mechanical Engineering, Electrical Engineering or Engineering Science—plus proven ability to assume a high degree of technical responsibility in your sphere of interest.

You will enjoy unusual professional freedom and the support of a wealth of systems knowledge. Comprehensive education programs are available plus the assistance of specialists of many disciplines. Working independently or with a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

For details, write, outlining your background and interests, to:

Mr. R. E. Rodgers, Dept. 524H2
IBM Corporation
590 Madison Avenue
New York 22, N. Y.



INTERNATIONAL BUSINESS MACHINES CORPORATION

NEW VOUGHT PROJECTS OFFER CAREER APPEAL TO CREATIVE MEN

Space, ASW, and weapon system work at Vought requires continuous R & D in methods and materials, structures and design. These projects have prompted exploratory work in the following areas:

Structures (Supersonic and Hypersonic)
Heat transfer, thermal stress and deflection analysis, and stress analysis using high-speed computers.

Manufacturing R & D
Welding and brazing of super alloys and exotics; advanced forming and cutting studies; prediction of metal fabricability.

Industrial Engineering
Project estimating, work sampling, line load and balance, and packaging and installation of new procedures.

Antisubmarine Warfare
Studies of detection and classification techniques involving Acoustics, Geomagnetism, Geophysics, Electromagnetics, Electrochemistry, Math.

Engineering Planning
Man-hour and budget forecasting, and project planning and scheduling.

Product Design
Automatic escape devices, atmospherically sound cockpits and advanced instrument displays for space pilot, crew.

Flight Test Instrumentation
R & D in new techniques for electronic gathering and reducing of flight test data.

Aerodynamics
Wind tunnel and model work employing Vought's 3,800-mph high-speed wind tunnel and new "high-temperature" laboratory.

Qualified applicants are invited to write:

J. W. Larson
Ass't Chief Engineer, Administrative
Dept. M-33.



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 a 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 undisplaced ads.

Send NEW Ads or Inquiries to Classified Adv. Div. of Aviation Week, P. O. Box 12, N. Y. 36, N. Y.

1049 Connie & Convair Parts

1049 4-Spinners & Afterbodies—Main Gear, Nose Gear, Actuating Cyls., Tip Tanks, Eng. Mounts, 2500RD Tilt Ares, Oil Cooler "D" Mount Structures, No. 1 Nozzle, Convair 240-440 NEW Hydraulic Pumps—Mfg. N. Y. Airbrakes, 240-Randix Gear & Retract Strut Parts, others.

ACL Aviation
76 Central Ave. Hubbard 9-9184 Rdgld Park, NJ

WANTED DC-3

Corporation wants executive DC-3. Send complete details. Principals only.

Box W-2305, Aviation Week
Class. Adv. Div., P.O. Box 12,
N.Y. 36, N.Y.

**SEARCHLIGHT Equipment
Locating Service****NO COST OR OBLIGATION**

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used aviation equipment and components not currently advertised. (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

**Searchlight Equipment
Locating Service**

c/o AVIATION WEEK

P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service

c/o AVIATION WEEK

P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

NAME
TITLE
COMPANY
STREET
CITY 8/10/59

**FOR SALE****Convair 240**

P & W CB-16/17 Engines
Water Injection
Long Range Integral Fuel
Sperry A-12 Auto Pilot
Executive Interior

Currently in Corporation use

FS-2311, Aviation Week
520 N. Michigan Ave., Chicago 11, Ill.

**C-47'S FOR SALE DC-3'S
ALSO
REPAIR OVERHAUL MODIFICATION**

VOLITAN AVIATION
INC.
12820 Pierce St. Pacoima, Calif.
Phone EM-9-1283

**WHERE
TO BUY**

Featuring additional
products, specialties
& services for
the aviation field

A. B. MURRAY CO. INC.

EST. 1945

AIRCRAFT
STAINLESS STEEL
TUBING FROM STOCK

Elizabeth, N. J. • Bristol, Pa. • McKeesport, Pa.

