Aviation Week and Space Technology

75 Cents

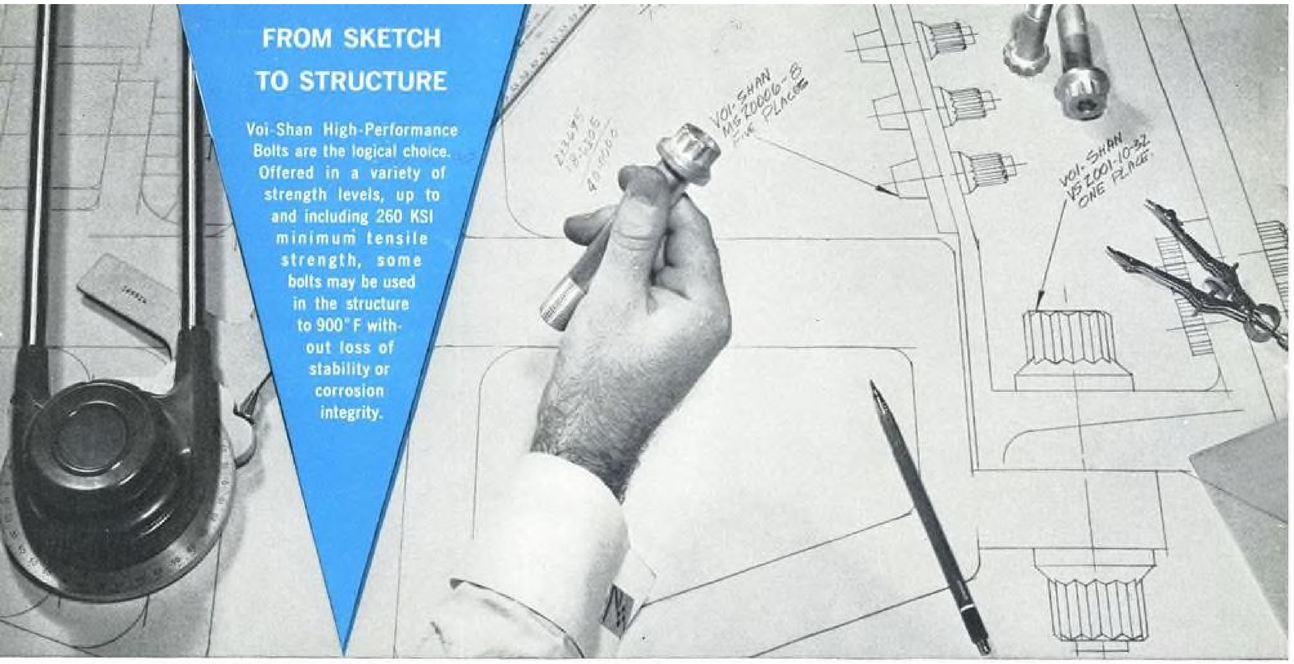
A McGraw-Hill Publication

January 16, 1961

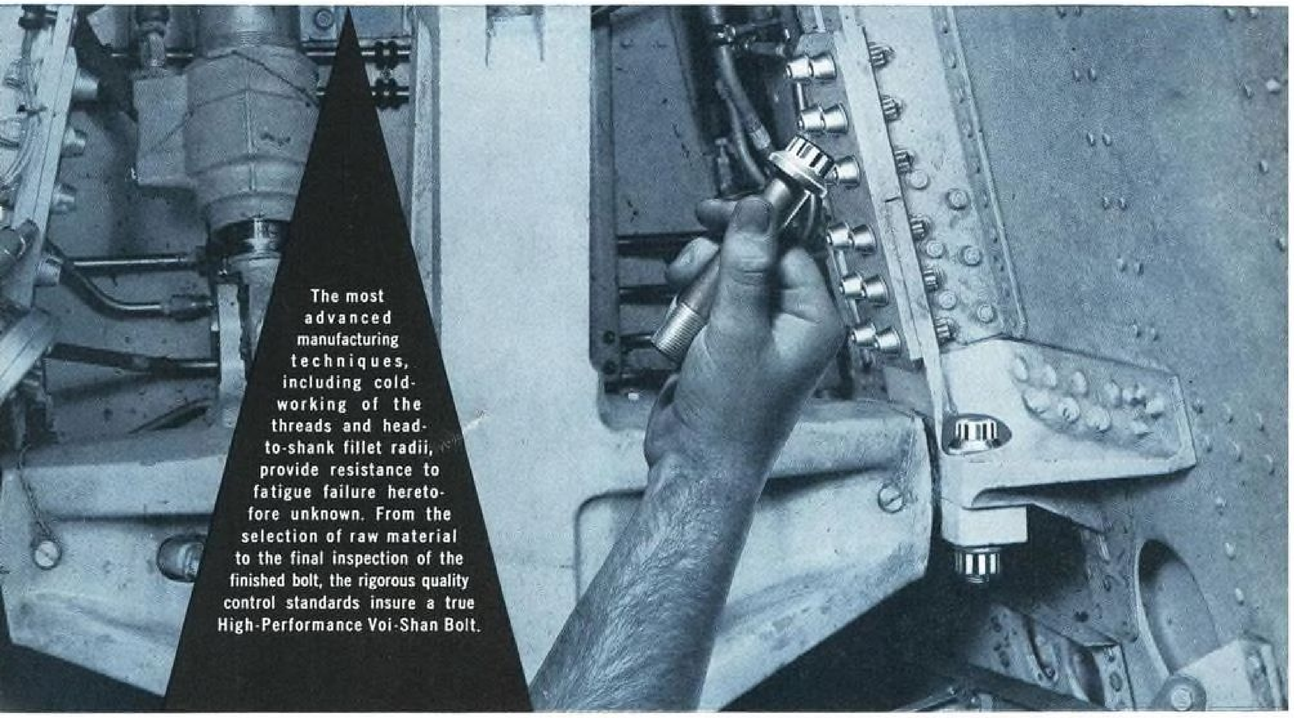
Samos, Midas Guidance And Control Systems

GE's Aft-Fan-Powered Caravelle Makes First Flight





VOI-SHAN HIGH-PERFORMANCE BOLTS



Boeing 707 structure photo, courtesy American Airlines



1. Internal Wrenching Tension Bolt 160 KSI
2. External Wrenching Tension Bolt 180 KSI and 220 KSI
3. External Wrenching Tension Bolt 220 KSI and 260 KSI
4. External Wrenching Shear Bolt 220 KSI and 260 KSI

VOI-SHAN MANUFACTURING COMPANY

a division of Voi-Shan Industries, Inc.
8463 Higuera Street, Culver City, Calif.

a message to men who are pioneering the future... Ponder for a moment the imagination behind Clayley's VERTOL craft of 1842, then marvel at where the Industry might be had this pioneer had today's production resources! ■ Because Ex-Cell-O is in business to help relieve you of many development and manufacturing details that can hamper your creativity, in this condensed list of capabilities you may find a means of getting your project off the ground sooner than scheduled: ■ Fuel controls and injection systems; linear and rotary actuators for GSE and airborne applications; air bearing devices; inertial guidance systems; servomechanisms; data processing memory drums; nuclear powerplant components; hardened and ground precision production parts. ■ Our Representative nearest you will gladly elaborate on Ex-Cell-O's products and services.

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN 60-12
Aircraft & Missile Division

Artist's conception of Sir George Clayley's mid-19th Century helicopter shows contra-rotating multiple rotors and pusher props. Design lacked a practical engine and power train.



MAN AND MISSILES FLY HIGHER, FASTER AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O AND ITS SUBSIDIARIES: BRYANT CHUCKING GRINDER CO., CADILLAC GAGE CO., MICHIGAN TOOL CO., SMITH BEARING CO. ■ EX-CELL-O FOR PRECISION

SILICONE NEWS from Dow Corning

Reliable In Emergencies



Silastic Is Always Ready for Use; Unaffected by Time, Oxygen, Ozone

Cabin decompression is a possibility (even though remote) in a jetliner flying at 30,000 feet or higher. In such emergencies, high flying commercial jets provide for passenger safety with automatic positioning oxygen masks. If decompression should occur, these silicone rubber masks will immediately pop out of their storage compartments, ready for the seat occupant to slip over his face.

Why are these masks made of Silastic®, the Dow Corning silicone rubber?

Here are the requirements as enumerated by the manufacturer, ARO Equipment of California, Los Angeles. Although it's stored crushed in a small area, the mask must return to its original shape without damage. It must be odorless; nontoxic in direct contact with skin; easy to clean and sterilize; flexible to —65 F; withstand a test of 72 hours at 160 F temperature without visible damage; and, be resistant to the cracking and checking effects of oxygen and ozone. Furthermore, the masks must retain these properties and remain reliable for an "in service" life of more than three years!

Silastic meets all of these operating and storage requirements.



Most rubber companies can provide you with parts made from Silastic and engineered to your specific needs. For full information write Department 1013B.

The nearest Dow Corning office is your number one source for information and technical service on silicones.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

AVIATION CALENDAR

Jan. 23-25—29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, N. Y. Honors Night Dinner, Jan. 24.
Jan. 28—Institute of Navigation's Western Regional Meeting, California Institute of Technology, Pasadena, Calif.
Feb. 1-3—Second Winter Military Electronics Convention, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.
Feb. 1-3—Solid Propellants Conference, American Rocket Society, Salt Lake City.
Feb. 14-16—Second Annual Symposium on Non-destructive Testing of Aircraft and Missile Components (unclassified), Society for Non-destructive Testing and Southwest Research Institute, Gunter Hotel, San Antonio, Tex.
Feb. 15-17—International Solid-State Circuits Conference, Institute of Radio Engineers, Sheraton Hotel, Philadelphia.
Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.
Mar. 9-10—Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia.
Mar. 9-10—Flight Propulsion Meeting, Institute of the Aeronautical Sciences, Cleveland, Ohio (classified).
Mar. 12-16—Aviation Conference, American Society of Mechanical Engineers, Statler-Hilton, Los Angeles, Calif.
Mar. 13-16—Test, Operations and Support Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.
Mar. 16-18—Fifth National Conference on Aviation Education, Mayflower Hotel, Washington, D. C.

(Continued on page 6)

AVIATION WEEK and Space Technology

ABP

January 16, 1961
Vol. 74, No. 3

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

Available only by paid subscription. Publisher reserves the right to refuse non-qualified subscriptions. Subscriptions to Aviation Week 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 orders forwarded to address shown in box below.

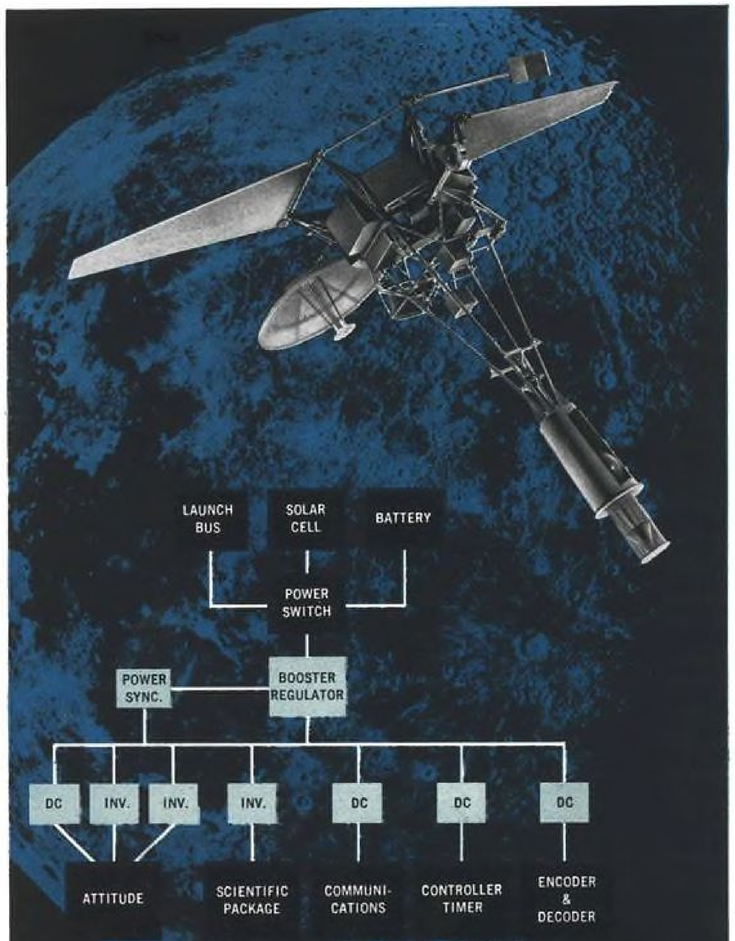
Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

Our primary aim is to provide subscribers with a useful and valuable publication. Your comments and suggestions for improvement are encouraged and will be most welcome. The publisher, upon written request, agrees to refund the part of the subscription price applying to the remaining unfilled portion of the subscription—if service is unsatisfactory.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.
©Copyright 1961 by McGraw-Hill Publishing Co., Inc. All rights reserved. Cable Address: "McGraw-Hill New York." Publications combined with AVIATION WEEK and 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 Fulfillment Manager, Aviation Week and Space Technology, 330 West 42nd Street, New York 36, N. Y.



TOTAL POWER SOLUTIONS...FROM ITT

THE MOST ADVANCED POWER CONVERSION JOB YET ATTEMPTED

Shown here is a simplified block diagram of the unique integrated power conversion system now being designed and manufactured by ITT for the Project Ranger moon probe, built for NASA by Jet Propulsion Laboratories. The over-all system provides 27 different DC and AC outputs at several discreet voltages, currents and frequencies . . . using ground, solar cell and battery power sources.

Total power capability such as this—for conversion, inversion, regulation and control—is readily available from ITT to solve your toughest power problems. Contact your ITT representative, or write for File AW-1368-1.

ITT and McCormick Selph combine their power and ordnance capabilities to provide the best in exploding bridgewire systems.

ITT **Industrial Products Division**
International Telephone and Telegraph Corporation
15191 Bledsoe Street • San Fernando, Calif. • EMpire 7-6161

static power conversion · instruments · closed circuit television

SUPERIOR | ACCURACY

in heat controls

for jet windshields



Convair 880 jet airliners are first to use new, advanced design anti-fogging, anti-icing heat control systems developed by Magnetic Controls Company.

Windshield icing and fogging problems are considerably more complex for jet airliners, compared with those encountered by piston engine planes. With jet travel, faster speeds, higher altitudes, plus greater extremes in temperatures and atmospheric pressures, many new problems develop. Magnetic Controls proportional heat control systems have helped to solve these problems for Convair 880 jets. The Magnetic Controls systems offer four distinct advantages:

- **Automatic compensation for windshield aging.**
- **Ultra-reliable, fully static design.**
- **Elimination of thermal shock for longer windshield life.**
- **Superior accuracy – proportional plus integral control.**

For complete information about this system and how it may help you obtain precise, accurate heat control for many applications, write or phone Magnetic Controls Company today.

MAGNETIC CONTROLS COMPANY

6413 CAMBRIDGE STREET • MINNEAPOLIS 26, MINN. • WEst 9-4691

Heat Control Systems • Static Inverters • Voltage Monitoring Systems

AVIATION CALENDAR

(*Continued from page 5*)

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

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

Mar. 27-31—1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, Columbus, Ohio. For information: V. W. Sikora, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Mar. 28-29—Nucleonics in Flight Symposium, American Nuclear Society, Statler-Hilton Hotel, Dallas, Tex.

Apr. 4-5—Aviation Technician School Administrators Conference, Purdue University, Lafayette, Ind.

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

Apr. 4-6—Lifting Re-entry Vehicles: Structures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 4-7—National Aeronautic Meeting, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 10-11—Spring Meeting, Western States Section/The Combustion Institute, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

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

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

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

Apr. 22-25—Annual Business Meeting and Conference, American Assn. of Airport Executives, Broadmoor Hotel, Colorado Springs, Colo.

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

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

May 8-10—National Aeronautical Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 15-17—National Symposium on Microwave Theory and Techniques, IRE, Sheraton Park Hotel, Washington, D. C.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

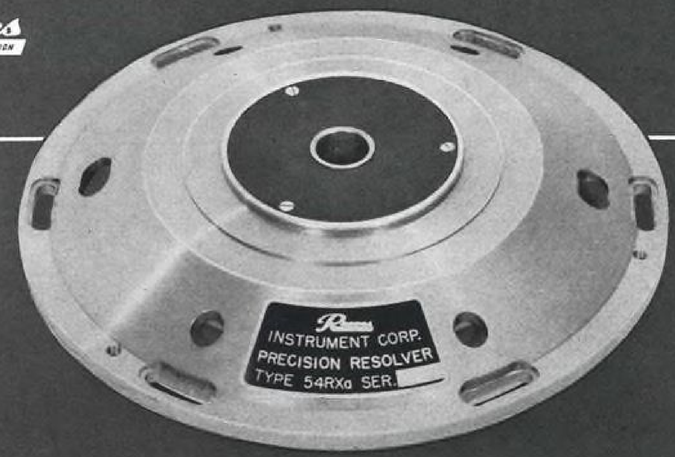
May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 22-24—Fifth National Symposium on Global Communications, Institute of Radio Engineers, Hotel Sherman, Chicago.

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

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

now in production at Reeves INSTRUMENT CORPORATION



pancake resolver

with

10 SECOND

FUNCTIONAL ACCURACY

AND 2-SECOND REPEATABILITY

integral bearing permits direct gimbal mounting

The new Reeves 10-second Resolver is the ideal instrument for precision stable platform applications. The units are available with either beryllium or aluminum housings for a wide range of operating temperature applications.

Reeves is especially proud of this latest addition to the comprehensive family of high precision resolvers currently in production and ready for inclusion in your systems packages. Whatever your resolver requirements Reeves has the size and design to meet your specifications. Reeves Resolvers are supplied in the 23, 15, and 11 case sizes. For complete specifications, write for data file 701.

Qualified engineers seeking rewarding opportunities in these advanced fields are invited to get in touch with us.