**ARGENTINE REPUBLIC
SALE OF GOVERNMENT PROPERTY**

AERONAUTICA ARGENTINA—
CUARTEL MAESTRE GENERAL—
DIRECCION GENERAL DEL MATERIAL
INTERNACIONAL PUBLIC BID No. 1/59

Date of Invitation: July 29, 1959
Date of Bid Opening: September 30, 1959
11 AM

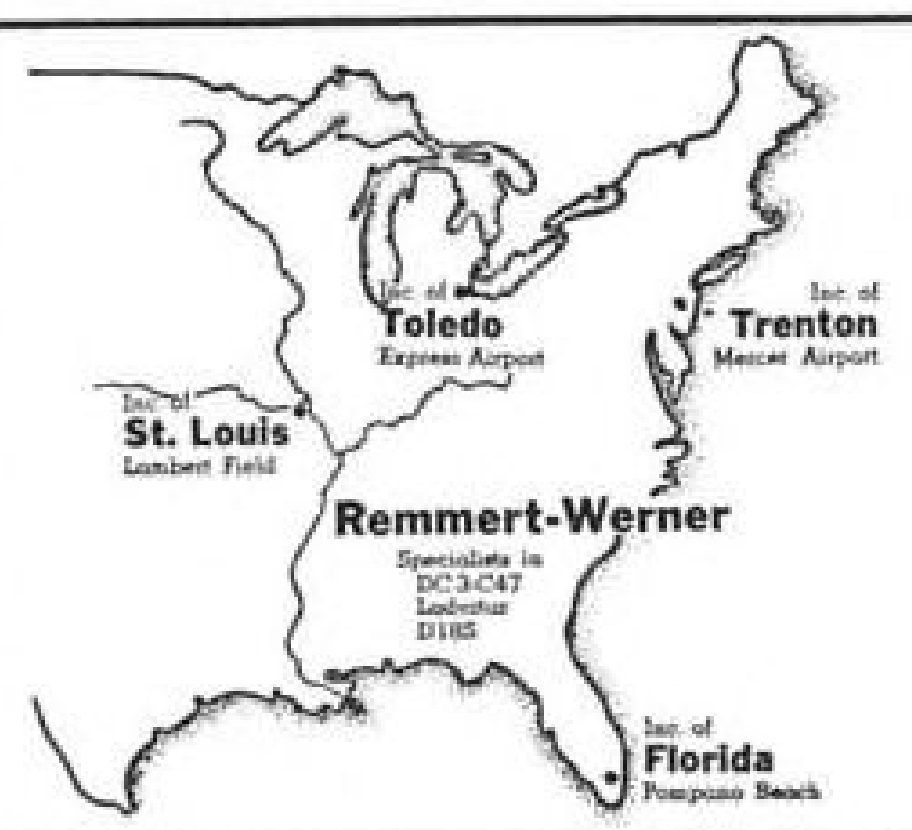
DESCRIPTION OF PROPERTY ON SALE:
11—"Vickers Viking" M.K.1B Aircraft
8—"Bristol" M.K.1A Aircraft

Perfect flight condition, few flight hours after inspection and major overhaul. Big stock of accessories, spare parts and engines for these aircraft will be on sale soon.

Forms and conditions for this sale can be obtained at the offices of the ARGENTINE AERONAUTICAL MILITARY MISSION IN THE U. S. A., 12 West 56th Street—4th Floor—New York 19, N. Y. and mailed after to DIRECCION GENERAL DEL MATERIAL AERONAUTICO (Comision de Adjudicaciones) Calle Tucuman 1427—Buenos Aires—Argentina.

Envelopes containing bids must be sealed and marked: "licitacion Publica de Venta Internacional No. 1/59—Apertura: Septiembre 30, 1959—11.00 horas."

New York, July 29, 1959.

**SALE—LEASE
C-47/DC-3C**

This Douglas 28 seat U. S. certificated passenger aircraft equipped with heavy landing gear, Goodyear disc brakes, air stair door, low time P&W engines is now available for sale, lease, lease purchase. Terms available for foreign and domestic operators.

NATIONAL AERO LEASING CORP.

P.O. Box 48-184 Miami International Airport
Cable AIRLAND Newton 5-0734

OXYGEN EQUIPMENT**SALES & SERVICE**

REGULATORS — MASKS — VALVES

PORTABLES & CYLINDERS

FIXED INSTALLATIONS

GOV'T. APPROVED REPAIR STATION

ZEP AERO Phone: Oregon 8-1161
EL SEGUNDO, CALIFORNIA

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, AUGUST 10, 1959

A.C. SPARK PLUG THE ELECTRONICS
DIVISION OF G.M.C. 42
AEROJET GENERAL CORP. 2nd Cover, 112
AIR FRANCE 46
AIR PRODUCTS, INC. 54
AIR REDUCTION SALES CO., DIVISION OF AIR
REDUCTION CO., INC. 100
AIRBORNE ACCESSORIES CORP. 6
ALLEGHENY LUDLUM STEEL CORP. 92
ALLISON DIV., G. M. CORP. 90
ALUMINUM CO. OF AMERICA MISSILES,
AVIATION ORDNANCE 110
ALVIS LIMITED 59
AMERICAN ELECTRONICS, INC., INSTRUMENT
DIV. B & 9
AMPEX CORP. 65
ANDREW CORP. 75
AVCO CORP. 4th Cover

BECKMAN INSTRUMENTS, INC., HELIPOT DIV. 77
BENDIX PRODUCTS DIVISION, BENDIX
AVIATION CORP. 51
BENDIX SYSTEMS DIVISION, BENDIX
AVIATION CORP. 72

CESSNA AIRCRAFT CO. 11
CHANCE VOUGHT AIRCRAFT, INC. 60-61
CHANDLER EVANS CORP. 106
CHERRY RIVET DIVISION TOWNSEND
COMPANY 66
CLIFTON PRECISION PDTS., INC. 3rd Cover
COLLINS RADIO CO. 67
COLUMBUS DIV., NORTH AMERICAN AVIATION. 91
CRUCIBLE STEEL CO. OF AMERICA 16-17

DAYSTROM TRANSICOIL DIVISION OF
DAYSTROM, INC. 86

EASTERN INDUSTRIES, INC. 22
EDGERTON, GERMESHAUSEN & GRIER, INC. 107
EDO CORP. 44
ELECTRIC AUTO LITE CO. THE, WIRE AND
CABLE DIV. 58
ELLIS & WATTS PDTS., INC. 119
ETHIOPIAN AIRLINES, INC. 119

FLIGHT REFUELING, INC. 109
FLUOROCARBON PRODUCTS, INC., DIV.
GARLOCK PACKING CO. 121

GENERAL ELECTRIC CO. 88-89
B. F. GOODRICH CO. 7

HARRISON RADIATOR DIV., G.M.C. 15
HAYDON A. W. CO. 84
HOUGH FRANK G., THE 97
HUGHES AIRCRAFT CO. 114-115
HYDRO AIRE, DIV. OF CRANE CO. 3

INSTRUMENT DEVELOPMENT LABORATORIES,
INC. 84
IRON FIREMEN MFG. CO., ELECTRONICS DIV. 63

JOHNS MANVILLE CORP. 13

KAMAN AIRCRAFT CORP., THE 70

LEWIS ENGINEERING CO., THE 112
LIBRASCOP, INC. 83
LOCKHEED MISSILES & SPACE DIV. 78-79, 133

MARQUARDT AIRCRAFT CORP., THE 68-69
MB ELECTRONICS, A DIV. OF TEXTREN
ELECTRONICS, INC. 65
MICRO SWITCH, A DIV. OF HONEYWELL
MINNEAPOLIS HONEYWELL REGULATOR
COMPANY, AERONAUTICAL DIV. 52-53

NORTH AMERICAN AVIATION 96, 111
NORTHROP CORP., NORAIR DIVISION 103

OSTER MFG. CO., JOHN (AVIONIC DIV.) 84

PHELPS DODGE COPPER PRODUCTS CORP. 64
PHILCO CORP., GOVERNMENT & INDUSTRIAL
DIV. 102
PROPULSION TEST FACILITIES, INC. 10

RADIO CORP. OF AMERICA 123
RADIO PLANE DIVISION NORTHROP CORP. 56

RAYTHEON CO. GOVERNMENT EQUIPMENT
DIV. 80

REDA PUMP CO. 57
RESISTOFLEX CORP. 94-95

ROCHESTER MANUFACTURING CO. 85
ROCKETDYNE DIV. NORTH AMERICAN
AVIATION 62

ROHM & HAAS CO., PLASTICS DIV. 12

SANBORN CO., INDUSTRIAL DIV. 108
SARGENT ENGINEERING CORP. 4

SCINTILLA DIV., BENDIX AVIA. CORP. 93
SHELL OIL CO. 48-49

SINCLAIR REFINING CO. 118
SOLAR AIRCRAFT CO. 116

SPACE TECHNOLOGY LABS., INC. 20
SPS CO., AIRCRAFT-MISSILE DIV. 120

STAVID ENGINEERING, INC. 24

TELEFLEX, INC. 74
TEXAS INSTRUMENTS, INC. 113

TRANS SONICS, INC. 5

U. S. STEEL CORP., NATIONAL TUBE DIV. 122
U. S. STEEL CORP. 98-99

VICKERS, INC., DIV. SPERRY RAND CORP. 18

WESTERN GEAR CORP. 76

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 124-131

EQUIPMENT
(Used or Surplus New)
For Sale 132

WANTED
Equipment 132

WHERE TO BUY
A. B. Murray 132

ADVERTISERS INDEX

ACL Aviation 132
Argentine Aeronautical Military Mission 132
Bendix Products Div. 132
Boeing Airplane Company 129
The Bristol Company 128
Chance Vought Aircraft, Inc. 131
Cornell Aeronautical Lab., Inc. 126
Engine Works 132
General Electric Co. 129
The Goodyear Aircraft Corp. 125
Honeywell Aeronautical Div. 128
International Business Machines 130, 131
The Mitre Corp. 127
National Aero Leasing Corp. 132
Sikorsky Aircraft 124
Mason & Dixon Lines, Inc. 124
Remmert-Werner, Inc. 132
Volitan 132
Zep Aero 132

Expanding the Frontiers
of Space Technology in

**FLIGHT
CONTROLS**

Flight controls offers one of the most interesting and challenging areas of work at Lockheed's Missiles and Space Division. From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems.