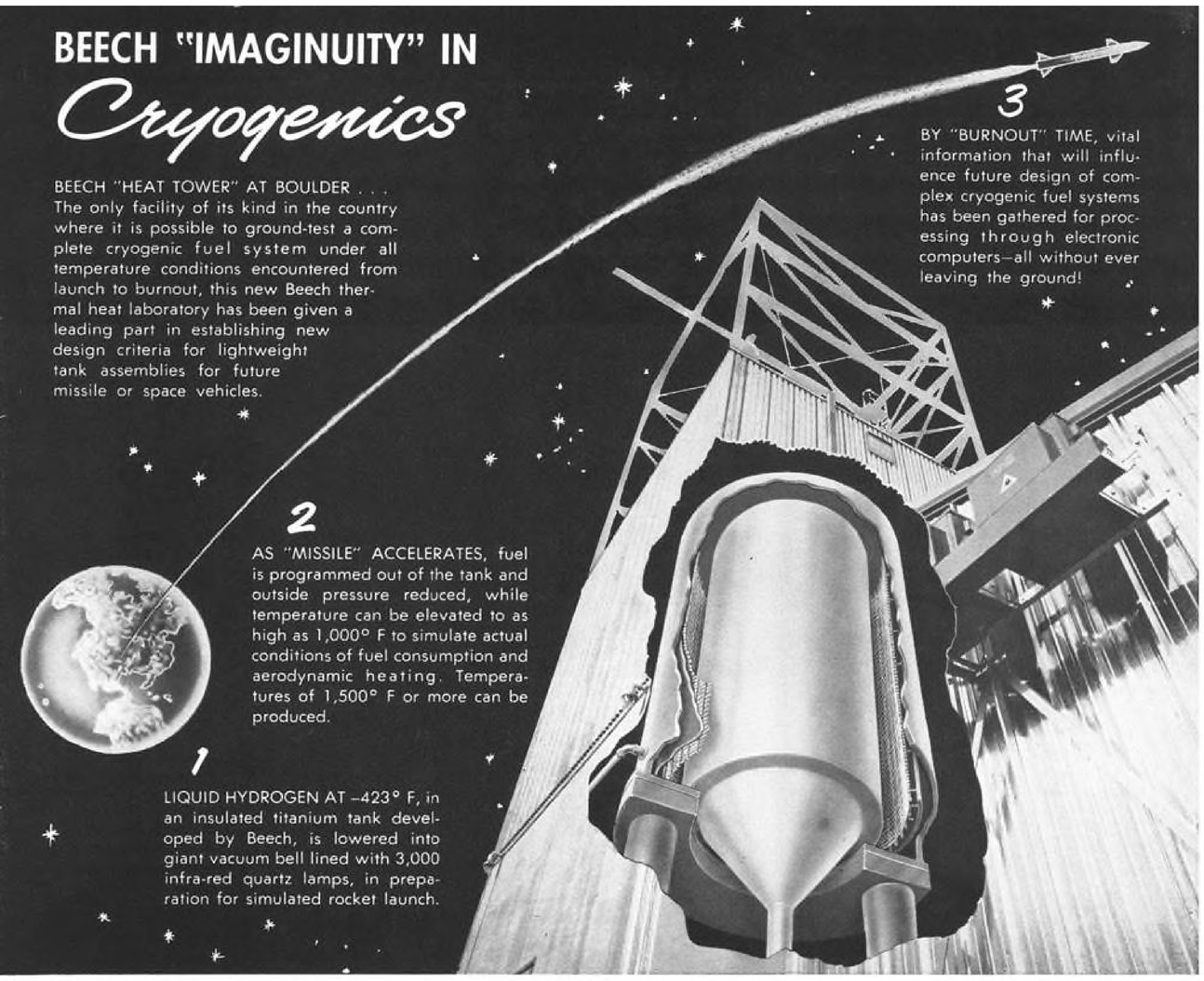
REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America • Roosevelt Field, Garden City, New York

Reeves INSTRUMENT CORPORATION

9RV60

BEECH "IMAGINUITY" IN *Cryogenics*



BEECH "HEAT TOWER" AT BOULDER . . . The only facility of its kind in the country where it is possible to ground-test a complete cryogenic fuel system under all temperature conditions encountered from launch to burnout, this new Beech thermal heat laboratory has been given a leading part in establishing new design criteria for lightweight tank assemblies for future missile or space vehicles.

1 LIQUID HYDROGEN AT –423° F, in an insulated titanium tank developed by Beech, is lowered into giant vacuum bell lined with 3,000 infra-red quartz lamps, in preparation for simulated rocket launch.

2 AS "MISSILE" ACCELERATES, fuel is programmed out of the tank and outside pressure reduced, while temperature can be elevated to as high as 1,000° F to simulate actual conditions of fuel consumption and aerodynamic heating. Temperatures of 1,500° F or more can be produced.

3 BY "BURNOUT" TIME, vital information that will influence future design of complex cryogenic fuel systems has been gathered for processing through electronic computers—all without ever leaving the ground!

Beech "space flights" at Boulder, Colorado . . .

Pioneering in testing of space vehicle components ...including liquid hydrogen fuel tankage systems

Big things are happening at Boulder. Here, near the Bureau of Standards cryogenic engineering laboratory, Beech has assembled a highly competent team of scientists, engineers and technicians, chosen for a combination of skills, experience and interests. Working with the most modern equipment (much of it Beech-developed), this team is performing vital roles in perfecting advanced propulsion systems and components. Beech qualifications for future assignments include more than 6 years experience in liquid hydrogen propellants and liquid hydrogen storage; research, development and fabrication of titanium tankage systems; and environmental testing of a wide range of missile components and systems to qualification.

Beech Aerospace Division

BEECH AIRCRAFT CORPORATION • WICHITA 1, KANSAS.



TEAMWORK IN PLANNING: Hallicrafters "BLUE STREAK" Teams support military programming groups for SAC aircraft at OCAMA and other materiel commands.



TEAMWORK IN INSTALLATION: Advanced ECM equipments are installed by "BLUE STREAK"-SAC teams with a minimum of down time. Maintenance and operational training is speeded up, too.



TEAMWORK IN MODIFICATION: Modernization of RF transmission systems completed in 30% less time through "BLUE STREAK" team assistance to base maintenance groups.

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

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



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

...a hard-hitting new striking force for electronic technical support

hallicrafters h ***blue streak project***

For further information on Hallicrafters facilities and experience in military electronics research, development and production, please write to: THE HALLICRAFTERS CO., MILITARY ELECTRONICS DIVISION, CHICAGO 24, ILLINOIS.

LOOKING FOR A CHALLENGING OPPORTUNITY?

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

HALLICRAFTERS REGIONAL SALES ENGINEERS

William E. Peugh—Joseph A. Small
4401 W. 5th Avenue, Chicago 24, Ill.
VAn buren 6-5300

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

Earl L. Giffin
Box 568, Far Hills Br.,
Dayton 9, O.
AXminster 8-5239

James R. Spencer
Box 435, Lincroft, N.J.
SHadyside 7-2369
(Red Bank, N.J.)

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

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

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many who may find it useful to review fundamentals from time to time.

Methods of Carburizing Alloy Steels

Carburizing is a means of impregnating the surface of steel with carbon, usually to very limited depths. Its purpose is to provide a hard, wear-resisting "case," or outer shell. Alloy steels, correctly handled, can be case-hardened without sacrificing desirable core properties.

There are three types of carburizing in general use:

Liquid Carburizing—The medium here is a hot-salt bath composed basically of cyanide compounds. The steel is immersed in the bath, the period of immersion depending upon the analysis of the steel and the depth of case desired. Liquid carburizing is a convenient method of producing thin, hard, wear-resisting cases, generally within the depth range of 0.02 to 0.03 in. However, deeper cases may be obtained, the actual depths depending upon economics and end uses.

Gas Carburizing — This method employs a furnace in which a carbonaceous atmosphere is created; i.e., gases that are high in carbon components, or those containing carbon. Steel subjected to gas carburizing can be case-hardened to depths generally ranging from 0.01 to 0.04 in. When quenching takes place immediately after carburizing, distortion can be kept to a minimum.

Pack Carburizing — Where the pack method is used, the parts to be carburized are buried in a container of dry carbonaceous materials. The container is sealed tight to prevent the infiltration of air, placed in a furnace and kept there for eight hours or more, the actual time depending upon the depth of case desired. Pack carburizing is particularly suitable where a deep case is essential (0.06 in. and over), although medium cases in the 0.04-to-0.06-in. range are possible.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

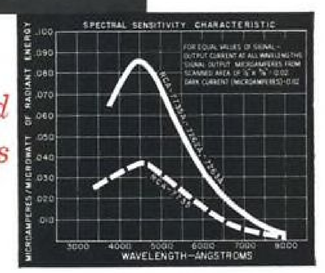
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Unequalled Light Sensitivity and Low Lag



New RCA photoconductor utilized in world's most sensitive vidicons



Now, an RCA exceptionally sensitive photosurface ushers in a new family of advanced vidicons unequaled anywhere for their light sensitivity and closely-controlled characteristics.

The RCA-7735-A—double the sensitivity of the 7735—provides good pictures at lower light levels with less lag than previously possible! This sensitivity and the tube's lower "lag" make the 7735-A ideal for industrial use.

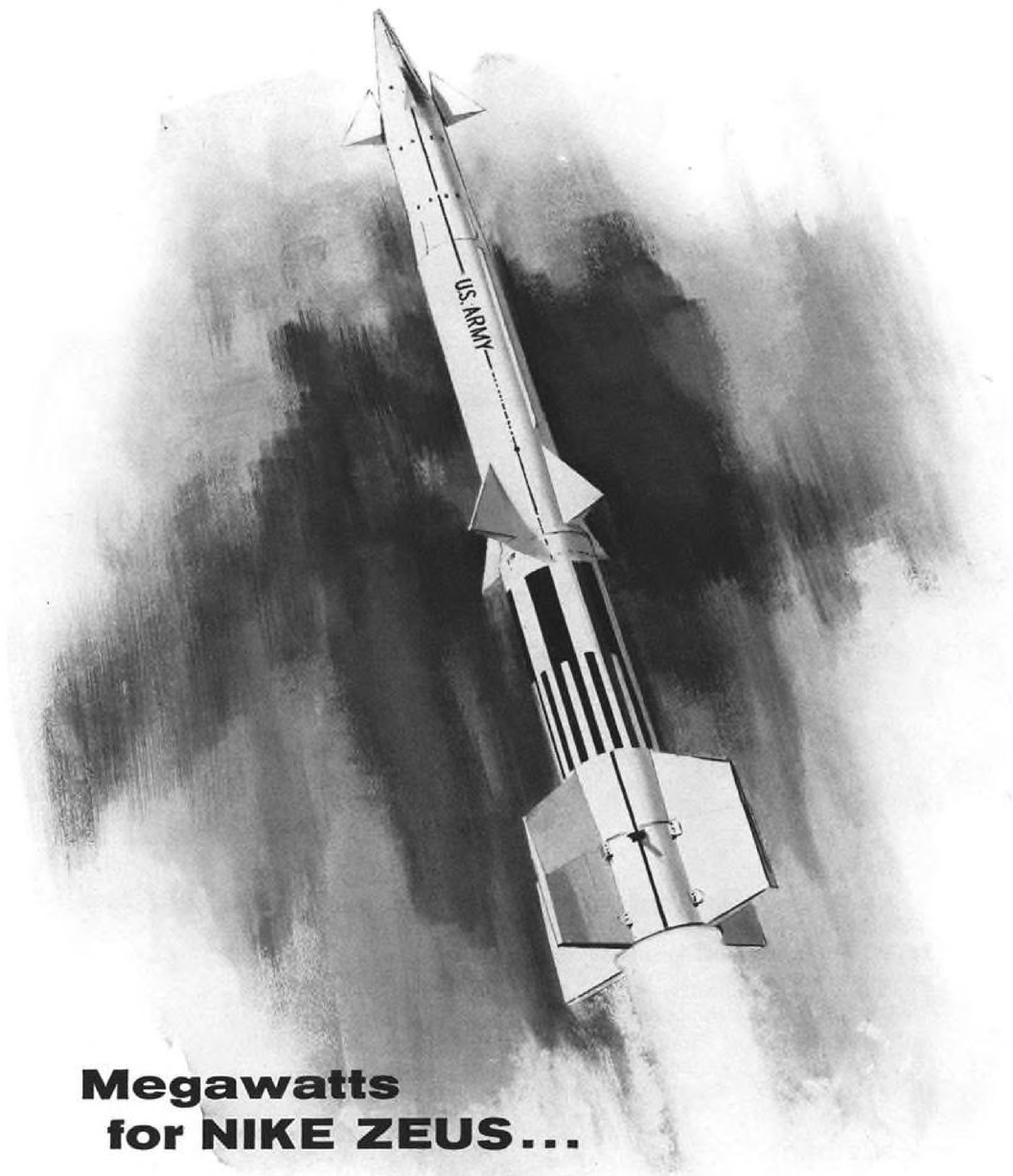
Two short-length vidicon types featuring the same sensitivity as the 7735-A are offered for use in compact transistorized cameras. RCA-7262-A is intended for normal outdoor-indoor environments. RCA-7263-A is especially designed for military or other applications involving shock, vibration, humidity, and altitude. Both types operate at 30% less heater power than any other commercially available type of vidicon.

All three of these advanced camera tubes feature a resolution capability of 600 to 900 lines, broad spectral response, and the high tube-to-tube uniformity that has become identified with RCA vidicons.

For complete information about these RCA vidicons—the most sensitive in the world—get in touch with: Marketing Manager, Industrial Tube Products, RCA, Lancaster, Pa. For a technical bulletin on any of these types, write Commercial Engineering, Section A-112-Q, RCA, Harrison, N.J.

RCA ELECTRON TUBE DIVISION FIELD OFFICES... Industrial Tube Products Sales: Detroit 2, Michigan, 714 New Center Building, TRinity 5-5600 • Newark 2, N. J., 744 Broad St., HUmboldt 5-3900 • Chicago 54, Illinois, Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900 • Los Angeles 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361 • Burlingame, Calif., 1838 El Camino Real, OXford 7-1620 • **Government Sales:** Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900 • Dayton 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366 • Washington 6, D. C., 1725 "K" St., N.W., FEderal 7-5800.

RCA The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA



Megawatts for NIKE ZEUS...

With a booster of over 450,000 pounds of thrust, NIKE ZEUS will need still another form of power to fulfill its anti-missile assignment. This other power is in millions of watts – energy for the system's extended range target tracking and discrimination radar transmitters.

Developed for the Army by Sperry out of its long experience in high power radars, and employing giant-wattage Sperry klystron tubes, the target tracking transmitters will permit greater-than-ever capability for radar tracking of "hostile" targets. The discrimination radar is designed to classify targets according to the nature of the threat.

NIKE ZEUS—the nation's only anti-missile missile system now in the advanced development stage—is undergoing R&D and pre-production programming under the Army Rocket and Guided Missile Agency (ARGMA) cognizance, with Western Electric as prime contractor and Bell Laboratories responsible for the overall system. It is the only missile system now in development for intercepting ICBM's . . . to defend our cities and defense sites.

SPERRY

SURFACE ARMAMENT DIVISION, *SPERRY GYROSCOPE COMPANY—DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N.Y.*





Canadair CL Forty Four, the largest Canadian aircraft, features the unique swing-tail to facilitate fast loading and unloading of the transport. Power for the aircraft is delivered by the Chatham low volume, low weight 200 ampere Y-Series transformer-rectifier.

Chatham Y-Series transformer-rectifiers furnish DC power to CANADAIR CL Forty Four transport

The Canadair CL Forty Four is the first plane designed with the unique hinged tail which swings back to give immediate and unobstructed access to the full cross-section of the fuselage for rapid loading and unloading of the cargo. The turbo-prop freighter, the largest aircraft built in Canada, has a payload of 33 tons and full transatlantic range capability.

DC power for the CL Forty Four is furnished by the revolutionary Chatham 200 ampere Y-Series silicon power transformer-rectifier. Canadair specified Chatham conversion equipment because they demanded unexcelled flight performance and reliability while restricting space and weight requirements to an absolute minimum.

Chatham Y-Series transformer-rectifiers—available in a range of outputs from 20 amps to 200 amps—are considerably smaller and lighter than competitive equipment with similar ratings. The 28VS200Y unit, for example, weighs under 17 pounds and occupies less than 310 cubic inches!

The ability to satisfy the toughest aircraft specifications with power conversion equipment that delivers unmatched performance and optimum physical configuration stems from Chatham's complete control over every step in design and production. Chatham even manufactures its own solid-state components so that designers are not limited by the "specs" of commercially available components.

Like Canadair, you can get the benefit of Chatham power conversion equipment know-how, too. Send today for Chatham brochure T-26A which describes power equipment that's immediately available. Or outline your needs and Chatham will recommend an original design to do the best job for you. Chatham Electronics, division of Tung-Sol Electric Inc., Livingston, N. J. TWX:LVTN NJ-489

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

CHATHAM ELECTRONICS
division of
TUNG-SOL ELECTRIC INC.

Another MX Test System at work...



This special Zyglo ZA-49 custom built for SKF Industries, includes an endless conveyor to move parts through the various inspection processing steps in timed sequence. One man can handle entire operation.

Magnaflux Field Engineer, Ross Peterson (at right), discusses acceptance standards with Rudolph Sansonneti, Chief Inspector and Henry McNeal, Production Engineer, Airborne Accessories Corporation, Hillside, N. J. Unit is standard Zyglo ZA-37.

You Save Money Finding Cracks with ZYGLO — Large or Small

Fluorescent Penetrant Test for Nonmagnetic Materials

The big machine above is a specialized, automated Zyglo System with which one man tests up to 375 non-ferrous bearing cages per hour for cracks, porosity, or leaks. It includes complete conveyorized handling and programmed processing, custom engineered and built by Magnaflux. Parts tested range from ¾" I.D. to 10" O.D.

The inset shows a hand-operated Zyglo ZA-37 used to test critical aircraft parts—from small screws in batches, up to 9-lb., 6" x 18" components.

Dozens of other Zyglo Units and Systems—larger, smaller and in between these examples—are available in standard, productionized-standard and specially engineered installations. Whether you need to test thousands of small parts per hour, a few large ones, or any combination, there's a Zyglo to meet *your* specs and savings objectives.

Further, no less than 26 precisely formulated Zyglo Test Materials provide 100% reproducible results at any degree of sensitivity you require. You never need over or under inspect with Zyglo.

For further information on Zyglo savings and quality standardization, phone our local Magnaflux Field Engineer, or write Magnaflux Corporation, 7306 W. Lawrence Avenue, Chicago 31, Illinois.

MAGNAFLUX CORPORATION
TEST SYSTEMS
A SUBSIDIARY OF GENERAL MILLS

MX Test Systems Include MAGNETIC PARTICLE, FLUORESCENT PENETRANT, THERMOGRAPHIC, EDDY CURRENT, ULTRASONIC, STRESS ANALYSIS, RADIOGRAPHIC TESTING, DYE PENETRANT & MAGNETIC FIELD



From the era of the "$2 ride" to today's million dollar blast off's, the success of air vehicle performance has hinged on the reliability of components. Since 1933, Pesco products have been acclaimed for their proven dependability. As man prepares to meet the new challenges of flight, imaginative Pesco engineers are developing new concepts of reliability and . . . through creative engineering . . . are translating them into precision components to deliver volatile fuel, control the flow of hydraulic power, actuate guidance devices, generate and convert precise power, and cool vital working parts. Because today's high mach aircraft demand fail-safe operation, Pesco designs and builds components to *meet and exceed* all anticipated requirements to provide assured performance under critical operating conditions.

PESCO PRODUCTS ASSURE RELIABLE PERFORMANCE

FOR AIRCRAFT, MISSILES, AND SPACECRAFT

PESCO PRODUCTS DIVISION
BORG-WARNER CORPORATION
24700 North Miles Road • Bedford, Ohio

CONSULT PESCO FIRST FOR
YOUR SPECIALIZED REQUIREMENTS IN . . .