Flight control programs at Lockheed include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

In the flight controls simulation laboratory, mathematical representations of elements in a control system are replaced one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems design.

**ENGINEERS AND
SCIENTISTS**

If you are experienced in one of the above areas or in related work, we invite you to share in the future of a company that has a continual record of achievement and to make an important individual contribution to your nation's progress in space technology. Write: Research and Development Staff, Dept. H-2-17, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed**MISSILES AND SPACE
DIVISION**

Systems Manager for the
Navy POLARIS FBMs;
DISCOVERER SATELLITE;
SENTRY; MIDAS;
Army KINGFISHER;
Air Force Q-5 and X-7

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

LETTERS

Jet Age Safety

Mr. Maier (AW June 29, p. 98) and all other airline passengers have cause to question their safety in the jet age. As an ex-military airline pilot, I feel reasonably well qualified to answer Mr. Maier's question as to whether ex-military pilots with airline transition training would provide safer jet airline operation than existing airline pilots. The answer must be an emphatic no. I believe most airline pilots with my background will agree with me that the military services are excellent training schools for the airlines, but several years of actual airline flying are necessary to provide a pilot with the knowledge and proficiency to confidently carry millions of passengers safely over our nation's airways.

However, this does not mean that there is no room for improvement in the safety of present day jet operations.

The inception of the Federal Aviation Agency was watched with keen interest and anticipation by all persons concerned with air travel. Here at last, it was hoped, is an agency which will do everything possible to preclude the tragic, but often avoidable, accidents on our airways in the past. To date it has failed miserably.

With the power to provide regulatory measures which could enhance airline safety 100%, it's head, Gen. Quesada, has instead chosen to engage in querulous debates with the president of the Air Line Pilots Assn. (AW June 29, p. 79), the pettiness of which can only cause one to wonder how the leadership of two such great organizations fell into such childish hands.

More specifically the Federal Aviation Agency has failed to:

1. Require airborne radar to be in operation on all flights of four-engine aircraft. Radar has thoroughly proven itself an indispensable tool to the pilot. It is one he should not now be required to work without due to false economies on the part of some airlines.

2. Settle the still smoldering pilot-flight engineer controversy by specifying that the third man on the jet be pilot-qualified. Most engineers could meet this requirement, while the "compromise solution" of carrying a superfluous third pilot plus an engineer is ridiculous.

3. Make mandatory a retirement age of 55 for all jet flying. While Boeing's Tex Johnston (AW June 29, p. 32) is undoubtedly correct in his assertion that jet flying should be based on proficiency rather than seniority, the only possible trend toward this at the present time (due to the strength of the pilots' seniority system) is to ground those pilots over 55 from flying jets. Any airline pilot knows the deterioration in efficiency and reflexes which develop when a pilot passes 50, and certainly no pilot over 55 has any business flying high performance jet airliners.

4. Require pilot proficiency checks to be given by an outside source—preferably FAA check pilots. Company check rides are foregone conclusions. How many company check pilots have the intestinal fortitude to give a final down check to a friend or neighbor

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.

pilot who can no longer "cut the mustard," knowing the financial and mental distress which would ensue? To my knowledge no pilot has ever been discharged as the result of flunking company check rides. The trouble is that all pilots just aren't that good, and there are a few with each company who should have climbed out of the cockpit long ago. Flight checks given by an unbiased outside agency would rapidly weed out these few.

All these rules could and should have been written into CAR long ago—yet they are probably not even being contemplated today. Conscientious pilots have fought this relaxed and complacent attitude for years. Unfortunately, until this attitude changes, you, Mr. Maier, and the passengers riding with you, are definitely not being provided the safety you need and deserve on your jet travels.

AIRLINE PILOT
Los Angeles, Calif.

'Moments of Truth'

I was particularly pleased with your June 29 issue of AVIATION WEEK, as it contained a considerable amount of sweet reasonableness and many fine "moments of truth." First off, let me establish that I am not exactly a disinterested party in the current cockpit dispute, as I earn my living as an airline flight engineer. Because of this, it was especially encouraging to find that three separate and distinct representatives of aviation, with interests quite dissimilar to my own, have taken exception to the policies and attitude of ALPA President Clarence N. Sayen.