- STATIC INVERTERS
- FREQUENCY CHANGERS
- CRYOGENIC COMPONENTS
- ENVIRONMENTAL COOLING
- AUXILIARY POWER SYSTEMS
- ELECTRIC POWER GENERATION

8791-PC

EXPORT SALES: Borg-Warner International Corp., 36 South Wabash Avenue, Chicago 3, Illinois

SET YOUR SITES ANYWHERE. **Only one turbocopter, the Sikorsky S-62, offers the true go-anywhere, land-anywhere capability required for missile site support. With its unique boat hull, the S-62 can operate from land, water, snow, marsh, tundra, thin ice. At 14,000 feet, it hovers and then delivers a 2,000-pound payload with pin-point precision. Using the same moving components as the H-19, the S-62 offers extensive parts inventory savings and up to 1,000-hour initial overhaul periods.**



UNITED AIRCRAFT CORPORATION

Sikorsky Aircraft Division

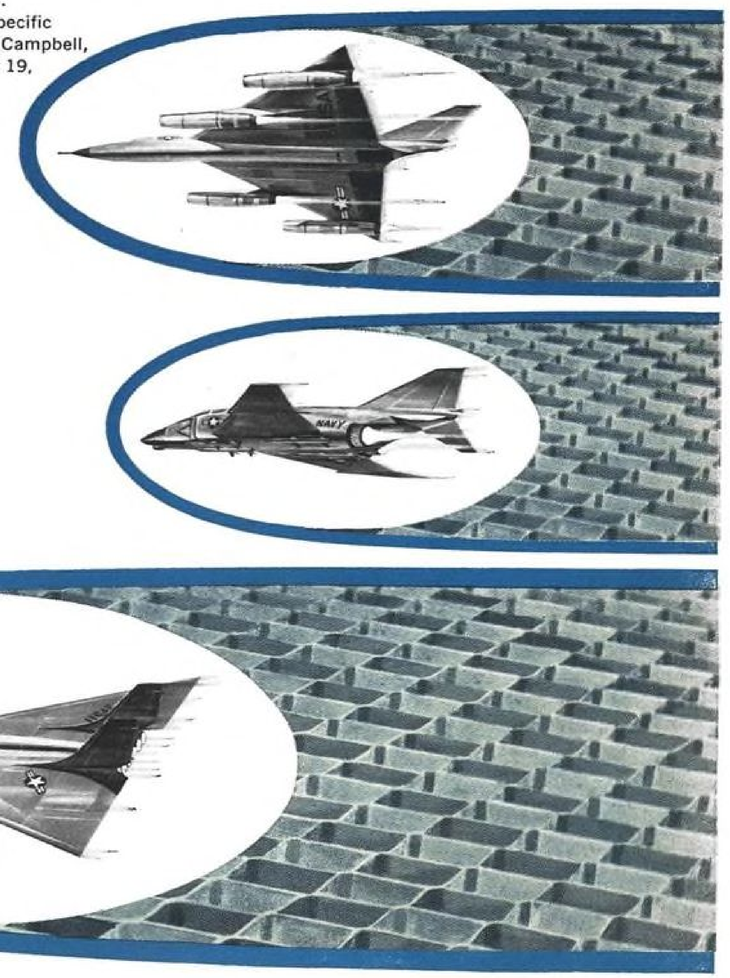
Stratford, Connecticut

ROHR STAINLESS STEEL HONEYCOMB
components are cooling off critical points on two of the "hottest" airplanes flying . . . Convair's B-58 HUSTLER and the McDonnell F4H2 PHANTOM. Honeycomb solves the problem of high-speed friction heating. And it reduces weight, increases strength, soaks up sonic vibrations.

This remarkable material will play an even greater role in the B-70 VALKYRIE . . . mighty mach 3 weapon system under development by North American Aviation.

Superior stainless steel honeycomb is one of many contributions Rohr has made to the aerospace industry during the past 20 years. Constant research, enlightened engineering, inventive manufacturing, and rich experience result in an unmatched capability for performance on a variety of assignments.
For the complete story or specific information, write Mr. A. R. Campbell, Sales Manager, Department 19, Rohr Aircraft Corporation, Chula Vista, California.

COOLING OFF THE HOT ONES



ROHR
AIRCRAFT CORPORATION

MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF.;
PLANT: RIVERSIDE, CALIF.;
ASSEMBLY PLANTS: WINDER, GA.; AUBURN, WASH.



To help men make decisions and exert control

The need for systems to help men make decisions and exert control over vast networks of rapid actions has created a fast-moving information technology. Accepting responsibility for instructing great computers, exploring system roles of men and machines, advancing system research – these are some of System Development Corporation's public interest functions in this new technology. ▪ *SDC's contributions to Sage and SAC control systems have equipped us for work in world-wide communications, education and medicine, traffic and logistics – for those information systems that will shape our culture.* ▪ *Participation in those fields has produced an interdisciplinary science based in four principal skills: Programming, Engineering, Operations Research and Human Factors. Senior professionals representing these four persuasions are invited to explore participation in our rapidly expanding programs. System Development Corporation, Santa Monica, California, Paramus, New Jersey.*

SDC

January 16, 1961

Aviation Week and Space Technology

Vol. 74 No. 3
Member ABP and ABC

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

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

MANAGING EDITOR.....William Gregory
TECHNICAL EDITOR.....David A. Anderton
EUROPEAN EDITOR.....Cecil Brownlow

BUREAU CHIEFS
WASHINGTON.....Evert Clark
LOS ANGELES.....Irving Stone
DALLAS.....Erwin J. Bulban

DESK EDITORS.....Craig Lewis, John A. Nammack, Harry Raven
AVIONICS EDITOR.....Philip J. Klass
ASSISTANT.....Barry Miller
TRANSPORT EDITOR.....L. L. Doty
ASSISTANTS Glenn Garrison, Robert H. Cook, David H. Hoffman, Jerome Bailey
ENGINEERING.....Michael Yaffee, Russell Hawkes, William S. Reed
SPACE TECHNOLOGY....Edward H. Kolcum, George Alexander
MILITARY EDITOR.....Larry Booda
BUSINESS FLYING.....Erwin J. Bulban, Herbert J. Coleman
CONGRESS.....Ford Eastman, Katherine Johnsen
EQUIPMENT.....Barry Tully
ART EDITOR.....Lawrence J. Herb
ASSISTANT.....Karl G. Neuman
SPECIAL PROJECTS.....Andrew A. Keil
EDITORIAL PRODUCTION....Arnold Sherman
ASSISTANT EDITORS.....Elizabeth M. Hein, Edith Walford
EDITORIAL ASSISTANTS.....Marjorie Nail, Marjorie Todd
LIBRARIAN.....Theresa V. Maggio

FOREIGN NEWS SERVICE
EDITOR.....John Wilhelm
LONDON.....John Tunstall
PARIS.....Robert E. Farrell
MOSCOW.....Ernest Conine
MEXICO CITY.....Peter Weaver
TOKYO.....Sol Sanders

DOMESTIC NEWS BUREAUS
ATLANTA 3.....1301 Rhodes-Haverty Bldg.
CHICAGO 11.....520 No. Michigan Ave.
CLEVELAND 15...1164 Illuminating Building
DETROIT 26.....856 Penobscot Bldg.
HOUSTON 25.....W-724 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.....T. H. Hunter, Jr.
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, R. Wallace, J. D. Warth
PHILADELPHIA..J. D. Willis, J. M. Tannehill
PITTSBURGH.....G. R. Schaefer
SAN FRANCISCO.....William Woolston
PROMOTION & RESEARCH MGR..C. C. Gersna
EUROPEAN MARKETING DIRECTOR Fulvio Piovano
RESEARCH & MARKETING.Rosalie Christesen

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

Stronger Space, Missile Efforts Urged..... 26
▶ New White House science aide asks single military program, more weapons, better management of NASA.

CAB Probe Centers on DC-8 Recorder..... 38
▶ Automatic unit shows that United jet transport had a 438 kt. groundspeed when it overshot Preston intersection.

Discoverer Tests Samos, Midas Guidance..... 88
▶ Major components undergoing extensive flight tests in Lockheed Agena A, B satellite payloads.

SPACE TECHNOLOGY
Stronger Space, Missile Efforts Assured 26
Mercury Program for Atlas..... 27
Thiokol Super Space Booster..... 34
Blue Scout Launches Test Payload.... 35
Trailblazer II Re-entry Tests..... 102
Soviets Plan More Animal Flights.... 105
Space Vehicle Log..... 107

MISSILE ENGINEERING
Pluto Research Spurred..... 74
Skybolt Prepared for Drop Tests..... 30
Army's New Rocket Grenade..... 32
GAO Criticizes Titan Delay..... 34
Japanese Sidewinder Production..... 83
Wag Tail Missile Adapted as ALBM.. 85

AERONAUTICAL ENGINEERING
HSS-2 Sub Hunter-Killer Role..... 52
VTOL Agreement on G.91 Replacement 36
Bell HUL-1M Tiedown Tests..... 58
Lycoming T55 Turbine Hail Test..... 66
Production Briefing..... 63

AVIONICS
Samos, Midas Guidance Tests..... 88
Microfilmed Drawings on IBM Cards.. 91
Filter Center..... 97
New Avionic Products..... 101

AIR TRANSPORT
CAB Probe Centers on DC-8 Recorder. 38
Air-India Global Route..... 41
Irish Troops Airlifted to Africa..... 43
Viscount Speed Reduction..... 43
Supersonic Transport Program..... 43
New Helicopter Airline..... 43
Liberia Behind in Airline Race..... 45
Airline Traffic—November..... 47
Shortlines..... 50
Airline Observer..... 50

MANAGEMENT
U. S. Retaliatory Forces..... 28
Kennedy Names Science Adviser..... 29
European F-104G Financing..... 32
Space Projects Cut Sharply..... 33
NASA Has Balance in Research Funds. 37
ARDC-Europe Space Research..... 117
Who's Where..... 23
Industry Observer..... 23
Washington Roundup..... 25
News Digest..... 37

BUSINESS FLYING
Piper Expects 1961 Profit Slump..... 27
Mooney All-Metal Mark 21..... 108

Calendar..... 5
Letters..... 136

EDITORIAL
New Vigor for Space Program..... 21

COVER: General Electric's Sud Aviation Caravelle makes its first flight powered by two GE CJ-805-23C aft-fan engines rated at 16,100-lb. thrust each which will power the production Caravelle VII. Tests on the first flight included a series of stalls, throttle chops and bursts, air starts, and a general aircraft system checkout. The aircraft was intentionally yawed 10 deg. with no noticeable change in fan speed.

PICTURE CREDITS

Cover—General Electric; 34—Thiokol; 35—USAF, Martin; 43, 65—General Electric; 52, 53, 55—Sikorsky; 58—Bell Helicopter Corp.; 60—Convair; 63—Lockheed; 66—Lycoming; 74, 85—Aviation Week; 75, 77—Chance Vought; 83 (bottom)—Northrop; 88, 89 (bottom)—Minneapolis-Honeywell; 89 (top)—USAF; 91—Collins Radio Co.; 96—Ramo-Wooldridge; 102—Atlantic Research Corp.; 105—French Air Ministry; 160—Johns-Manville; 108 (top)—Mooney Aircraft Co.; 108 (bottom)—Tony Linck; 109, 112—E. J. Bulban.

85,241 copies of this issue printed

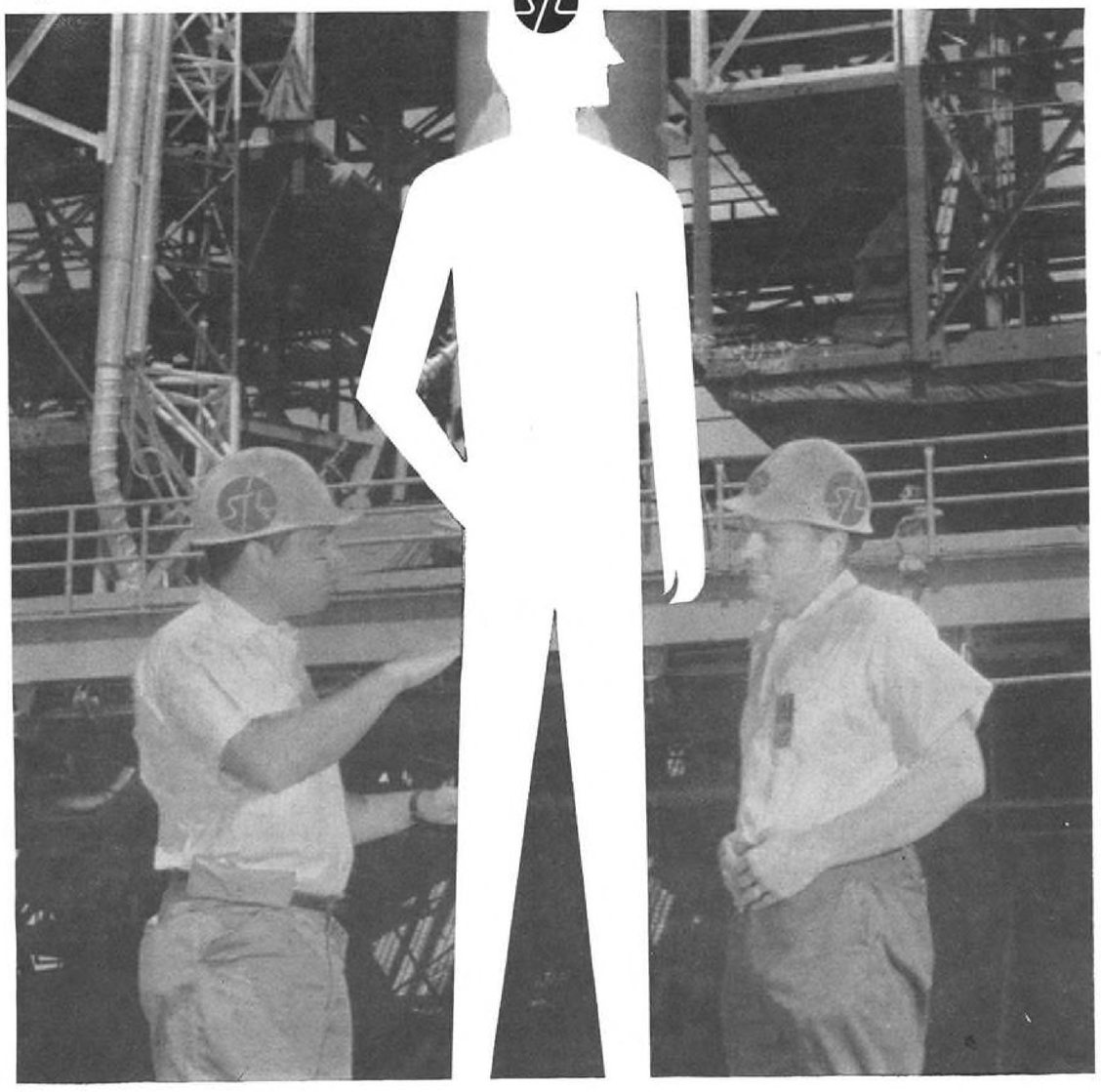
A special breed of generalist for **S**pace **T**echnology **L**eadership

America's dramatic accomplishments in space technology are made possible not only by developments in science, but by advances in technical management concepts. A new type of generalist has emerged to meet the demands of systems engineering and technical direction of complex missile and space projects. This technical manager combines a broad knowledge of science and engineering with the leadership capability to fuse the disciplines of creative specialists into a dynamic, effective team • In its six years as a principal contractor for the Air Force, NASA, and ARPA, STL's hard core of technical management generalists has set the pace in developing new members of this very scarce breed • Their unique ability is the prime asset in Space Technology Leadership • Scientists and engineers who would add this new management dimension to their professional careers are invited to submit their resumes to STL, where they will receive meticulous attention.

SPACE TECHNOLOGY LABORATORIES, INC. P. O. BOX 95005 A LOS ANGELES 45, CALIFORNIA

a subsidiary of Thompson Ramo Wooldridge Inc.

El Segundo • Santa Maria • Edwards Rocket Base • Canoga Park STL Cape Canaveral • Manchester, England • Singapore • Hawaii



EDITORIAL

New Vigor for Space Program

It is evident from events of recent weeks that Vice President Lyndon Johnson will be running the national space program and that he intends to run it with more vigor than any top level government official has displayed since Sputnik I heralded the practical beginning of the space era. The report of President Kennedy's ad hoc committee on space (see p. 26) further emphasizes the energy and drive that the new administration intends to inject into both the civil and military aspects of our national space effort. The blunt specifics of the report's criticism of the current management and direction of the space program will certainly receive widespread endorsement from the knowledgeable working levels in industry and the military, although some super-sensitivity can be expected from the NASA administration that stimulated President Eisenhower to announce recently that this country is now "pre-eminent" in space accomplishments.

Although admittedly a "hasty" performance, this report does a far better job of putting a finger on the specific weakness of the national space program and prescribing remedies than all of the long, drawn-out congressional committee hearings on the subject in both Houses. It is just this sort of swift incisiveness that is required in the organization and operation of a new national space program, because the time for effective action in this international area is growing very late.

Birth of a Space Council

In addition to the personal leadership to be supplied by Vice President Johnson, the space program will see the birth of the National Aeronautics and Space Council as a strong directive and policy formulating force. We use the term birth rather than revival purposely because its activities since creation by the National Space Act of 1958 have given little evidence of life. Both in its composition and in its hardly more than a dozen meetings—despite the critical urgency of the space program—this group has exhibited the traditional ineffectiveness of the committee approach to executive action while actual space policy has been distilled by a small group of ex-infantrymen and bookkeepers in the White House.

With Vice President Johnson's intention to make the Space Council an active and effective organization, he must devote special care to appointments to its ranks. Some, such as the Secretary of Defense, Secretary of State, NASA administrator and Atomic Energy Commission chairman are specified by law and offer no choice. But there are four additional memberships that can be filled with a wide latitude in qualifications. It is with these appointments that Mr. Johnson should particularly concern himself to ensure that he gets expert professional advice necessary to point his program in the best directions and keep it moving at the maximum possible pace.

Space technology is a new field, and the experts in this area are not to be found among the elder statesmen of the academic ivy or the corporate boards. They are of necessity younger men who have had the vision and enthusiasm to drive into new technology long before it became either fashionable or profitable. This is the same type of person who performed so well earlier in creating the new technology spawned by nuclear fission. Effective space policy cannot be organized in a technical vacuum, as the experience of the past few years has amply demonstrated. Nor can effective technical input come from scientists and engineers acting purely in advisory capacities without responsibilities for achieving results.

Stronger Military Voice

There are ample political resources available in Mr. Johnson himself and his key committeemen on both the Senate and House space groups to provide the necessary legislative support for an effective space program. Additional elements of this resource are not required on the Space Council. Another glaring weakness of the current composition of the Space Council is the lack of adequate military representation. Certainly Mr. McNamara, the new Secretary of Defense, can be expected to take his Space Council post more seriously than his predecessors, but even so, he will find it difficult to squeeze it in with his multitudinous other responsibilities.

The old National Advisory Committee for Aeronautics wisely bypassed the Cabinet level in picking its members and concentrated on the top technical levels, such as the Deputy Chief of Air Staff for Development and the Deputy Chief of Naval Operations for Air, in order to get more expertise in formulating its admittedly effective research programs. In naming the additional Space Council member required from a government agency other than State, Defense and AEC, it would seem appropriate to name an Air Force officer with both top level technical responsibilities in space technology and considerable experience with his new field. USAF contributes about 90% of the current military space effort.

New NASA Chief

Under the new pattern that is evolving for the national space program, it is obvious that NASA will be operating under stronger policy direction form the Space Council—indeed such direction has been totally lacking up to this moment. Thus the new NASA administrator should find himself with a clearer and probably more demanding blueprint of future achievements required, but also with more substantial financial and policy support. This post will also require the very ablest technical manager who can be found from the ranks of the younger, more vigorous and more knowledgeable people who are not only familiar with this technology but enthusiastically believe in its future value, and who are not interested in slowing their technical pace to that of the bookkeeper's scratching pen.

The Kennedy Administration has taken some positive initial action to inject new vigor and effectiveness into the national space program. Its next big hurdle in this area lies in making the proper appointments to the National Space Council and the top levels of NASA.

—Robert Hotz



SANTA ANNA'S
LACK OF RECONNAISSANCE.....
MIDWIFE TO THE **BIRTH OF**
TEXAS

Sam Houston said that knowing what the other fellow was doing placed him ahead in the game of war. Santa Anna frequently ignored reconnaissance.

These contrasting philosophies set the stage for a most remarkable battle. On a warm April afternoon, 1836, Santa Anna was enjoying a siesta. His aides sipped champagne nearby. Santa Anna's entire Mexican army felt secure as it nestled against the San Jacinto River.

Presumably, Santa Anna would have been more apprehensive if he had known that a courier, Captain Miguel Bachiller, had been captured by Deaf Smith, one of General Houston's highly effective "eyes." Also captured was correspondence which mentioned that Santa Anna was camped with only a 1,000 man vanguard. Sam Houston's 800 man army paused as Deaf Smith reconnoitered, returning with incredible news . . . not one Mexican scouted between the two forces. The Texans attacked . . . frontally over flatlands in the middle of the afternoon . . . and the result was surprise and victory.

Santa Anna's power had been based on maintenance of a potent fighting force. But Santa Anna's downfall resulted from failure to plan for reconnaissance. He invited defeat by ignoring reconnaissance . . . the military basic that has helped shape the history of the world.

Today, CAI's specialty in reconnaissance is helping shape history to the advantage of the Free World. Typical of CAI contributions is the Integrated Reconnaisaance Intelligence System. Known as **IRIS,** the system features rapid processing and the ability to produce super-clear photos at any speed, any altitude, day or night. The **IRIS** system is in production and available now.

For a detailed look at CAI's Full Circle Capability write for the informative brochure, Sight for Flight.

CHICAGO AERIAL INDUSTRIES, INC.

550 WEST NORTHWEST HIGHWAY, BARRINGTON, ILLINOIS • offices: DAYTON, LOS ANGELES, WASHINGTON, D.C.

OTHER DIVISIONS: KINTRONIC, CHICAGO AERIAL SURVEY, Franklin Park, Illinois; PACIFIC OPTICAL CORP., Inglewood, Calif.

WHO'S WHERE

In the Front Office

Edward M. Bostick, president and chief executive officer, Melpar, Inc., Falls Church, Va., succeeding **Thomas Meloy,** now board chairman. Also: **Arthur C. Weid,** executive vice president.

David S. Lewis, executive vice president, McDonnell Aircraft Corp., St. Louis, Mo., and **Nicholas Dykstra,** vice president-finance.

W. D. Bryson, a vice president, Solar Aircraft Co., San Diego, Calif., a subsidiary of International Harvester Co.

Ralph D. Henderson, vice president-finance and administration, Vard Division of Royal Industries, Inc., Pasadena, Calif., and **John T. McGraw,** director of engineering.

Philip Moore, vice president-manufacturing, Dallas (Pa.) plant of Linear, Inc.

Fred J. Knepper, vice president-finance, Autonetics, a division of North American Aviation, Inc., Downey, Calif.

John Hull, a vice president, Walter Kidde & Co., Belleville, N. J., in charge of the International Division.

Glenn A. Wilson, vice president-purchases and special projects, Firth Sterling, Inc., Pittsburgh, Pa.

Dr. Adolph H. Rosenthal, scientific adviser to the president, Kollsman Instrument Corp., Elmhurst, N. Y.

Chicago Aerial Industries, Inc., Barrington, Ill., has named Vice President **George Hoeck** as director of administration.

G. C. Pearce, assistant to the vice president sales, The Garrett Corp., Los Angeles.

Air Force has appointed the following officers Site Activation Task Force Commanders for Titan II Ballistic Missile Sites: **Col. William E. Todd**—Griffiss AFB, Rome, N. Y.; **Col. Julian M. Bleyer**—Little Rock AFB, Little Rock, Ark.; **Col. Murray A. Bywater**—McConnell AFB, Wichita, Kan.

Honors and Elections

Capt. Gordon McGillivray, Middle East Airlines, has been named chairman of the International Air Transport Assn.'s Technical Panel for the Europe-Mediterranean area, and **Lars Enderlein,** Scandinavian Airlines System, was named vice chairman; **Douglas Newham,** British Overseas Airways Corp., was named chairman of the IATA Technical Panel for the North Atlantic area, and **Harold Ferris,** Trans-Canada Air Lines, was named vice chairman.

Aerospace Industries Assn., Washington, D. C., has announced the following elections: **Stanley Hiller, Jr.,** of Hiller Aircraft Corp., 1961 chairman of the Helicopter Council, and **Peter J. Papadakos** of Gyrodyne Company of America, continues as vice chairman; **Albert R. Mead** of Grumman Aircraft Engineering Corp., 1961 chairman of the Aerospace Research and Testing Committee, and **H. M. Rush** of Rohr Aircraft Corp., vice chairman; **H. C. Christen** of Lockheed Aircraft Corp., 1961 chairman of the Quality Control Committee, and **Frank McGinnis** of Sperry Gyroscope Co., vice chairman; **O. F. Janssen, Jr.,** 1961 chairman of the Spare Parts Committee, and **Herschel S. Nelson** of McDonnell Aircraft Corp., vice chairman.

(Continued on page 116)

INDUSTRY OBSERVER

► One cause of delay in the first test firing of Minuteman has been uncertainty whether flight control system actuators have sufficient torque to operate engine nozzles. Recent studies indicate the actuators may not be powerful enough to handle expected variations in nozzle bearing friction, which cannot be measured without firing the solid propellant engine.

► **North American and Boeing are searching for the basic cause of guidance problems that are plaguing the Hound Dog missile, planned for use with the B-52. One theory is that difficulties may be caused by transients introduced in the missile's inertial guidance system when it is switched from the bomber's electric power system to the missile power system just before launch.**

► Air Force Ballistic Missile Division is considering a $20 million reliability improvement program for the Midas early warning satellite as a result of a study made by Arinc Research Corp. One reliability problem stems from the fact that the satellites will operate in the vicinity of the inner Van Allen radiation belt and may require the use of vacuum tubes instead of transistors, calling for a larger satellite power supply.

► **Specifications for the Saturn booster recovery system are being rewritten so all feasible methods can be considered. North American Aviation and Ryan proposed systems last November using the Rogallo wing (AW Dec. 12, p. 34), and National Aeronautics and Space Administration is evaluating these proposals. NASA previously has favored a parachute recovery system.**

► Lockheed has selected RCA to build the automatic programing and test system (APATS) to be installed in the Hivos orbital simulator (AW Nov. 14, p. 23).

► **Air Force has instructed Westinghouse Electric to consider using elements of the Sperry AN/ALQ-27 electronic countermeasures system in the ECM system being developed for the North American B-70. The ALQ-27, canceled last year for lack of funds, was developed for the Boeing B-52H and was the first attempt at a completely integrated system, and USAF is trying to recover some of its $100 million investment. Prototype ALQ-27 will be flight-evaluated soon in a KC-135 at Eglin AFB.**

► Nearly 50 companies bid for the role of Bullpup second production source early this month. Martin Co. is prime contractor for the Navy air-to-surface missile. Major factor in Navy's request for proposals was its experience with Sidewinder in which costs dropped drastically after a second source was introduced.

► **Results of a Defense Department study refute the Electronic Industries Assn.'s contention that imports of Japanese transistors for consumer products pose a serious threat to U. S. producers of military-type transistors. The study was requested by the Office of Civil Defense and Mobilization, and this agency now is expected to reject the EIA petition that importation of Japanese transistors be restricted.**

► Allison T63 turbine engine will be used in the four-place helicopter design Kaiser Fleetwings will submit in the Army light observation helicopter competition. Kaiser has bought license rights for the aircraft from Doman Helicopters, which designed but never built it.

► **Launching for Project Flashlight, an Air Force Cambridge Research Laboratory geodetic triangulation technique survey, is scheduled for Feb. 15 from National Aeronautics and Space Administration's Wallops Station. Two five-stage, solid-fuel vehicles, assembled by Ryan's Aerolab Development Co., will be launched to 1,000 naut. mi. altitude at two hour intervals, releasing 10 flares before reaching peak height and six flares at intervals after apogee.**

► Soviet Union has developed two new light aircraft—the KhAI-17, a 770-lb., 93-mph. monoplane with a 30-hp. engine driving a pusher propeller, and the KhAI-18, an 1,100-lb. aircraft powered by a 50-hp. engine with a top speed over 125 mph. and range of 1,865 mi.



SOME SILICONE RUBBER "FIRSTS"...WHERE YOUR SILICONES MAN PLAYED THE LEAD

The combined technical and research facilities of Union Carbide Corporation, with tremendous resources of chemical experience and knowledge, have brought about outstanding achievements in silicone rubber. Ten of these contributions, which industry has enthusiastically accepted, are depicted on our film strip here.

Important thing to remember: Whenever you need the strikingly superior advantages of silicone rubber, see your UNION CARBIDE Silicones Man first. Advantages such as low temperature flexibility, thermal and oxidation stability at very high temperatures; low compression set; weather, ozone, oil resistance; electrical resistance or conductivity. Your Silicones Man has them all at his fingertips. Write Dept. AA-9002, Silicones Division, Union Carbide Corporation, 270 Park Avenue, New York 17, N.Y. *In Canada:* Union Carbide Canada Limited, Bakelite Division, Toronto 12, Ontario.

Unlocking the secrets of silicones
Rubber, Monomers, Resins, Oils, Emulsions

The term "Union Carbide" is a registered trade mark of Union Carbide Corporation.

UNION CARBIDE SILICONES

Washington Roundup

NASA-Military Space Fight Criticized

First public criticism of the campaign to build a stronger military space program has been voiced by Rep. Overton Brooks, head of the House space committee. Brooks agrees that an enlarged and broadened military program is needed and agrees with the Wiesner report (see p. 26), but he said: "I have taken a dim view of various efforts which have been under way, largely behind the scenes, to downgrade the civilian space agency on the ground that a greater military effort is needed. . . . The two should work together because many of their goals will be common."

At the same time, Keith Glennan, who retires this week as administrator of the National Aeronautics and Space Administration, denies that the civilian space agency is girding for an attack by the Defense Department.

Glennan says there always will be pulling and hauling between the two agencies, but he believes that there is less controversy and more cooperation between them now than anyone expected a year ago.

Glennan attributes this largely to the Astronautics and Aeronautics Coordinating Board, which is co-chaired by Defense Director of Research and Engineering Herbert York and NASA Deputy Administrator Hugh Dryden. The board, less than a year old, has created understanding and made decisions, whereas the lower-level Civilian-Military Liaison Committee was primarily a pipeline, Glennan said.

Next NASA administrator will be a surprise to most. None of the contenders publicly mentioned so far will be chosen for the job.

Musical Chairs

Research and development in the Air Force may be supervised personally by Under Secretary Joseph Charyk until he replaces Herbert York as Defense research chief. Courtland Perkins leaves the Air Force research job Feb. 1.

Charyk, who once held the Air Force research job, is expected to have John Rubel as his top deputy if he takes York's post. Dr. Marvin Stern would then become the Air Force research secretary. So far, neither Army research director Richard Morse nor Navy research chief James Wakelin has been asked by the Kennedy Administration to stay on.

Watch for top management changes in two major aerospace firms—Convair Division of General Dynamics, where President J. V. Naish will move on to a non-aviation post, and Douglas Aircraft, where top level managerial talent will be imported from the auto industry.

Expect significant changes in Defense Department's bookkeeping system designed to make what really happens to the money more obvious. Controller-designate Charles J. Hitch considers the present system misleading if not deceitful.

Ned Trapnell, former public relations man, Atomic Energy Commission information aide and newsman, will handle public affairs and legislative liaison for USAF Secretary-designate Eugene Zuckert, with whom he worked at Atomic Energy Commission in the early 1950s.

Cost Sharing Snag

General Electric has refused to accept the principle of government-industry sharing on a percentage basis for company-initiated development programs. This is one of three possible cost-sharing arrangements, spelled out in a revision of Sec. 15 of Armed Services Procurement Regulations and aimed at cutting government costs.

Approximately 20 other major defense contractors have signed percentage agreements. GE is willing to accept alternative ASPR provisions, but the military services are insisting on percentage cost sharing because they believe it assures better program management and control.

Airline circles are buzzing over the reported existence of a series of candid photographs taken in the cockpit of jet transports in flight, showing flagrant violations of civil air regulations by pilots and copilots. Pictures are expected to be submitted to the Federal Aviation Agency soon.

An 18-month campaign by Rep. John Moss' House Government Information Subcommittee has resulted in a White House order rescinding the authority of two dozen government agencies to originate security classifications on information. They included the Migratory Game Bird Commission and the Indian Arts and Crafts Board.

—Washington Staff

Stronger Space, Missile Efforts Urged

New White House science aide asks single military program, more weapons, better management of NASA.

By Evert Clark

Washington—Single military space program, revamped management of the civilian space effort and acceleration of ballistic missile programs became virtual certainties last week when President-elect John F. Kennedy named Dr. Jerome B. Wiesner to be his White House science adviser (see p. 29).

Wiesner headed a Kennedy task force which only the day before had delivered a report that sharply criticized the U.S. position in the missile, space and aeronautical research fields, and urged these and other strong corrective measures.

The report is expected to become the Kennedy Administration's blueprint for greatly revised missile and space activities for a number of reasons, including these:

• **Wiesner,** who is head of Massachusetts Institute of Technology's Research Laboratory of Electronics, and Dr. Bruno B. Rossi, MIT physics professor who also served on the task force, have been advising Kennedy on scientific matters since before the national political conventions last July.

• **Trevor Gardner,** another member of the task force, is a trustee of the Air Force-affiliated Aerospace Corp. and one of the architects of USAF's space programs. He and Wiesner formerly were associated in the old Hycon Eastern Corp. Gardner, who has been prominently mentioned for a number of Kennedy Administration posts, including National Aeronautics and Space Administration director, was made USAF assistant secretary for research and development by President Eisenhower but resigned in 1956 because he differed with the President and Defense Secretary Charles E. Wilson over what Gardner considered inadequate support of research and development. He is now president of Hycon Manufacturing Co.

• **The task force report,** repeatedly mentioned the "urgent need to establish more effective management and coordination of the U. S. space effort," and called for a strong National Aeronautics and Space Council, staffed by technically well-informed members who seriously accept the responsibility for directing the conduct of the program. This council is to be headed by Vice President-elect Lyndon B. Johnson.

Kennedy emphasized again last week in commenting on the Wiesner report that Johnson "will be playing a leading role in coordinating activities in this field." Kennedy called Johnson, who headed the Senate Committee on Aeronautical and Space Sciences, "the author of the Space Act" that created NASA. Two of Johnson's key advisers on space—his Senate committee staff director, Kenneth E. BeLieu, and Max Lehrer, assistant staff director—were members of the nine-man Wiesner task force.

Although Kennedy referred to the 19-page Wiesner report, which was prepared in approximately a month, as "a highly informative working paper," there was little doubt that most of its recommendations would be implemented, particularly since the criticisms and recommendations contained in the report so closely paralleled what Kennedy and Johnson have been saying over the past year.

The task force also gave Kennedy a secret report on military programs. Other members of the group, formally known as the President-elect's Ad Hoc Committee on Space, were Donald F. Hornig, chairman of Princeton University's Chemistry Department; Edward M. Purcell, Harvard University physics professor; Edwin H. Land, president of the Polaroid Corp., and Harry J. Watters, Land's assistant.

In five major recommendations, the task force urged that:

• **The Space Council** be made "an effective agency for managing the national space program." President Eisenhower chaired the Council, which was created late in 1958 by the Space Act, for its first year but asked Congress to abolish it a year ago and did not use it through 1960.

• "**One agency on military service**" within the Defense Department be given responsibility for all military space developments. USAF's major portion of current military space work, Gardner's presence on the task force, the fact that Defense Secretary-designate Robert S. McNamara and Deputy Secretary-designate Roswell Gilpatric have had close Air Force association, plus Lyndon Johnson's favorable attitude toward USAF space work, all point to the Air Force as the probable agency.

• **NASA be given** "a vigorous, imaginative and technically competent top management," including an administrator, deputy administrator, and four technical directors for propulsion and vehicles, the scientific program, non-military space applications and aerodynamic and aircraft programs. NASA now has four technical offices—one for development and launching of vehicles, one for spaceflight programs, one for advanced research and one for life sciences.

• **National space program** be reviewed and objectives redefined on the basis of two years' experience. "Particular attention should be given the booster program, manned space flight, the military uses of space and the application of space technology to the civilian activities of the country."

• **Organizational machinery** be established in the government "to administer an industry-government civilian space program." The apparent duplication between this and the recommendation for a NASA technical director for non-military space application was not explained.

Need for Early Action

The panel called its survey "a hasty review," but said it had found a number of major personnel, technical and administrative problems that "require the prompt attention of the Kennedy Administration." It spoke of "the overriding necessity to provide more efficient and effective leadership" and said it had devoted a major portion of its time to that aspect of the program.

Findings included:

• **Ballistic missile program** is "lagging" and development of missiles and their control systems, base construction and missile procurement "must all be accelerated if we are to have the secure missile deterrent force soon that the country has been led to expect." Missiles are being relegated to "routine management" because space is drawing away "the sense of excitement and creativity." For the near future, adequate deterrent is "much more important for the nation's security than are most of the space objectives," but there is "no alternative but to press forward with space developments."

• **There are three military space** programs, overlapping in some cases with NASA's, and direction of this "fractionated" military program must be pulled together.

• **NASA is "preoccupied** with the development of an in-house research establishment," particularly in the scientific fields.

• **NASA is giving too little** attention to provisions for basic research and advance development in aeronautics. "Possibly after careful investigation the Space Council would prefer to stimulate this work by non-governmental arrangements or by placing it entirely in another agency," the report said.

• **Boosters still are** the chief limiting factor in the space contest with Russia—a race in which the U. S. clearly leads in scientific areas—and "rapid development of boosters with a greater weight-lifting capacity is a matter of national urgency."

• "**Mercury (man-in-space) program,** based on the Atlas, is marginal and if the Atlas proves inadequate . . . it may be necessary to push alternatives vigorously." Titan should be studied for a possible Mercury role (see box).

• **If the Centaur** liquid hydrogen upper stage develops difficulties in the next three to four months "we must act promptly to initiate an alternate."

• **Saturn clustered booster's** intrinsic complexity and lack of growth possibility means that the F-1 1.5-million-lb. single chamber engine should be studied to see if it is progressing well enough to be a Saturn back-up and a building block for larger vehicles. If not, "a parallel development of a somewhat smaller engine should be started."

• "**A major technical** and management review of the Rover (nuclear rocket engine) program seems urgent" because its technology is new, extrapolation of its reactor to useful sizes is so great and serious international political problems may be raised by flying it.

• "**Above all we must** encourage entirely new ideas which might lead to real breakthroughs." The example given was Project Orion, aimed at a spaceship propelled by small nuclear explosions.

• **Competent scientists** and scientific missions must continue to have an important place in space exploration, since much of the U. S. success has come from such a practice.

• **Man will explore space,** but giving Mercury a top national priority and publicizing it the way it has been has led to the mistaken belief that manned flight is the most important aim of non-military program.

• "**Vigorous program**" to exploit practical space systems is needed. In addition to great military and civilian benefits inherent in weather, navigation, communication and mapping satellites, the communication and navigation systems should contribute to "an inspection system which might accompany a disarmament agreement."

Bambi Study Program

Los Angeles—Industry proposals for a study program involving ballistic missile boost-intercept (Bambi) systems concepts have been requested by Aerospace Corp., which has technical and management responsibility for the Advanced Research Projects Agency project. Initial funding for the studies will be about $3 million.

New NASA Center

Washington—National Aeronautics and Space Administration Life Sciences Research Center will be located at Ames Research Center, Calif. The new center will be responsible for research in flight medicine and biology, space medicine and behavioral sciences and space biology.

Mercury Effort Aimed at Atlas Improvement

Langley Field, Va.—Upper airframe and adapter sections are being strengthened on Atlas boosters for Project Mercury in an effort to improve the space launch capability of Atlas, which currently is the controlling factor in the manned satellite program.