No less a luminary in the world of flying than Boeing's "Tex" Johnston expresses the opinion that his company's 707 can be operated with a three-man crew "adequately and safely," and that the addition of a fourth man is, if anything, detrimental (p. 32). Mr. Johnston's interest is obvious; public acceptance of the product of his company can only be acquired if it is operated safely, efficiently, and economically. Boeing has for many years produced aircraft that have operated safely, efficiently, and economically with a crew consisting of two pilots and a flight engineer.

National Airlines President George T. Baker quotes impressive statistics of jet aircraft operation with a crew of two pilots and a flight engineer (p. 33). Mr. Baker also appears to be the first representative of management to have recognized the talent Mr. Sayen possesses in the use of catch phrases, slogans, and euphemism. (My favorite slogan is "the fail-safe concept," which never seems to be adequately defined by Mr. Sayen.) Flight engineers were

known as flight engineers all during World War II and as far back as the days of flying boats, but now Mr. Sayen prefers to replace that nasty phrase with "third-man," "third-crew member," etc. Mr. Baker shrewdly recognizes the situation in its true perspective: safety is not the criterion by which a third pilot would be added to the crew; the third pilot is a wedge in the door through which ALPA will try to gobble up the flight engineers, thereby creating a monopoly in aviation second only to the teamsters in the field of transportation.

Finally, Mr. Sayen's negative and dictatorial attitude is recognized and promptly squelched by FAA head Gen. Elwood Quesada, a man of great stature, whose significant contributions to aviation have been recognized and highlighted by a recent issue of a widely circulated national news magazine. AVIATION WEEK has done us all a great service by publishing both the Quesada and the Sayen letters simultaneously (p. 79), so that we can make comparisons on the characters of both men.

It would appear, from the rantings and ravings of Mr. Sayen in his attempt to discredit the flight engineers, that the average airline passenger could get the idea that every flight involves a constant battle, from pre-flight to post-flight, between the pilots and flight engineers. The effect this would have on undermining his confidence in the crews flying the aircraft in which he is traveling is obvious. However, let me assure Mr. Traveling Public that the vast majority of pilots and flight engineers get along harmoniously in a climate of mutual respect and admiration in the cockpits of the nation's airliners. If any differences of opinion exist, they are left on the outside when the cockpit door is slammed shut. There is simply too much work and concentration involved in flying a large airliner from "A" to "B" to allow petty differences of opinion to interfere.

In my opinion, it is a pity that such an admirable group of men as the airline pilots should be represented by a person of the calibre of Mr. Sayen.

J. F. FEMMININO
Franklin Park, N. J.

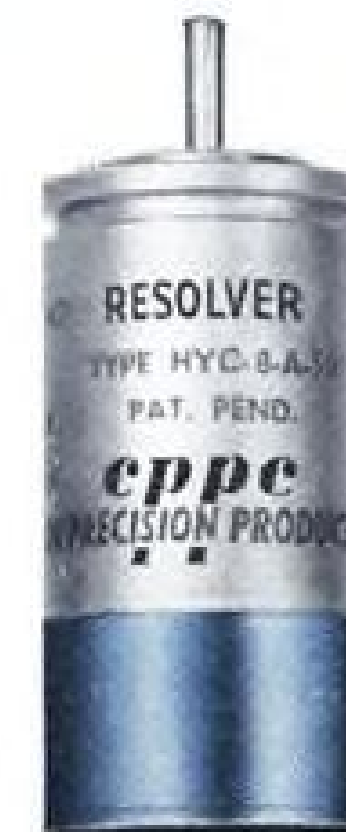
Passenger Miles

On p. 45 in the July 6 issue of AVIATION WEEK, under the heading Shortlines, appears the statement "American Airlines reports it reached 20.5 million revenue passenger miles on Friday, June 19, the first time any airline has topped the 20 million mile per month mark." Aside from the obvious error in the next to last word, may we point out, with all due credit to A.A.L., that Eastern Air Lines, on Jan. 5, 1958, recorded 21,223,153 revenue passenger miles, and on April 5, 1959, had 20,463,259 revenue passenger miles. Our records also show several other days on which we exceeded the 20 million mark.