Major Mercury subsystem development is essentially complete, according to program director Robert R. Gilruth, and improvement of Atlas capability now is a primary program goal. He said both Atlas and Titan were considered as launch vehicles early in the program, and he stands behind the Atlas selection despite the record of a single success in nine attempts to launch space payloads.

Atlas was chosen because of its more advanced development and because it eliminates one potential difficulty in that all three engines ignite on the ground. Two-stage Titan ignites sequentially, and the second stage engine starts at very high altitude.

Mercury-Atlas failure in July brought about an exhaustive assessment of data from this launch and from earlier experiments which used the Atlas as a space vehicle booster. Resultant studies have included the effects of vibration, shear and gust loads, plus wind tunnel studies over the flight Mach number range and a re-evaluation of the Mercury capsule angle-of-attack profile.

The area where booster and capsule are joined will be heavily instrumented in coming Mercury-Atlas shots, Gilruth said, and both he and his operations chief, Walter C. Williams, expressed confidence that Atlas with its beefed-up structure will have an adequate performance capability for Mercury missions.

An interim booster modification will be made for the second Mercury-Atlas experiment so it can be flown before April. Booster-capsule mating area will be partially beefed-up for the mission. Later Mercury-Atlas boosters will have the complete modification.

Gilruth pointed out that the 29-month-old Mercury development program has progressed to the point where integration of an orbital capsule on any vehicle but Atlas would be too complex. He said the original two-year target date for meeting program objectives proved too optimistic, but "manned orbital flight in 1961 is still in the cards."

Piper Expects Profit Slump in 1961 Sales

New York—Piper Aircraft Corp. last year set a new high mark for company sales—$40 million—but company president W. T. Piper told stockholders that profits for the coming year will be "considerably lower" than those gained in the 1960 period.

Piper said he expects the firm's dollar volume will hold close to 1960 sales. However, he explained that the major factors which will adversely affect 1961 profits will be heavy costs involved in putting the new four-place Cherokee into production at Vero Beach, Fla. (AW Jan. 9, p. 100), and the possibility of a "deepening recession."

The manufacturer has invested about $1.5 million in the new production facility. In addition, most employes are new and untrained, another factor affecting the cost pattern. Piper predicted the Cherokee eventually will outsell the Tri-Pacer, but only about 350 will be sold this year, due to production limitations.

Biggest question mark for 1961 sales, Piper continued, is in the twin-engine field: "Although we anticipate sales of at least 300 units, this more expensive line of airplanes is inclined to be affected to a greater extent by an economic recession."

Last year Piper sold 2,680 units, exclusive of military sales (13 Aztec twins delivered to U. S. Navy), its best production since 1947. Piper expects to sell 700 two-place Colt lightplanes in 1961 and development emphasis now is on a two-place, low wing plane made of plastic bonded glass fiber (AW Dec. 26, p. 13).

Total sales for 1960 were $40,211,828, up from $34,262,898 the year before. This resulted in a gross profit of $10,159,477, an increase of $1,846,521 over 1959. After taxes, interest and dividends, Piper showed a 1960 net income of $3,523,375, as compared with $2,781,871 in 1959.

Kennedy Urged to Inform Public, Improve U.S. Retaliatory Forces

Washington—Increased effort to strengthen and protect the U.S. nuclear striking force and to improve conventional forces was recommended by the National Planning Assn. last week in a report that urged President-elect John F. Kennedy to tell the public the "unvarnished truth about the national emergency."

Communist threat to the survival of the U.S. is a fact "which should be far more widely understood than it is today," the report said. It was prepared by the association's Committee on International Policy, headed by Frank Altschul, board chairman of General American Investors Co.

Noting that the Soviet threat continues unabated and that war is no longer a practical solution to international disputes, the report said the U.S. has not yet committed adequate resources to the careful protection of its retaliatory power, which is the key to deterring war. The group pointed out that the Soviets will continue to use local war or the threat of total war for some time as an instrument of policy.

When the U.S. can finally convince Soviet leaders that any further attempts at aggression will be far too risky from the point of view of their own self-interest, the report said, fruitful negotiations will then become possible because the Soviet Union will share with the U.S. a common interest in finding "institutional formulae" which will permit both to escape from the "tragic dilemmas" of the nuclear age.

"First and foremost," the report said, "we must do whatever lies within our power to achieve at the very least parity in the military domain. Both political parties in the last campaign were agreed on the necessity of increased expenditures for defense. Without presuming to expertise in these matters, we assume that this involves, in any event:

- **"The immediate hardening** and dispersal of strategic bases.
- **"The strengthening** of the political and military command and control of our nuclear forces, both to insure the survival of these controls in the event that command and communications are placed under deliberate surprise attack, and to reduce the chance of accidental unauthorized acts of war.
- **"The speeding up** of the Minuteman missile program.
- **"The speeding up** of the anti-missile missile program.
- **"The rapid acceleration** of the program of construction of more Polaris-carrying nuclear submarines.
- **"Greater emphasis** on long range basic research in the physical sciences.
- **"The placing** of a considerable part of the Strategic Air Command on an airborne alert, accompanied by the immediate procurement of an adequate stock of essential parts and the training of the requisite number of pilots and crews."

The purpose of these measures, the report said, is primarily to achieve invulnerability for the deterrent and to restore its credibility. Coincidentally, it added, the U.S. should take steps to increase materially the conventional forces and airlift capacity to the end that in a variety of circumstances the U.S. would have other options open to it than all-out thermonuclear war.

Rocket Shots to Test Hydrogen in Zero-G

Washington—Liquid hydrogen performance under solar radiation heat loads and in zero gravity will be assessed in a series of rocket flights from Wallops Island, Va., the first of them scheduled next week.

The experiment includes the the first attempt on the East Coast to recover a launch package in midair. A helicopter will try to snatch the payload camera during its parachute descent.

Thermal data telemetered from the unrecovered payload, and recovered film data on motions of the liquid hydrogen during flight, will be used in Centaur second stage and Saturn upper stage S-IV and S-V engine development.

Programed profile for the ballistic flight calls for a 118-mi. apogee and 40-mi. range. Approximately 0.2 lb. of liquid hydrogen will be carried in a 25-lb. Dewar bottle. The bottle and a 30-lb. recovery pack will be installed in an 87-in. nose section. Total payload weight is 250 lb.

The recovery pack contains data camera, 11.5-ft. diameter parachute, radar chaff, Sarah beacon, flotation bag and dye marker. It will be jettisoned 380 sec. after launch. After a 120-sec. free fall, the parachute will open at 25,000 ft. altitude.

If the air recovery attempt fails, the data camera is designed to survive an expected free-fall impact of 25 fps.

Program, consisting of nine Aerobee 150A launches, is being conducted by National Aeronautics and Space Administration's Lewis Research Center. Harold Gold is project manager.

The Dewar container is made of two stainless steel spheres surrounded by heating coils, which will provide equivalent radiant heat simulation for Centaur and Saturn mission environments. Inner sphere is 9-in. diameter and made of 0.01 in. steel. The 11-in. outer jacket is 0.03 in. steel.

Both spheres have windows with a strobe light illuminating the interior of the Dewar. The camera will be pulsed, exposing five frames per second over a 340-sec. period from 11.5 sec. before burnout to separation.

The flask will be mounted on a spin table which will be spun to 3 rps. The nose section will have two helium nozzles to provide 110-lb. thrust and counteract drag for 20 sec. Total zero-gravity flight time is estimated at 5.1 min.

The Aerojet-General Aerobee launch vehicle is 316.28 in. long with a 15-in. diameter. Stabilizing fin span is 46.8 in. The liquid-fueled motor has a specific impulse of 198 lb./sec., and a thrust of 4,100 lb.

Single-stage Aerobee vehicle burns 51.5 sec., and with the Dewar and camera payload will reach a 116,300 ft. altitude and 5,600 fps. velocity at burnout. The payload is programed to coast 179.5 sec. after burnout to apogee, nose over and fall free until a barometric switch signals parachute deployment 500 sec. after launch.

Because the mission depends on previously untried recovery, the launch schedule depends on a smooth sea state and 15,000-ft. cloud ceiling.

Norad Center Funds Requested by Gates

Colorado Springs, Colo.—Secretary of Defense Thomas S. Gates, Jr., asked the House and Senate appropriations committees last week to release $8.5 million to excavate Cheyenne Mountain west of here as a step toward moving the North American Air Defense Command's combat operations center under ground.

The request came as Canada's opposition Liberal Party leaders in convention last week demanded that the Canadians withdraw from Norad.

Canadian Defense Minister Douglas Harkness, here for a conference with Norad commander Gen. Laurence S. Kuter, said that Norad was necessary for the defense of North America, and the effort must be coordinated.

Congress had previously appropriated $10 million for the COC project, of which $1.5 million had been spent for a road to the site. Work was stopped when it developed that planning for the center must include provisions for detection and tracking of satellites. COC plans now have been revised to include satellite detection and tracking.

Gates said that $12.5 million would be asked for the project in Fiscal 1962.

Wiesner Named Kennedy Science Adviser

By Ford Eastman

Washington—Dr. Jerome B. Wiesner, long associated with defense scientific and technical activities, was chosen last week to be President-elect John F. Kennedy's scientific adviser.

Dr. Wiesner, a professor of electrical engineering at Massachusetts Institute of Technology and currently a member of the President's Scientific Advisory Committee, will replace Dr. George Kistiakowsky as chairman of the committee. The appointment came a day after Dr. Wiesner gave Kennedy a critical report on the U.S. space and missile effort (see p. 26).

Kennedy also chose Washington newsman Arthur Sylvester as assistant secretary of defense for public affairs last week and named Newton Minow chairman of the Federal Communications Commission. Minow will replace Frederick W. Ford, who will remain as an FCC member.

In addition to the strong views on the space and missile program Dr. Wiesner's committee expressed last week, he also feels that the White House Scientific Advisory Committee has directed Defense Department scientific matters to a greater degree than necessary. He will probably urge Defense to obtain a sufficient number of competent technical personnel to evaluate and direct its own programs (AW Dec. 26, p. 15).

Wiesner's Experience

Dr. Wiesner was born in Detroit May 30, 1915 and received B. S., M. S. and Ph. D. degrees from the University of Michigan, the last in 1950. He was associate director of the university's broadcasting service 1937-40 and chief engineer for the Library of Congress in 1940-42. Wiesner was on the staff of the MIT radiation laboratory 1942-45 and of the University of California's Los Alamos Laboratory 1945-46. He has been on the MIT faculty since 1946 and a professor of electrical engineering since 1950, and he is director of MIT's Research Laboratory of Electronics.

Wiesner's research work is credited with helping to develop the scatter communications technique, and during World War II he was in charge of developing large airborne early-warning radar. He was in charge of the electronic development group at Los Alamos and planned instrumentation for the nuclear bomb test at Bikini.

A member of the President's Scientific Advisory Committee since 1957, Dr. Wiesner also has served on the Army Scientific Advisory Committee since 1956. He was technical director of the committee that wrote the Gaither Report, which was critical of the U.S. defense effort.

Arthur Sylvester, Washington correspondent for the Newark Evening News, was chosen for the DOD information post now held by Murray Snyder. The announcement came in the midst of reports that the incoming Defense Department administration headed by Robert S. McNamara is considering a policy of releasing more information to the public than has been released under current policies.

Meanwhile, top Eisenhower Administration officials continued to submit their resignations. These include Thomas S. Gates, Jr., defense secretary; James H. Douglas, deputy defense secretary; Maurice H. Stans, Budget Bureau director; George B. Kistiakowsky, special assistant to the President for science and technology and John A. McCone, AEC chairman.

Submitting his resignation, Gates told the President that the basic principles followed in the defense program have "provided the United States with a military strength second to none and at a cost that has not impaired the national economy. Today our armed forces have the greatest striking power in our history—many times greater than in 1953."

Accepting the resignation, the President commented that "at the same time, provision has been made to see that this pre-eminence can be sustained in future years."

In a summary of fiscal and budgetary accomplishments that accompanied his resignation, Stans told the President that in the 20 years preceding 1953 there were only three years in which a balanced budget was accomplished. However, he said in the eight years of the present administration three balanced budgets have been achieved and two more are proposed—apparently the Fiscal 1961 and 1962 budgets.

Top foreign policy, defense and fiscal officials of both outgoing and incoming administrations will be included in a meeting between President-elect Kennedy and President Eisenhower Jan. 19, the day before inauguration.

The Senate planned to complete hearings on all of Kennedy's Cabinet appointments and to be ready to vote on them Jan. 21, the day after Kennedy's inauguration. Sen. Richard Russell (D.-Ga.), Armed Forces Committee chairman, promised last week to give close scrutiny to McNamara's plan to put approximately $1.5 million from sale of his Ford Motor Co. stock in a trust over which he would have no control while in office. He sold 24,750 shares to avoid conflict of interest.

New Senate committee assignments include Sen. John Stennis (D.-Miss.) as chairman of the Preparedness Investigating Subcommittee of the Armed Services Committee, a post formerly held by Vice President-elect Lyndon B. Johnson. Sen. Stuart Symington (D.-Mo.), newly appointed to the Senate Foreign Relations Committee, is expected to be particularly active on its disarmament subcommittee. Sen. Spessard Holland (D.-Fla.) is a new member of the Senate Space Committee, and Sen. Robert Byrd (D.-W. Va.) is a new member of Armed Services Committee.

President Defends His Defense Policies

Washington—The "bomber gap of several years ago" between the U.S. and Russia was rejected as a fiction by President Eisenhower last week and he said the missile gap "shows every sign of being the same."

In his final state of the union message, the President justified his defense policies and urged Congress not to return to "crash-program psychology of the past when each new feint by the Communists" resulted in panic.

His statement on defense and his description of the U.S. space program as pre-eminent for the betterment of mankind differ sharply with the views of the Kennedy ad hoc committee on space (see page 26).

The President characterized his defense policies as adequate, designed for the long pull, able to adjust to advances and capable of fighting local or general war. He backed his position with this 1953-1960 box score:

- **Missile status, with Atlas and Polaris operational, Titan to become operational this year and Minuteman next year, Thor and Jupiter squadrons deployed and many types of smaller guided missiles in the inventory. He said less than $1 million was spent annually on long-range missiles when he took office.**
- **Nuclear ships, with 49 authorized and 14 commissioned, including three Polaris submarines. There were no nuclear ships eight years ago.**
- **Completion of the development of supersonic aircraft, with Mach 2 aircraft now operational.**
- **Maintenance of mutual security ties and Administration support to strengthen allies. Combined strength of U.S. allies is five million men, over 25,000 aircraft and several thousand ships.**



FIRST BOEING B52-H jet bomber to roll out at Wichita plant displays two pairs of Douglas Skybolt air-launched ballistic missiles.

Skybolt Prepared for First Drop Tests

Wichita, Kan.—Teams of Boeing B-52 Stratofortresses carrying multiple loads of Douglas GAM-87A Skybolt air launched ballistic missiles could maintain a continuous airborne alert providing a nuclear threat to the enemy comparable to that of Polaris-carrying submarines at a cost "substantially less," studies by Boeing Airplane Co.'s Wichita Division indicate.

Although Boeing-Wichita engineers would not go into detail concerning the studies, they emphasized that the comparison is not intended to degrade the Navy's continuous alert roving missile launch facility strategy. Rather it serves to illustrate that adding the airborne system would provide a three-dimensional mobile ballistic missile base system with Minuteman on rails, Polaris under the water and Skybolt aloft that would strengthen U.S. war potential and deterrent force at a reasonable cost.

Indications are that the Skybolt warhead will provide a nuclear yield on target comparable to that of the submarine-based Polaris.

Tactical Capability

Tactical capabilities that Skybolt-equipped B-52 bombers would provide include:

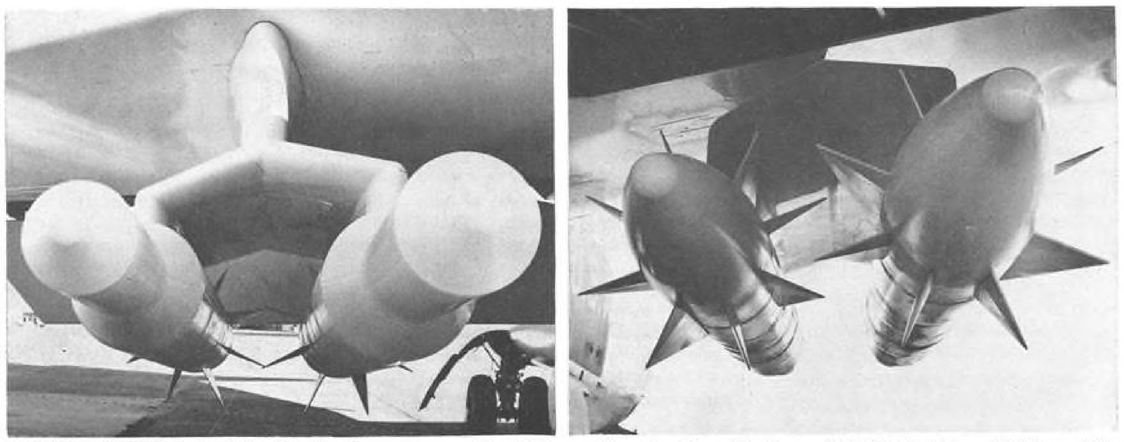
- **Constantly moving,** difficult-to-destroy ballistic missile launch sites, harder to locate and knock out than the Polaris system.
- **Posing sharply reduced** defense reaction time for a potential enemy, since the airborne missiles can be positioned close to his borders, reducing launch to strike on target time to a minimum.
- **Launcher's ability** to perform additional destruction by penetrating the enemy's territory with the manned bomber to seek out and destroy further targets with its gravity-dropped nuclear weapons which reportedly can provide greater yield with less circular error probability than any missile warhead.

Boeing-Wichita engineers pointed out that B-52H rollout, which had the missile platform bomber fitted with a dual launcher under each wing carrying a total of four Skybolts, did not represent the system's ultimate capability since additional launchers could be installed to increase the number of Skybolts that the bomber could carry.

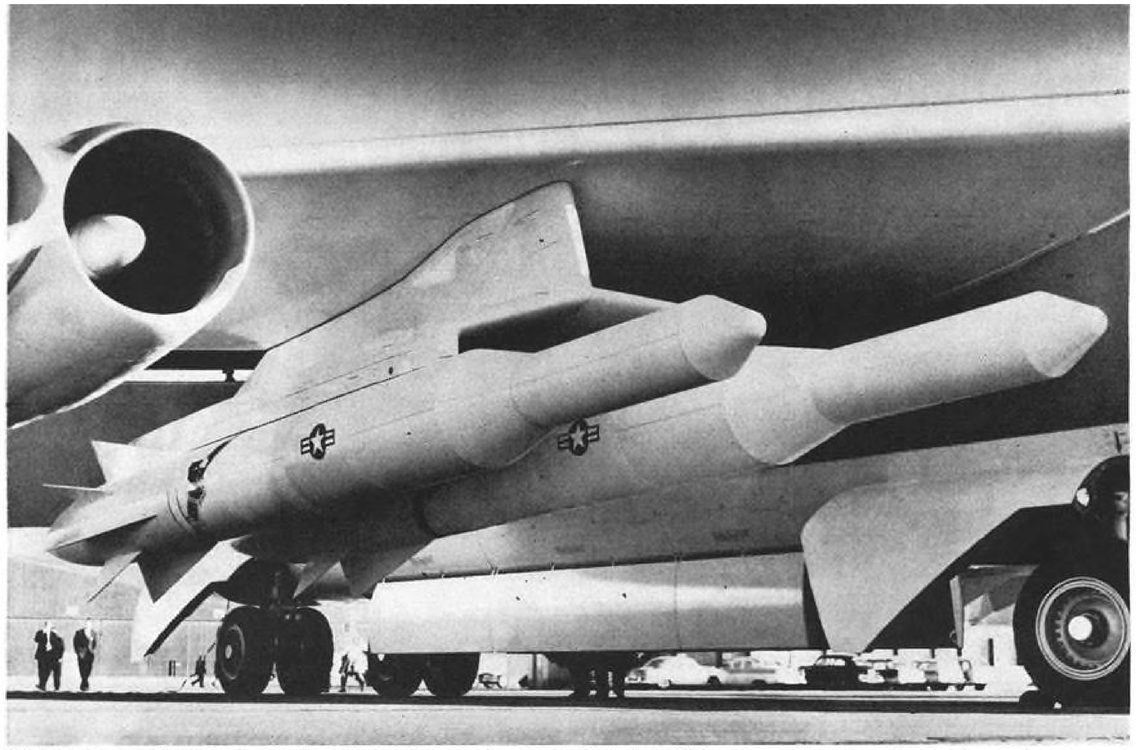
'Hard Points'

They also noted that both the B-52H and earlier B-52G are fitted with missile launcher "hard points," (structural beef-up) and that the Skybolt could also be carried by B-52s previous to the G series. Programing is now under way for some retrofit to provide earlier bombers with Skybolt capability.