EUGENE DU BOIS
Regional Manager
News Bureau
Eastern Air Lines, Inc.
New York, N. Y.

advanced PRECISION COMPUTING RESOLVERS for Cascaded Resolver Systems

SIZE 8 FEEDBACK WINDING RESOLVERS

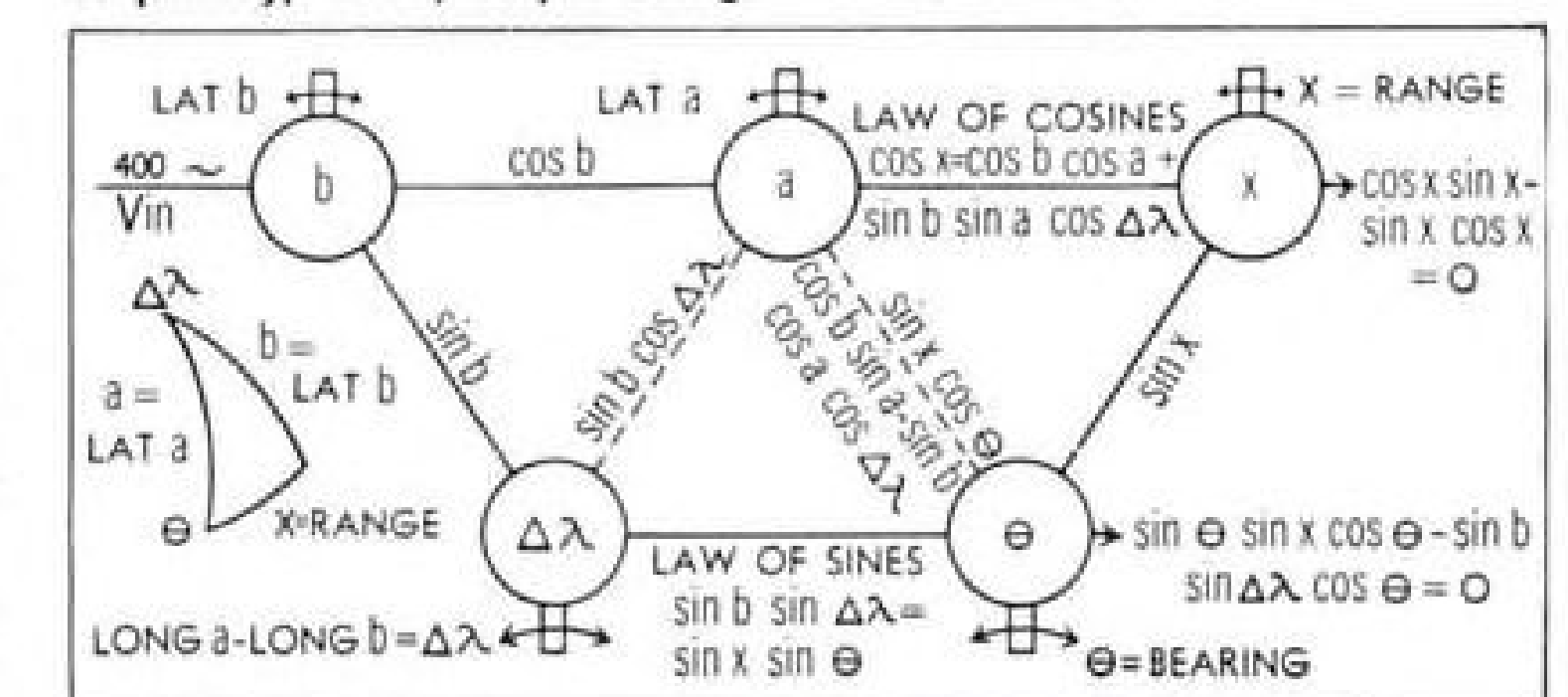


These resolvers are designed for use with transistorized amplifiers and permit the solution of spherical triangles in a size 8 cascaded resolver chain.

Functions of the spherical triangle which can be produced are indicated in the schematic below. More complex trigonometric functions, as well as systems involving coordinate axis transformation, can be generated with the use of these resolvers.

Accuracy: Functional error .1% or less; winding perp. $\pm 5^\circ$. Electrical

cal characteristics: Input voltage 13.7v (compensator); Zro 234 + 15v400~ (stator); output voltage 13.7v (rotor); phase shift (stator 237 + j553; max. null voltage as primary) 20.5°; output voltage 1 mv/v.