Skybolt program currently calls for



T-SHAPED PYLON designed by Douglas is a permanent installation and is not a droppable item. Skybolt tail fairings (right) are jettisoned by means of explosive bolts, immediately following a free-fall drop from the underwing mounts. Skybolt missile is 39 ft. long.



STAGGERED MOUNTING characterizes side-by-side mounting of the Skybolt ALBMs. Inverted T-pylon offers minimum drag.

the missiles to become operational approximately a year and a half after the last B-52H now programed joins SAC. Current B-52H production is scheduled until mid-1962, with 102 airplanes now programed. These are slated to join six strategic wings beginning this May.

Skybolt was scheduled to be carried aloft for the first time last week on a specially modified B-52G testbed to start evaluation of its compatibility with the bomber. The configurations carried by the B-52H at its recent unveiling (AW Jan. 9, p. 27) will be used since they are identical to actual missiles except for motors, guidance systems and other hardware, but are weighted to provide proper characteristics including center of gravity. Displayed Skybolts will also be used in the drop test program, which will start in 60-90 days.

According to GAM-87 Program Manager John Gorgenson, the missile faces no technical problems severe enough to hold up the development program. As he pointed out, Douglas is attempting to develop the missile with a high-degree of reliability and is not seeking to attempt technical breakthroughs that might compromise the planned operational date. A prime idea is to achieve the same degree of operational reliability in subsystems as is experienced by the B-52 carrier airplane. Although he foresees a growth potential for the missile in greater range and "payload," these versions are sidetracked at present to put maximum effort into making the current configuration operational at the planned date.

GAM-87 design responsibility included that of the inverted T-launcher which carries two Skybolts. Gorgenson noted that design of missile and launcher were done concurrently and shapes of both were varied as necessary to develop a minimum drag installation.

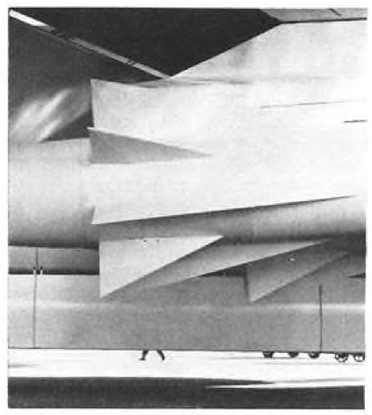
Launch is free-fall and wind tunnel studies indicate that the approximately 11,000-lb. missile has sufficient mass to provide a clean separation from the bomber without need for mechanical ejection devices. Immediately after drop, a streamlined tail cone, fitted to minimize drag while the GAM-87 is captive, is separated by means of explosive bolts and the first-stage of the two-stage Aerojet-General polyurethane-based solid-propellant motor is fired.

Skybolt is fitted with eight delta-configuration tail fins. Examination of the missiles on the B-52H indicated that the four large fins are fixed to provide stability and the four smaller fins appear to be movable to provide control. Fins have sharp leading edges and blunt trailing edges.

Solid fuel is temperature-qualified to approximately −30F. To protect the motor against detrimental effects of lower temperatures and temperature cycling, Douglas developed an integral electrical heating system, basically similar in practice to that used on electrically heated windshields.

Skybolt Cut

Washington—Funding for development by General Electric of the USAF-Douglas Skybolt air-launched missile's re-entry body has been cut in half. This follows funding cuts for most other Skybolt contractors. Money is part of the Fiscal 1961 budget. The Fiscal 1962 budget requests contain no Skybolt development money.



EXPENDABLE TAIL CONE fairing extends some 7 ft. behind the Skybolt fins. Fins span about 18 in., but vary in length. Long fins are fixed and provided aerodynamic stability; short fins appear to be movable for use as control surfaces.

$140 Million in U.S. Mutual Aid To Finance 100 European F-104Gs

By Cecil Brownlow

Paris—U.S. mutual aid funds estimated at $140 million will underwrite the cost of 100 of the 949 Lockheed F-104G all-weather fighters now fairly well scheduled to be produced in Western Europe by the industries of four nations.

Latest tally of Europe's production plans for the F-104G following Italy's entry into the program (AW Nov. 21, p. 26) shows that the air forces of the nations involved will receive:

• **West Germany**—604 F-104Gs from the European production program. Germany also has ordered a total of 96 F-104Gs and 30 two-seater F-104F advanced trainer versions from Lockheed production lines in the U.S. F-104 total, all completely funded by West Germany, now stands at 730.

• **Italy**—125, of which 75 will be financed by Italy, 50 by U.S. mutual aid funds.

• **The Netherlands**—120, of which 95 will be financed by the Dutch government, 25 by the U.S. The Netherlands' contribution must still be approved by the Dutch parliament, a move considered to be largely a formality.

• **Belgium**—100, of which 75 will be financed by Belgium, 25 by the U.S. Belgian participation also must receive parliamentary approval. The government last fall threatened for a time to withdraw from the program following economic losses sustained by severance of ties with the former Belgian Congo and resentment over U.S. support of United Nations intervention there. Newest strike-inspired crisis could cause the government to take a second look at its subsequent decision to go ahead. On the surface, however, it appears to Belgium's advantage to approve the program in view of its share of the over-all European production plan and subsequent business and employment opportunities.

Rather than contribute to the continued dollar flow from the States, the U.S. contribution is expected to consist primarily in the provision of equivalent components purchased directly from Lockheed production lines in the U.S. rather than in substantial outlays of cash within Europe itself.

Production figures for the various industry combines involved remain unaltered from those laid down at the time of Italy's formal entry into the program in November, with Belgian, Dutch and Italian industries profiting from Germany's large order and still-limited manufacturing facilities. The breakdown and distribution of the end products:

• **All-German southern group** of Messerschmitt, Heinkel, Dornier and Siebel, 210 airframes all scheduled for the West German air force.

• **Northern group** of Holland's Fokker and Aviolanda and Germany's Focke-Wulf, Hamburger Flugzeugbau and Weserflugzeugbau, 375—120 to the Dutch air force, 255 to the Germans.

• **Italian-Belgian combine** of Societe Anonyme Belge de Constructions Aeronautiques (SABCA), Avions Fairey and Fiat, 364—255 for Italy and Belgium, 139 for Germany.

The over-all program as of late last week remained on a nation-to-nation basis despite efforts in high North Atlantic Treaty Organization quarters to convince the participants of the possible potential advantages of converting it into a formal NATO project (AW Dec. 26, p. 20).

Advantages cited by NATO officials, who use the relatively unencumbered European Hawk production effort to back their claims, include a cutting of nationalistic red tape plus savings that would be encountered by the elimination of the normal tax and custom charges on hardware shipped from one country to another.

Opposition to such an integrated program by some of the participants—both government and industry, including U.S. firms concerned—apparently stems largely from a conviction that it would add to, rather than cut, the red tape involved.

"The commercial people," one NATO official said last week, "are afraid of the 'government by committee' idea and think it would only mean more delay and paperwork. There are ways around this but it's hard to convince anyone of it."

Another, citing opposition to integrating the program as a NATO effort, termed the European F-104 production project as one that "grew up like Topsy without any real plan to begin with. The West Germans bought the 104 and, with Lockheed, sold it to the other nations."

It was, he added, well on its way to its present proportions before any thought could be given toward bringing it into the NATO fold.

Army's New Rocket Grenade Has High Lethality, Reliability

Los Angeles—Army has unveiled its new light anti-tank weapon (LAW) now renamed the XM72 rocket grenade. The small folding-fin, solid-propellant rocket is intended as a replacement for the bazooka. It was conceived by engineers of Flightex Fabrics, Inc., prime contractor.

Lt. Gen. John H. Hinrichs, Army chief of ordnance, reports that XM72 is three to five times more lethal than its predecessor and has somewhat better range and accuracy. The greater power of the shaped-charge warhead is produced by a powerful new chemical explosive called Octol.

Reliability, economy and light weight are advantages claimed for the new missile. The Army hopes to get the unit price down to between $25 and $35 in production quantities. Weight of the missile and its disposable combination container and launch tube is less than 5 lb. One soldier could carry four XM72s in combat without sacrificing personal equipment. The launcher-container is a telescoping tube which is 3 in. in diameter, 25-in. long when collapsed for carrying or storage and 38-in. long when extended for firing. The tube is discarded after firing its missile. Army officials have concluded that it would be more expensive to reload the tubes than to throw them away. Each launcher has a canvas sling so that a number can be carried over the shoulder. This is discarded with the end covers of the tube before firing. The inner part of the telescoping tube is of aluminum and the outer section is of glass fiber.

Electric igniters have been avoided in the XM72 for the sake of reliability. Instead, a percussion cap-fired squib is used to ignite the propellant. The hammer that detonates the percussion cap is spring-loaded by the act of extending the launcher tube. The trigger that releases the hammer is on top of the tube. The solid-propellant motor, made by Radford Arsenal and Bridgeport Brass Co., burns out before the rocket grenade leaves the muzzle of the launcher. The six forward-folded magnesium fins open as the missile leaves the launcher. Maximum diameter of the warhead is 66 mm. and the motor is narrower. Permissible operating temperature range is from 25F to 125F.

Gen Hinrichs said United States Army development and procurement funds are now divided with 57% going for conventional weapons and 43% for rockets, not counting Nike Zeus.

Air Force Space Project Requests Cut Sharply in Fiscal 1962 Budget

Washington—Air Force space program budget requests have suffered major cuts in the Fiscal 1962 budget submitted to Congress today, with the principal victims Aerospace Plane, Saint satellite intercept-inspect system, Dyna-Soar boost-glide orbital vehicle and space combat weapon system.

Other development programs, such as Aircraft Nuclear Propulsion and Skybolt air-launched ballistic missile, also felt the effect of cuts made by the Department of Defense and the Bureau of the Budget.

The stage has been set to recover these and other losses through congressional and Administration action in the wake of a report to President-elect John Kennedy by an ad hoc committee on space headed by Jerome B. Wiesner, who will be Kennedy's science adviser (see p. 29). Committee also made a classified report on military space systems which is reported to advocate increased emphasis in this area.

Original request for the Dyna-Soar research and development program was $146 million. This was cut to $70 million, with spending for Fiscal 1963 projected at $109 million.

Aerospace Plane, the concept of a liquid oxygen-liquid hydrogen burning vehicle which would take off normally weighing about 500,000 lb. and then gather another 500,000 lb. of liquid oxygen in the outer fringes of the atmosphere before proceeding on space missions, was cut to $1 million for feasibility studies.

Original request was $20 million (AW Oct. 31, p. 26).

Saint system 649F, which has gone beyond the study phase, has been allotted $12 million. Air Research and Development Command wanted $32 million for this vehicle, which would rendezvous with an unknown satellite and inspect it with television to determine its mission. Space combat weapon system, for which $80 million was asked, was cut to nothing.

USAF asked $75 million to continue development of a nuclear-powered airplane under the ANP program, but this was cut to $35 million. ANP, which is advanced development system 625A, has a balance of unreleased money from the current fiscal year of $30 million from an original appropriation of $75 million.

Skybolt ALBM, which was designed primarily to give the B-52 long-range bomber a standoff capability, has no money in the budget although Air Force wanted $270 million (AW Dec. 19, p. 26).

Largest sum in the 1962 budget for ballistic missiles is for the Titan ICBM, which is allotted $1.150 billion. Air Force requested $850 million. Budget is increased about $350 million from the current fiscal year.

Atlas ICBM allotments reflect production phaseout of this missile. From the current year sum of $1.175 billion, the Atlas budget has dropped to $200 million, $35 million less than the sum requested.

Budgetary items affecting the Boeing Airplane Co. were revealed last week by Democratic Sen. Henry Jackson and Warren Magnuson of Washington.

• **Minuteman** solid propellant intercontinental ballistic missile is listed for $917 million, a slight cut from the $1.079-billion original request for procurement. New development money amounts to $3.5 million. For Fiscal 1963, $1.277 billion is planned for procurement and $6 million for development.

• **B-52** is not funded in Fiscal 1962 (AW Dec. 19, p. 26).

• **Jet cargo aircraft** development, for which $30 million was released two weeks ago for the current fiscal year, is listed for $98 million in the budget, and $243 million is planned for Fiscal 1963. Aircraft is designated the CX-1 under Specific Operational Requirement 182.

• **72 KC-135** jet tanker planes would be purchased out of a budgeted $185 million. Air Force wanted to buy 107 of these aircraft for $275-million. Projected figure for 1963 is $250 million.

• **Request for $23 million** to buy six C-135 electronic countermeasure trainers was eliminated from the budget.

B-58 Speed Runs

Edwards AFB, Calif.—Convair B-58 supersonic bomber made speed runs here last week unloaded and with loads of 1,000 and 2,000 kilograms around a closed course in an attempt to set world records for the 1,000 and 2,000 km. distances.

Runs were made within a time period previously authorized by the Department of Defense after authority had been canceled in mid-December as the result of an internal Air Force controversy in which the B-52G was chosen to set a non-refueled distance record in time to be announced at the annual Wright Day dinner in Washington (AW Dec. 19, p. 25).

GAO Criticizes USAF Titan Delay

Washington—Air Force was criticized in a General Accounting Office report to Congress for a five-month delay in the operational date of the first storable-fuel Titan II squadron, primarily because of reluctance to allow $163 million for modification.

Ballistic Missile Division recommended in March, 1959, that storable liquid fuels be used in some of the planned Titan squadrons. This Titan II plan was approved by Air Force in November, but the operational date was postponed five months.

GAO said that the modification, giving Titan immediate reaction capability, greater reliability, inertial guidance, and less exposure to enemy attack, should have received "immediate action" in view of the top priority of the ballistic missile program. GAO emphasized that no saving was gained by the delay and that the additional costs for storable fuels are eventually recovered through reduced costs for base installation, operation, and maintenance.

The report was the second in GAO's continuing investigation of USAF management of its ballistic missile programs. The major part was submitted to Congress on a classified basis, at Air Force request. The first report was critical of Space Technology Laboratories (AW May 30 p. 30), which has since then been replaced by Aerospace Corp.

Other findings in the unclassified sections were:

• **There was an "unwarranted delay"** of 10 months in providing captive test facilities in the Thor program to minimize flight test failures. GAO said the delay was due to prolonged negotiations between USAF and the contractor as to who would finance costs in excess of the amount originally contemplated by the contractor.

• **Instead of Army's procedure** of captive-testing every assembled Jupiter missile before flight testing, Air Force attempted flight testing of Thor development missiles more than one year prior to the captive testing of an assembled missile, with "unfavorable results."

• **Modifications should** have been incorporated in Thor at the contractor's West Coast plant before shipment to the Cape Canaveral flight test center. "By contrast, Jupiter missiles required less modification after arrival at the flight test center and were launched within a month after arrival as compared with the average of over four months required for Thor missiles," GAO commented.

Thiokol Designs Super Space Booster

By Michael Yaffee

New York—Unsegmented, solid propellant rocket motor, 14 ft. in diameter and 63-ft. long, will be proposed to National Aeronautics and Space Administration as the best multi-million-pound-thrust space booster that can be built with existing technology.

The motor as designed by Thiokol Chemical Corp's Redstone Division, will burn for 82 sec., producing an average thrust of 2.4 million lb. Motors would be loaded at the plant and barged to sites in hermetically-sealed canisters.

For space work, the company will propose clustering seven of the motors into a 43-ft.-diameter booster that would be capable of producing almost 17 million lb. thrust. Increasing length and burning rate of individual motors slightly, Thiokol says, will give the booster a 20-million-lb.-thrust capability. Thiokol is also expected to recommend using three of the motors for the second stage of a large, multi-stage space vehicle that the company says could be built within three years.

One of three NASA contractors doing preliminary design studies on large solid boosters (AW Dec. 12, p. 26), Thiokol expects to finish this work shortly and plans to submit its final report by the middle of February. This report will consist of Thiokol's recommendations for a motor design and for a "demonstration program" to build and prove out a motor of this design.

Aerojet-General Corp. and Grand Central Rocket Co., the other two NASA contractors, plan to submit their final reports sometime in March. Both are expected to recommend segmented rocket fabrication, using motor segments 10 ft. in diameter which can be transported overland. Like Thiokol, they will probably suggest the use of solids in the second stage as well. Individual motors would be clustered, up to a limit of perhaps seven, to obtain the required thrust.

As part of its study, Thiokol considered motors ranging from 10 to 28 ft. in diameter. Thiokol engineers studied both segmentation and on-site loading. The results of these studies, a Thiokol engineer says, indicated that the larger the motor was, the better and more reliably it would perform and the less it would cost.

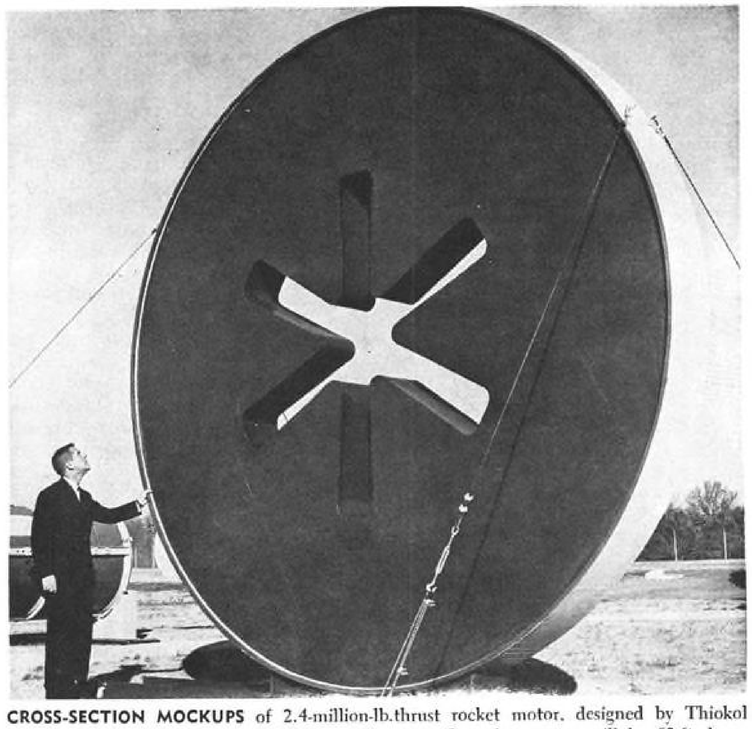
One of the conditions laid down in the NASA contract, however, was that the preliminary design study be based on current technology. Consultations with hardware fabricators, says Thiokol, showed that a 14-ft.-diameter case was about the largest that could be built on existing equipment. The implications are that the company will recommend larger individual motors in the future if NASA or, more likely, the Air Force can be persuaded to underwrite the cost of the required new tooling. Current thinking at Thiokol's Redstone Division is believed to favor a cluster of four motors, 18-20 ft. in diameter, for the first stage followed by a two-unit cluster of the same size motors for the second stage.