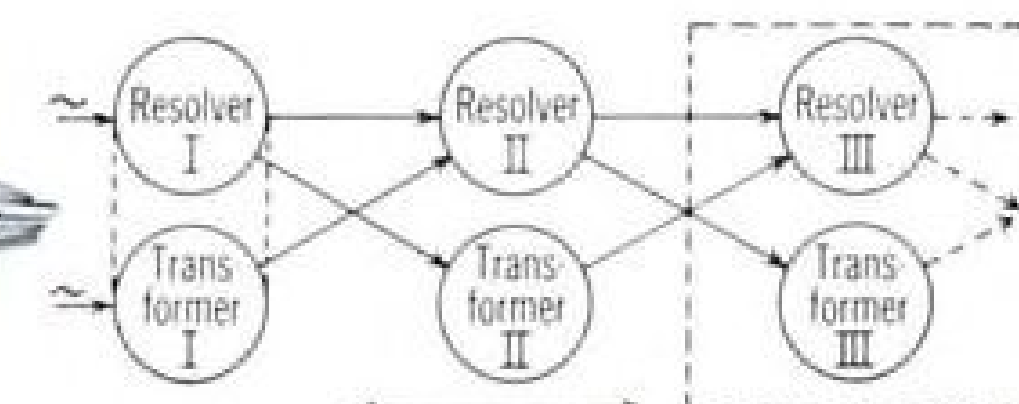
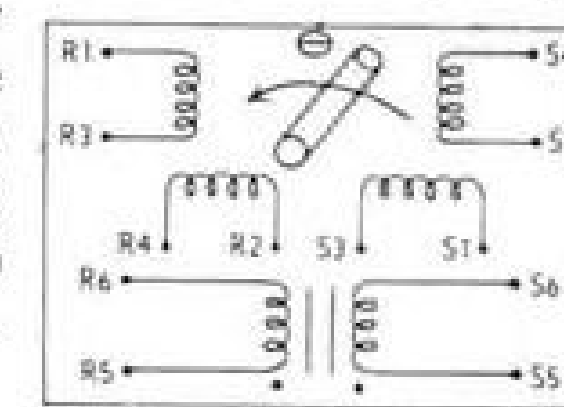
SIZE 11 AMPLIFIERLESS RESOLVER FOR ANGULAR DATA TRANSMISSION



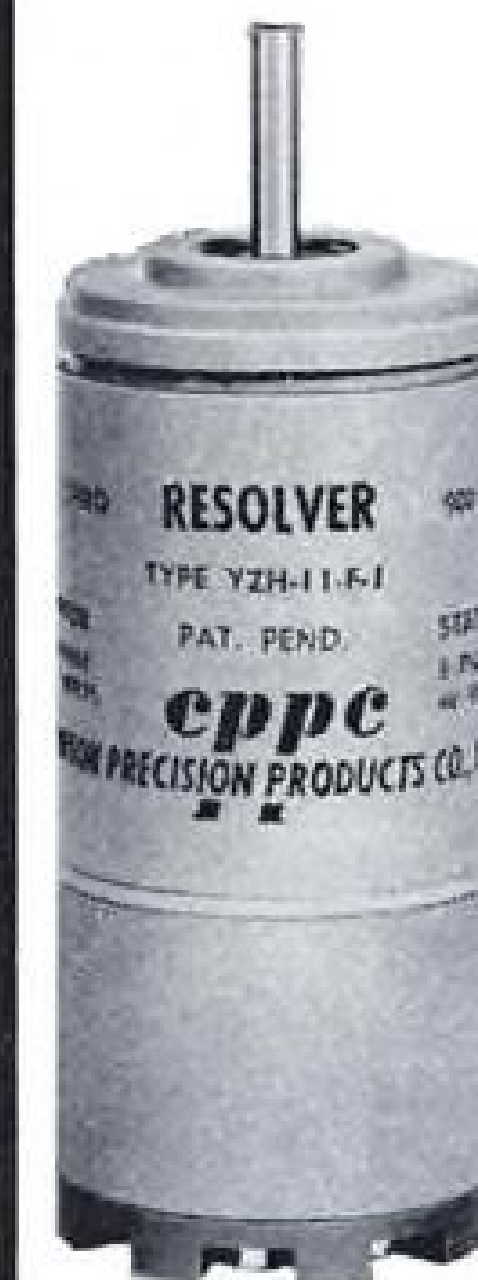
These size 11 resolvers incorporate an integral transformer which simulates a resolver function at maximum coupling. They are used in the typical chain application indicated below for angular data transmission. In this particular application, the output information can be served at either end of the chain.

Quick disconnect allows ease in harnessing.

Accuracy: $\pm 5'$ of arc or less; winding perp. $\pm 5^\circ$. Electrical characteristics: Input to EITHER rotor or stator. Input voltage 115v1600~; output voltage 110v both stator and rotor as primary; phase shift (stator primary) 1.1°; phase shift (rotor primary) 1.9°; Zso (nom.) 990 + j13500; Zro (nom.) 1150 + j13500.



SIZE 11 RESOLVER TRIMMED FOR ZERO PHASE SHIFT CONTAINS ALL COMPENSATION IN 2 1/4" LENGTH



The YZH-11-E-1 precision computing resolver has been developed for use in a cascaded, amplifierless resolver system at 900~.

These units have been trimmed to provide zero phase shift and compensated for transformation ratio stability, under temperature, when working into their iterative impedance.