Segmented motor construction was ruled out for a number of reasons. Most important, says Thiokol, was the fact that if transportation on land is required, the largest motor that can be considered because of road clearance limits would be 12 ft. or possibly 13 ft. in diameter, segmented or otherwise, and regardless of weight. Clustered in a booster, even with optimum design, says Thiokol, such motors probably could not produce more than 15 million lb. thrust collectively. As an upper limit, this 15 million lb. figure would soon prove unacceptable in future space work, the company feels, and thereby rules out land transportation.

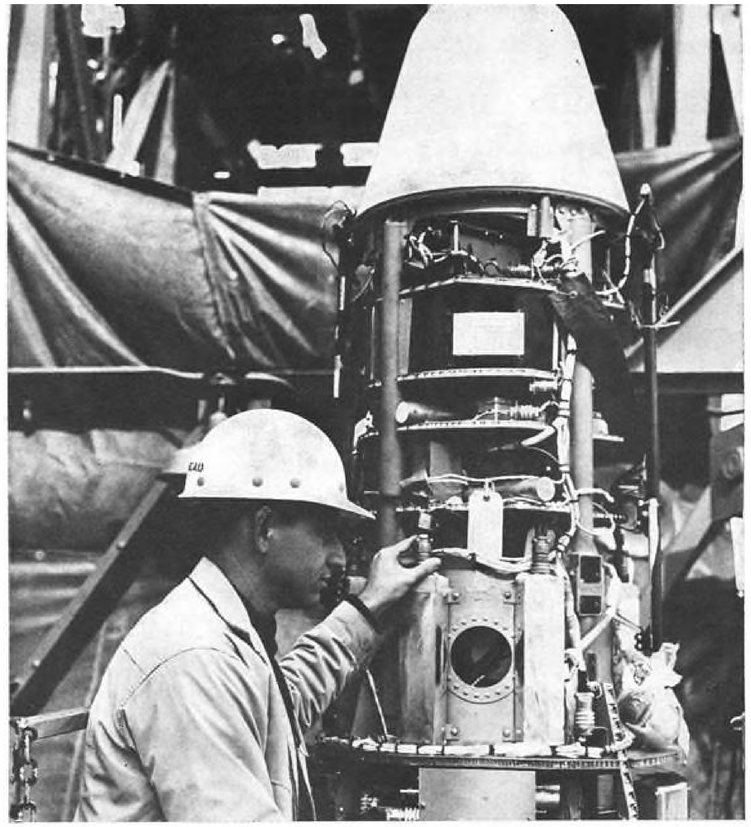
With water transportation, all limitations are removed, says Thiokol, and then there is no point in accepting any weight or reliability penalties associated with segmentation. Having decided on this approach, the company developed a concept for a hermetically-sealed canister that will be compatible with commercial barge transportation.

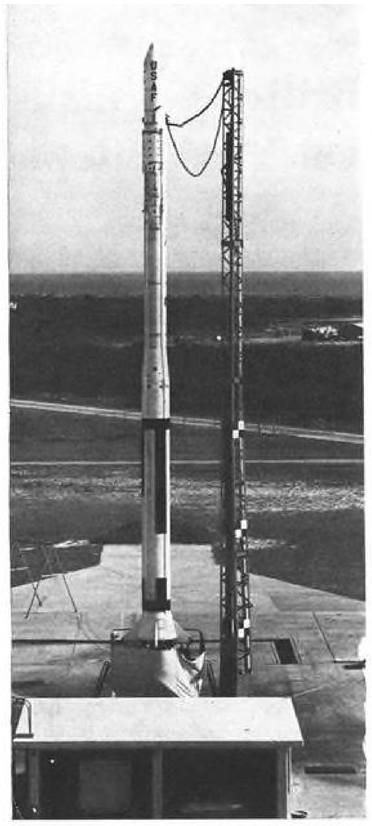
Thiokol decided against on-site motor fabrication and loading, which it regards highly, particularly for motors in the 18-30 ft. dia. class, primarily because its study contract was restricted to the Atlantic Missile Range and to "state-of-the-art" technology. It could take as long as two months to make a large solid motor on site, Thiokol says; and this would mean that perhaps twice as many launching pads would have to be built, requiring more money and real estate on an already crowded range.

As part of its NASA contract, Thiokol was required to develop a general design for a liquid-propellant upper stage. The company designed a liquid-propellant second stage approximately 40 ft. in diameter, after several consultations with NASA's Marshall Space Flight Center. At the same time, on its own, Thiokol developed a second stage design based on a cluster of three of its proposed 14-ft.-diameter solid-propellant motors. A large space vehicle using new solid motors in first and second stages and available liquid propellant engines in third and fourth stages, says Thiokol, could be ready in three years



CROSS-SECTION MOCKUPS of 2.4-million-lb.thrust rocket motor, designed by Thiokol under NASA contract, measures 14 ft. in diameter. Complete motor will be 63-ft. long.





MARTIN CO. scientist completes checkout of equipment designed to detect flux of cosmic ray secondary neutrons escaping from earth's atmosphere. Boron tri-fluoride detectors were part of over-all instrument package in Blue Scout, shown on pad prior to launch.

Blue Scout Launches Space Test Payload

Cape Canaveral—Blue Scout three-stage solid-propellant rocket was fired 1,200 mi. down the Atlantic Missile Range Jan. 7, carrying eight space experiments in its nose cone.

Third in a series of 12 planned shots, it was the first to carry a complete autopilot control system, operated by a timer-actuated attitude programmer and precision autopilot. The 36,908 lb.-probe also was the first fired vertically. First two Blue Scouts were launched at a 70 deg. angle.

Control was maintained through use of aerodynamic surfaces and jet vanes on the Aerojet-Senior first stage. Control of the Thiokol XM-33 second stage and the Hercules-Allegany Ballistic Laboratory X-254-powered third stage was by hydrogen peroxide reaction jets.

Primary objective of the research and development flight was checkout of launching techniques and vehicle configuration. Secondary objective was to send the 392-lb. scientific payload to an apogee of over 1,000 mi. and to recover the 90-lb. instrumentation package. Recovery attempt was unsuccessful.

Vehicle performance was monitored by 1,400 sec. of clear telemetry, and all eight experiments were monitored successfully. Failure to recover the capsule after an aircraft tracked it to the water did not affect results of the experiments. Recovery was desired principally to determine effects of re-entry on the capsule.

The series of eight experiments included:

- **Radio-frequency background** measurements in cislunar space in the range of 50 cycles per second to 100 kilocycles. Ionosphere acts as an effective block to electromagnetic phenomena in this range.
- **Aerodynamic turbulence** measurements along the vehicle surface to determine and correlate total acoustical and vibration environment of the carrier throughout the flight. This was a Wright Air Development Division experiment.
- **Concentration, size, flux** and energy measurement of micrometeorites.
- **Flux backscatter** measurement of albedo neutrons.
- **Radiation dose** measured as a function of time for evaluation of radiation hazards man may meet in space.
- **Unit to detect** electrical signals above and below the ionospheric cutoff.
- **Ion density** measurements in the upper atmosphere.
- **Concentration and energy** distribution measurement of charged particles in the upper atmosphere as a function of time and position.

Scout's flight was along a path which took it near Antigua in the Leeward Islands. At the apogee of 1,000 mi., the instrument package touched the lower edge of the Van Allen radiation belt.

In addition to telemetry signals, data was recorded on tape in the capsule. Capsule parachute was initially deployed at 38,000 ft. when the capsule was traveling at 775 fps. Parachute was disreefed and fully open four seconds later at 36,000 ft. After eight more seconds, the rate of descent was 80 fps. The capsule hit the water at 45 fps.

After impact, the parachute was disconnected and a Sofar bomb created an underwater explosion to aid hydrophone location of the package. Dye marker was also ejected. Radio beacon guided the search aircraft to the spot, but by the time a range ship reached the area the package had sunk.

British, Germans Reach Agreement On VTOL Replacement for G.91

Bonn—West German and British defense officials reached substantial agreement last week on plans for a joint development and production program for a VTOL light reconnaissance and close-support aircraft based upon the Hawker P. 1127 as an eventual replacement for the Fiat G.91.

Agreement was reached at negotiations here in which German officials also agreed to purchase a limited number of Short Seacat Navy anti-aircraft missiles for evaluation purposes and where the groundwork was laid for closer integration of aircraft engine development programs of the two nations.

In announcing the VTOL agreement on a bilateral basis, representatives of the two nations said they would welcome participation in the project by other members of the North Atlantic Treaty Organization.

Technical requirements for such a fighter have been studied in the past in a cooperative effort by Germany, Great Britain, France and Italy, and the latter two nations may join the program within the near future.

Formal communique issued at the conclusion of the meeting said the VTOL close-support fighter would be developed "on the basis" of the P. 1127 which began untethered hovering flight tests in November (AW Dec. 5, p. 33). Performance improvements, however, probably will be substantial.

German officials, who want a family of VTOL aircraft ranging in scope from a high altitude interceptor to a transport, believe such a close-support fighter should be capable of sustained supersonic speeds at near ground level altitudes. The P. 1127 is powered by a 15,000-lb.-thrust Bristol Siddeley BS. 53 forward-fan engine.

The agreement also should increase British support for Germany's expected Mach 3 entry in the NATO VTOL fighter competition (AW Dec. 5, p. 72) which is scheduled to be powered by 5,000-lb.-thrust Rolls-Royce R. B. 153 turbojet engines. France and Germany already have announced plans to jointly produce a high performance VTOL for the NATO competition (AW Dec. 26, p. 20).

The close-support development program also may be presented to the North Atlantic Treaty Organization on a joint basis with the request that it be designated an official NATO program, a move that could increase its production potential and further expand the organization's common weapons program between member nations.

British delegates to the Bonn session included Minister of Aviation Peter Thorneycroft and Ambassador Christopher Steel. German representatives included Dr. Theodore Beneeke, chief of West German air force research and development and a VTOL advocate; Gen. Adolph Heusinger, air force inspector general and chief of the air force Lt. Gen. Joseph Kammhuber. Defense Minister Franz Joseph Strauss had been scheduled to attend but was detained by illness.

A major mission of the Thorneycroft visit was to gain West German support for use of the de Havilland Blue Streak IRBM as a common booster system for a planned West European space effort (AW Dec. 26, p. 25). Advance indications were that the Germans might be hesitant, preferring instead such U.S. systems as the Chance Vought Scout if, in fact, they formally join the common space effort, and no mention of these discussions was made in the final communique.

Douglas Layoffs

Long Beach—Another 280 clerical and administrative employes have been laid off at the Douglas Aircraft Co. Long Beach plant in the steady personnel reduction caused by DC-8 production slowdowns and by phasing out of C-133B transport production for the Air Force. Total employment at the plant now is down to 9,600 from the 19,400 level of a year ago. Since Dec. 1, 3,960 employes have been laid off.

USAF, Army to Test Fiat G.91 in U.S.

Washington—Air Force and Army will make independent evaluations within the U.S. of Italy's Fiat G.91 lightweight strike fighter for possible acquisition as a reconnaissance and close-support aircraft.

Two R. 1 versions of the aircraft, spare parts and ground-handling equipment were flown from Turin last week aboard two USAF Douglas C-124 transports for Ft. Rucker, Ala., where they will undergo extensive Army tests. Army pilots already have flown the G.91 from Fiat's plant at Turin.

Another two G.91s—slightly modified R.3 versions as ordered by the West German air force—are scheduled to be flown to Kirtland AFB, N.M., sometime next month for evaluation by USAF pilots and technicians.

The G.91 exceeds the 5,000-lb. empty weight limitation placed on Army aircraft by the Defense Department and any decision to purchase the aircraft ostensibly would require a specific waiver by the Defense Department. Similar waivers have been granted in the past for the Grumman AO-1 Mohawk observation aircraft and de Havilland-Canada's Caribou cargo plane.

The Army apparently would want the G.91 for combined reconnaissance and tactical support purposes.

Air Force is believed to be looking at the aircraft for use primarily in a close-support role.

If either or both services should place an order for the G.91, which is the standard lightweight fighter for the North Atlantic Treaty Organization, it would be manufactured within the U.S. under an agreement negotiated between the U.S. government and Fiat. Under the agreement, the U.S. has the right to reproduce the G.91 in all its versions.

Minuteman Bids

Los Angeles—Modified design requirements for the Malmstrom AFB Minuteman ICBM complex have been prepared by Army Corps of Engineers Ballistic Missile Construction Office and new proposals will be requested in the near future. Companies on the list of prequalified bidders will be able to obtain bidding documents, including the change requirements, from the district office of the Corps of Engineers in Seattle on about Jan. 16. The first round of bids received was rejected because the lowest bid was higher than the government was willing to pay (AW Dec. 26, p. 16). Final arrangement will probably be a negotiated contract rather than the "lump sum unit price" contract usually let by the Corps. Bids on the Titan base at Davis-Monthan AFB are also 50% over government estimates, according to Brig. Gen. A. C. Welling.

U.S. Provides Aircraft For Laos Government

Washington—Eight aircraft were furnished the Laotian government by the U.S. last week for use in the war with Pathet Lao rebels.

The four North American T-6 single-engine trainers and four Sikorsky HUS-1 helicopters were to be used for observation flights, but Laotian pilots were reported using the T-6s to attack rebel positions.

The Laotian government also warned the Soviet Union last week that unless it stops dropping arms and supplies to pro-Communist rebels (AW Jan. 9, p. 26), Laos will take appropriate defensive action.

NASA to End Year With Balance Of $50 Million in Research Funds

Washington—National Aeronautics and Space Administration expects to end Fiscal 1961 with $50 million in unobligated research funds, but it intends to resist pressures for a rush of last-minute contracting aimed merely at justifying increased requests for Fiscal 1962.

Although NASA's research funds need not be spent in any specific year, it has been the tendency of Congress to watch the executive agencies closely and to cut the next appropriation request of an agency that has come through a spending year with a large balance. To avoid this, some agencies make certain near the end of the fiscal year that they obligate as large a percentage as possible of the money available.

NASA says it has attempted to obligate its fund carefully, according to changing demands of its programs. So far the agency has escaped being accused of padding requests and has escaped being pushed into large year-end spending aimed only at clearing the books.

NASA's first fiscal year was only nine months long, since the agency began operations on Oct. 1, 1958, a quarter of the way into Fiscal 1959. By the end of the fiscal year for June 30, 1959, it had obligated $176 million, or 89% of its $197 million research and development appropriation.

One reason the percentage ran that high for the agency's short first year was that NASA simply carried on a number of existing space programs transferred to it from other parts of the government. Of the $197 million, NASA had actually paid out only $34 million, or 11%, by the end of the fiscal year, largely because it was a new agency ordering hardware faster than the bills came due.

In Fiscal 1960, the first full year of operation, NASA again obligated 89% of its research and development appropriation, or $296 million out of $333 million. Spending climbed to $133 million, or 37% of the appropriation.

Figures for Fiscal 1961 are available only for the first five months—through last Nov. 30. Assuming that the money is obligated at a constant rate through the year, the five-month figures indicate an obligation rate of 79% of the appropriation—10% lower than for the two previous years. Spending rate, however, shows another considerable increase as more bills come due, reaching 62%.

The pattern of carrying research funds over in increasing amounts from one year to the next does not reflect either padding of the appropriations requests or cancellation of programs, NASA says, but is caused by:

- **A tendency** to underestimate technical difficulties of programs which push the limits of technology. The result is that a program moves more slowly than expected, delaying the obligating and spending of funds for it.
- **Over-optimistic estimates** of the lead-time needed to develop complex components. This also has the effect of delaying the obligating and spending of funds.

Another possible danger in NASA's practice of carrying the no-year research funds over to later years is that Congress, despite the legality and historical precedence of the no-year appropriations, might begin to treat these appropriations as annual funding, which must be returned to the Treasury at the end of a fiscal year.

NASA has followed a practice of estimating the total cost of a new program, rather than attempting to sell the program to Congress on the basis of its projected cost for the first year only.

The agency admits its early program cost estimates were unrealistically low—the best example is Project Mercury. The original estimate two years ago was $200 million, and the most recent was $500 million (AW Jan. 2, p. 17). NASA believes that subsequent estimating and contracting experience is teaching it how to estimate much more closely.

IAM Engineers' Strike Halts Northwest Flights

Washington—Northwest Airlines suspended all domestic service last week after a three-month-old strike of 28 DC-8 flight engineers spread to include 260 other flight engineers assigned to piston equipment.

At the same time, the airline announced the immediate restoration of a full pattern of Douglas DC-8 jet service to the Far East, suspended Oct. 11 after the company and International Assn. of Machinists flight engineers failed to reach an agreement over wage issues on the turbojets.

Engineering duties on the four DC-8s assigned to international flights are now being handled by engineer-qualified pilots, the company said. Jet maintenance will be handled at Seattle.

Cancellation of the domestic flights has grounded the majority of Northwest's 58 aircraft piston fleet, with the exception of a few which provide service beyond Tokyo service.

While the jet engineers' strike was primarily over wage issues, an IAM spokesman said, it has been expanded to include an over-all issue of crew complement on the jets. Walkout of the piston-equipment engineers came only after the airline resumed a partial domestic jet service Dec. 31, using supervisory personnel at the flight engineer's station on a Seattle-Chicago-Miami routing.

IAM contends this action made it clear that there is more at stake than a matter of pay scales for turbojet duty. The union feels that even if the wage issue were settled, the airline would insist the engineers take pilot training.

News Digest

President Eisenhower last week rejected a Civil Aeronautics Board proposal to let 22 supplemental airlines haul cargo to foreign countries and haul cargo and passengers between the U.S. and its territories. He said this would have "a potentially serious economic impact" on scheduled U.S. carriers, and said it is doubtful whether CAB has the power to grant the temporary certificates allowing the flights.

Boeing Vertol Division-Kawasaki Aircraft Co. agreement for production of the Vertol 107 helicopter by Kawasaki in Japan has been approved by the Japanese government.

Explosion of Pershing 25 sec. after launch early this month at Cape Canaveral was first failure of the first stage in 10 development shots. Army was attempting to find the cause last week.

Sikorsky Aircraft Division of United Aircraft will produce twin-turbine anti-submarine warfare HSS-2 helicopters (see p. 52) for Navy under a $34.2-million letter contract calling for production throughout 1962.

Polaris A2 missile 30 in. longer and more powerful than the operational A1 model passed the third in a series of tests by making a 15-min. flight 1,600 mi. down the Atlantic Missile Range, Jan. 10. The A2 is designed to carry a nuclear payload 1,725 mi.

Northrop T-38 Talon jet trainer recently achieved maximum level flight speed of Mach 1.27. Aircraft was equipped with General Electric production version J85-5 engines. Speed is Mach .07 in excess of guaranteed performance. Previous top speed was Mach 1.22 which was made with the YJ85 engines. First of the supersonic trainers will be sent to Randolph AFB, Tex., late in February.

CAB Probe Centers on DC-8 Recorder

Automatic unit shows that United jet transport had a 438 kt. groundspeed when it overshot Preston fix.