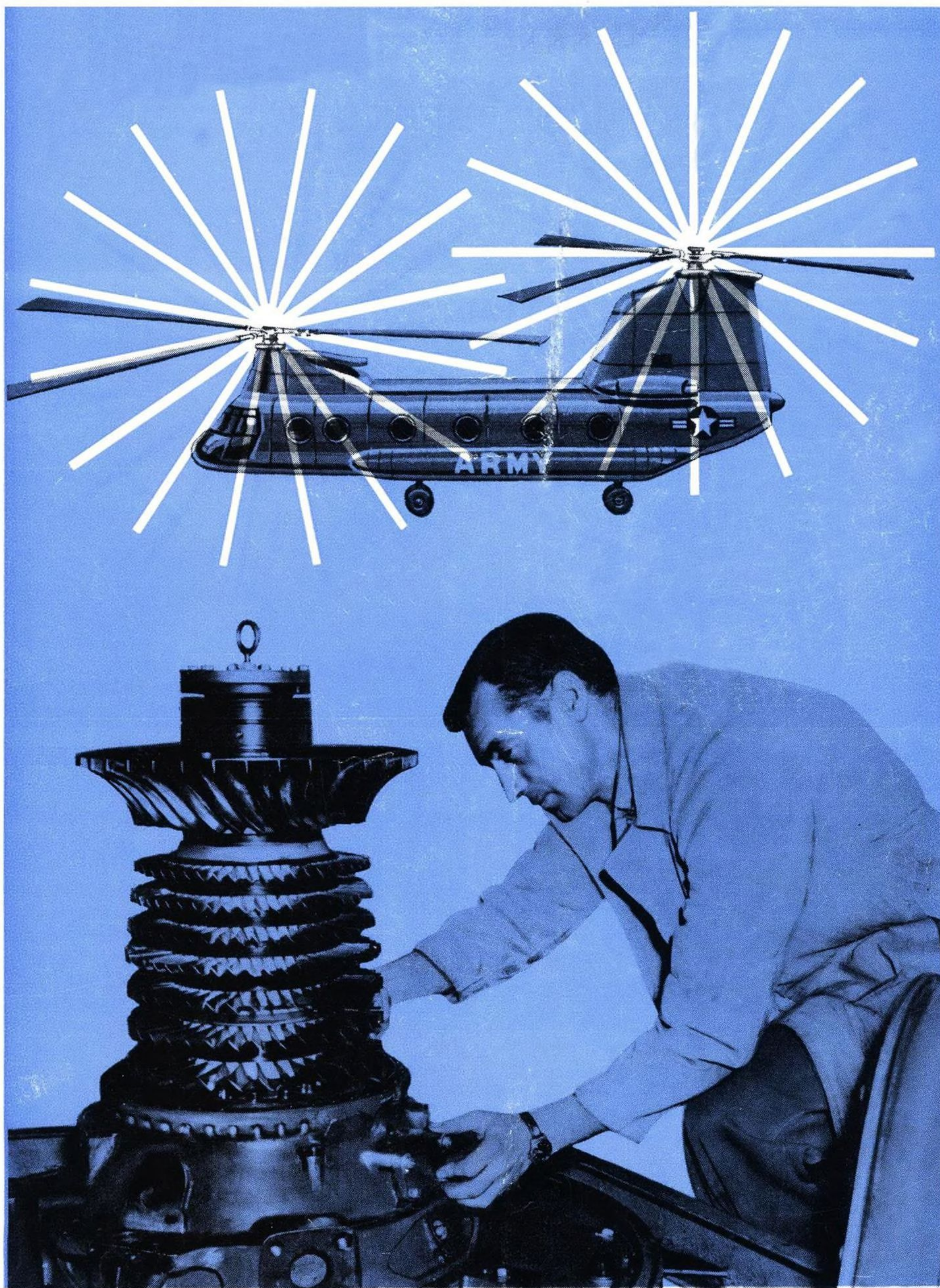
Accuracy: Functional error .1% or less; winding perp. $\pm 5'$. Electrical characteristics: Input voltage (stator) 40v900~; output voltage (rotor) 33.2v; phase shift 0; max. null voltage 1 mv/v.

Also ready for delivery is an equivalent, compatible pancake resolver. By its use, differential information from an inertial platform may be obtained and introduced into the system.

ENGINEERS — Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. A8

cppe CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS, PENNSYLVANIA

Sales Office: 9014 W. Chester Pike, Upper Darby, Pa. — Hilltop 9-1200, TWX Flanders, Pa. 1122 — or our Representatives



Lycoming Turbines to "Lift" a Flying Army—After exhaustive study, Army and Air Force Evaluation Boards have chosen Avco/Lycoming's T 55 turbine engine for a key assignment in America's new and highly mobile Pentomic Army. Its mission: to power the Vertol "Chinook" all-weather troop and transport copter. The powerful, versatile T 55 is another Avco milestone in the turbine power revolution.

Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N. Y.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.