By David H. Hoffman

New York—United's DC-8, pushed by a tailwind, was averaging 438 kt. groundspeed when it flew over Preston Intersection en route to the Dec. 16 collision here, data from the stricken jet's flight recorder disclosed last week.

The DC-8 was making good a groundspeed of about 329 kt. when it rammed a Trans World Airlines 1049A Constellation 11 mi. northeast of the fix, Civil Aeronautics Board investigators were told as they sought to unravel the cause of the tragedy during public hearings here.

Preston was the jet's clearance limit and marked the spot where its pilot should have entered a one-minute holding pattern while awaiting radar vectors to the Runway 4 Instrument Landing System at Idlewild Airport. United instructs its pilots to fly holding patterns at 180 kt. IAS.

Air traffic controllers in the New York Center had advised the speeding jet, "radar service terminated," at 10:33:20 EST. But according to the flight recorder recovered from its wreckage in Brooklyn, the DC-8 overshot Preston at 10:32:18 and was well beyond the intersection when radar surveillance officially ended.

Why radar controllers failed to warn the jet's pilot of his untenable position, and why the pilot failed to detect it himself, were the two questions still at issue as the hearing moved into its seventh day here. Each, in turn, focused attention on the human imperfections in airline cockpits and on the procedural and mechanical deficiencies of the air traffic control system.

As witnesses took the stand to testify, the questions of William F. Crawford, chief attorney for the Federal Aviation Agency, evoked answers into evidence that the Colts Neck Visual Omnirange (VOR), which the DC-8 pilot would have used to fix his position over Preston, was operating normally during the hours before and after the collision.

Ernest Gayle, FAA's chief of facilities maintenance in the New York area, told CAB's panel of investigators that a VOR course deviation of plus or minus 1.2 deg. would trigger a buzzer alarm in the monitoring station manned around the clock by his office. On Dec. 16, he said, no such alarm sounded as a result of malfunctions in the Solberg, Robbinsville or Colts Neck VOR transmitters. These three stations offer radials that converge at the Preston intersection.

Should the flow of commercial electricity to a VOR be interrupted, Gayle said, a standby engine-driven generator would restore the station's signal within 20 to 60 sec. Nevertheless, the buzzer would sound until deactivated and an entry made in the monitor's log.

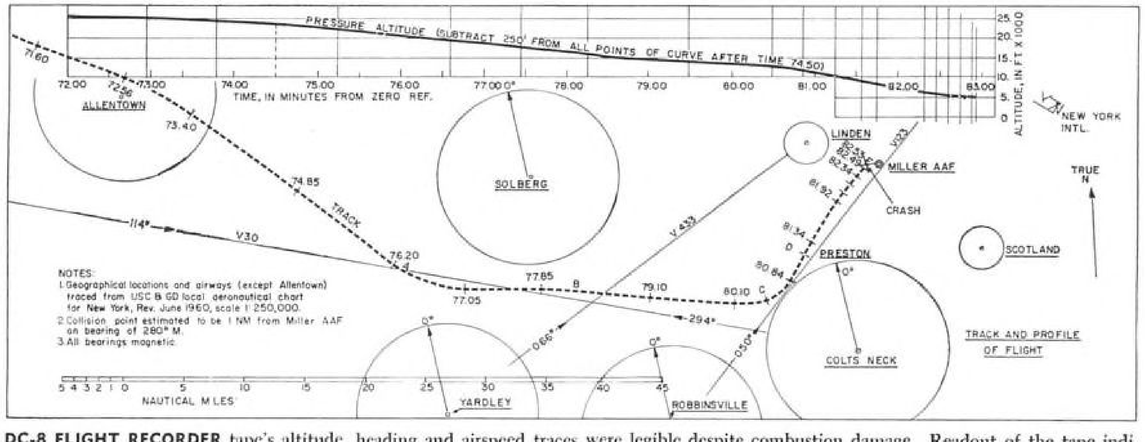
Gayle's testimony centered on the reliability of VOR transmitters. It followed the statements of four veteran airline captains who contended that on the day of the crash their airborne receivers showed Colts Neck VOR was sending either an erroneous signal or no signal at all (AW Dec. 26, p. 27).

Capt. Walter Moran, supervisor of flight training for American Airlines in New York, reported that Colts Neck apparently failed while the Boeing 707-120 he commanded was abeam the station at 5,000 ft. about 5 hr. after the midair collision. The trouble occurred about 5 naut. mi. southwest of Preston.

Noting that his Pictorial Deviation Indicator (PDI) was displaying a red warning flag and that his Radio Magnetic Deviation Indicator (RMDI) refused to point to Colts Neck, Moran said that he elected to reverse course while determining whether the applicable receiver had failed. Over the Robbinsville VOR, however, the receiver functioned normally when tuned to several other nearby stations.

Reorienting himself on Victor Airway 123 en route to Preston, Moran flew northeast until he passed abeam Colts Neck a second time, according to his testimony. At this point, he said, identical indications of a receiver failure registered in the cockpit, forcing him to conclude that there was an area of "nil radio reception" in the vicinity of the intersection.

Capt. W. S. McCormick of American, who departed Idlewild about an hour before the crash in a Boeing 720, reported that when he tuned in Colts Neck during climbout, a warning flag appeared on the face of his PDI. His receiver, on the other hand, worked normally when cross-checked with other stations and continued to do so for the remainder of the flight.



DC-8 FLIGHT RECORDER tape's altitude, heading and airspeed traces were legible despite combustion damage. Readout of the tape indicated 82.53 min. elapsed from 14:11 GMT, when the jet's gear left the runway at Chicago, and 15:33:32 GMT, the approximate time of collision. Times after takeoff are plotted beside broken black track line above. At A (15:28:41 GMT), radar reported the jet crossing V-30. At B (15:29:02 GMT), the jet was leaving 17,000 ft. at a groundspeed of 472 kt. At C (15:31:29 GMT), the jet was descending at about 3,600 fpm. Crossing Preston (D) at 15:32:18 GMT, the jet's altitude was 8,700 ft. E marks point of collision, which occurred at an altitude of 5,175 to 5,250 ft. MSL. Altitude profile uses a base time of 14:10:20, when power was applied to the jet's flight recorder.

Position Fixed

Nearing Preston at 6:30 p.m. EST on Dec. 16, Capt. P. L. Wallace of United testified that when he visually fixed his position over the intersection, omni instruments indicated it was still in front of his DC-8. Asked by Idlewild Approach Control, "Are you over Preston now," Wallace radioed: "We don't quite show it."

Capt. W. J. Picune of United reported that at the time his PDI signaled passage over Preston, a visual check indicated he was "four to five nautical miles from Miller Army Air Field." Less than 5 hr. earlier that day, United Flight 826 struck TWA Flight 266 about one mile west of Miller.

Under questioning from FAA's counsel, however, Picune admitted that he had been advised by approach control that his pattern over Preston exceeded the boundaries of the airspace reserved for holding. Crawford then established that none of the captains reporting difficulties with Colts Neck had notified FAA despite Civil Air Regulation 40.361, which requires a pilot to advise "the appropriate ground facility" of navigational aid irregularities encountered in flight.

Witnesses Questioned

Representatives of United Air Lines and the Air Line Pilots Assn. at the hearing questioned witnesses independently. But their questions often had the same apparent effect: to elicit evidence that might result in a sharing of blame between FAA and the aircrew members who died in the crash. Their case, therefore, was thought to rest on the possibility of a Colts Neck malfunction and on air traffic control's failure to monitor the jet's progress past Preston.

From the outset of the inquiry, Crawford began amassing evidence that center controllers, under FAA directives, need furnish radar flight-following service to civil turbojet aircraft between 24,000 and 39,000 ft.—not to those below except in certain situations. A host of FAA officials, including David Thomas, director of the bureau of air traffic management, Wayne Hendershot, chief of air traffic management for the New York area, and Leigh Reynolds, chief controller in the New York Center, raised these points in elaboration:

• **Radar handoffs between center** and approach control facilities in the New York area are not normally accomplished. The over-all objective of the air traffic control system is to use this procedure (under which an approach controller positively identifies an aircraft's blip on his scope before assuming control of it) wherever continuous radar coverage is available. But here, traffic congestion, a shortage of controllers and the absence of height-finding radar makes the process impractical.

• **Radar coverage extended aircraft** below 24,000 ft. by a center is at the individual controller's discretion. A pilot need not be advised when radar surveillance is initiated nor when it is terminated, even though this process may be repeated several times en route. However, when radar separation—as opposed to standard 10-min. en route separation is employed—an aircraft must be kept under continuous identification and surveillance. Pilots, during such periods, must be advised of conflicting traffic but controllers need not vector the known aircraft away from the unknown aircraft.

• **Estimated times of arrival** (ETAs) on aircraft proceeding to an approach control feeder fix are forwarded to the approach controller by the center. Estimated times en route (ETE) are standard for each aircraft type. To illustrate, all DC-8s over Allentown are assigned the same ETE to Preston. Center controllers, under FAA directives, need not forward revised ETAs to approach control unless, in their opinion, "other aircraft are involved."

• **Pilots are responsible** for staying within the boundaries of a holding pattern's airspace. The outer limits of reserved airspace in any two holding patterns can abut laterally, but aircraft holding within the same pattern are afforded 1,000 ft. altitude separation from other aircraft. The length of one-minute patterns is 16 stat. mi.; the length of two minute patterns is 19 stat. mi. Blips from a crowded holding pattern frequently merge on controller's radar scopes.

United Testimony

As a result of this system, Capt. I. E. Sommermeyer, United's vice president-flying, testified last week, airline pilots were led to believe they were under radar surveillance " all the way to touchdown" when within range of radar.

According to recorded pilot-controller conversation, United's Flight 826, en route to Preston, was given a shortcut clearance to the fix at 10:25:09 by New York Center. Seconds later it was instructed to maintain "present heading until intercepting V-30," one of the two airways involved in the new routing. The pilot was then advised his aircraft was crossing V-30 and, later, that he was 16 mi. from V-123, the course to Preston.

Under these circumstances, United's counsel at the hearing asked Sommermeyer, would you have expected radar coverage? The reply was, "Absolutely."

High Airspeed

As to why the jet involved in the accident was holding a high airspeed at the time it passed Preston, Sommermeyer explained that by using only "idle reverse thrust" on the inboard engines, the pilot could have slowed the DC-8 from 350 to 200 kt. in 45 sec. Application of full reverse thrust on inboard engines, he said, would have cut this time in half.

Analysis of the flight recorder on board the DC-8 indicated that reverse thrust actually was utilized by the pilot at approximately the time he passed over Preston.

Electra Crash Hearing

Boston, Mass.—Eastern Air Lines' emergency cockpit procedures last week were expected to undergo scrutiny in a Civil Aeronautics Board hearing into the causes of the Oct. 4 crash of a Lockheed Electra into Boston harbor.

Testimony in the first day's hearing was opened in Boston and indicated that the turboprop transport lost about three quarters of its power, at least momentarily, following its takeoff from Logan International Airport.

At impact, three engines had been brought back to almost full takeoff power.

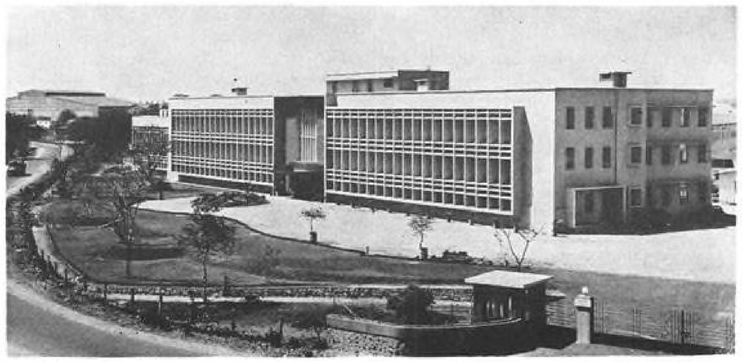
The investigation was expected to explore the question of whether temporary loss of power was sufficient cause for the apparent complete loss of control of the aircraft.

Evidence showed that the propeller of No. 1 engine was feathered at the time the plane fell almost vertically into the bay off the runway. No. 2 engine was developing 3,310 shp. and No. 3 was developing 3,315 shp. No. 4 engine was producing 3,550 shp. at the time. Full takeoff power is 3,500 shp.

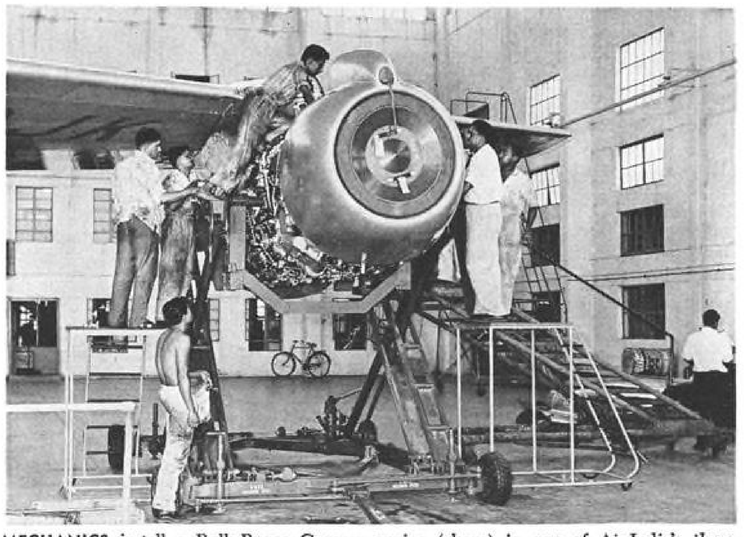
None of the eye-witnesses who testified reported sighting a flock of birds in the Electra's vicinity. However, testimony by investigators confirmed that 75-100 bird carcasses were found along the takeoff runway. Starling feathers and bird fragments were found in No. 1, 2 and 4 engines. Gull feathers were in No. 3.

Air-India Hopes to Complete Global Route

By Robert H. Cook



AIR-INDIA'S technical staff of more than 1,500 is housed in this new Technical Building, completed in 1959, at the airline's Santa Cruz Airport headquarters.



MECHANICS install a Rolls-Royce Conway engine (above) in one of Air-India's three Boeing 707s. Jet maintenance work is done in a new $6.4-million hangar built last year. Instrument overhaul section (below) uses hand-built test cabinets as an economy measure.



Bombay — Air-India International hopes to win new routes to the U.S. this year to close the Tokyo-New York gap in its round-the-world route and mark the climax of an expansion program laid down more than 13 years ago.

A Tokyo-California route, with a stop at either Los Angeles or San Francisco, plus a new route to link the West Coast with Air-India's Atlantic service, would clear the carrier to operate a global service a dozen years after it began international service with flights to London.

Bilateral negotiations covering these routes, recessed last October, are tentatively scheduled to resume in March. It is generally conceded that the current bilateral provides for an Air-India transpacific route, but the requested addition of Honolulu to this route is a matter for negotiation, as is the request for a route from the West Coast to New York. The Indians also are interested in a West Coast-London polar route.

Strategic Location

The key to Air-India's rapid progress and future plans lies in India's strategic location straddling the only practical air route between Europe and the Far East. With Communist nations blocking more direct routes, airlines must fly through India, and they find Indian traffic provides substantial support for these long-haul operations.

Backed by this powerful bargaining advantage, the Indian government has negotiated routes which have permitted Air-India to expand its system from 5,158 to 28,171 mi. in the last decade.

Last year, the airline carried more than 100,000 passengers, compared with less than 8,000 in 1949.

The expanding carrier has eased some of the competitive pressure on its routes by limiting the number of flights U.S. and other airlines can fly to India, and through revenue pooling agreements with British Overseas Airways Corp. and Qantas Empire Airways for services to the U.S., Australia and Japan. Similar agreements have been reached with Aeroflot on service to Moscow and Czechoslovakian Airlines for service to Prague.

Planning for an all-turbojet fleet in the near future, Air-India now operates three Rolls-Royce Conway-powered Boeing 707s and will take delivery on a fourth this April. Negotiations for two more Boeings are currently under way with Indian government officials.

Maintenance on the 707s is conducted in Air-India's new hangars at Santa Cruz Airport, on the outskirts of Bombay. Construction has started on a new jet engine overhaul facility, and it is expected to be completed by April, 1962. Air-India now overhauls about 10 Curtiss-Wright engines a month here for its Constellation fleet and does contract overhaul for the Indian air force.

Rolls-Royce Conway engines used on the 707s are currently overhauled by the manufacturer in England. Overhaul time originally set at 700 flight hours has now reached 1,350 hr. and is expected to be expanded to the 1,600-hr. mark in the near future.

From a fleet total of 22,000 hr. flight time on the Conway engines, Air-India reports it has had only five failures in operation, two of them in flight. The carrier reports the ruggedness of the turbojet powerplant was further proven recently when a 707 engine ingested a 40-lb. vulture while landing at Santa Cruz. Teardown of the engine failed to disclose any damage which might have caused an engine shutdown if the aircraft had been in normal flight.

Air-India presently has assigned 30 pilots to Boeing 707 service and estimates it will require 10 more to staff its service with the fourth turbojet, scheduled for April delivery.

Transition training for the turbojet service was greatly accelerated by the use of a Curtiss-Wright simulator, the airline said. Ground instruction of six weeks included three weeks of simulator time for both pilots and copilots. Flight instruction averaged 20 hr. for pilots and 15 hr. for copilots.

Pilot recruitment has not been a problem for Air-India, which customarily has filled its pilot ranks with senior pilots formerly employed by Indian Airways Corp. Major pool of pilots for both airlines is taken from the government's Civil Air Training Center at Allahabad. Majority of students at the center are college graduates who have already obtained private pilot licenses. They spend from one to two years earning an air transport rating, after which they are employed on local service operations with Indian Airways, flying DC-3s, Herons and Viscounts.

Abundance of low-cost labor also has enabled Air-India to solve many of the problems of cost and supply of testing equipment at its overhaul base. As an example, the airline does not purchase manufactured stands for its instrument overhaul work, but buys blueprints of the unit for approximately 10% of the item's manufactured cost. Panels and testbeds are then made locally with these plans.

The airline gets maximum use of its small force of highly trained mechanics, by employing a large labor force for such unskilled tasks as parts cleaning and other duties, thus releasing skilled technicians for more important duties.

Air-India's nine Lockheed Super Constellations are being phased out as the jet transports go into service and the carrier works toward an all-turbine operation. Several of these Constellations probably will be transferred to Indian Airways to provide greater capacity on internal routes.

Indian Airways serves local- and long-haul routes within India, while Air-India operates international services. Air-India was organized in 1946 by J. R. D. Tata, based on Tata Airways. International service was launched two years later on a route to London. Terms of the government agreement, which called for making the airline a competitive factor in international operations, called for India to finance and control 49% of the airline. The government also guaranteed subsidy, to be repaid with 50% of future profits.

The international carrier was nationalized in 1953, and at the same time, the government merged a number of small carriers into a single nationalized internal carrier, Indian Airways. The Air-India agreement called for a 10% cash payment and five-year 5% bonds based on the depreciated book value of the carrier's assets. The bonds were redeemed in 1958, and all of Air-India's capital has been supplied by the government since then.

Rapid expansion of the carrier's international routes began almost immediately, with service added to Singapore and Hong Kong in 1954, to Tokyo in 1955, Sydney in 1956, Moscow in 1958, New York last May, and Kuwait last October.

From the beginning of its international services in 1948 with three Super Constellations, the airline cut its system breakeven load factor from 83.8% to 57.3% by the end of 1959. Actual load factor attained in 1959 averaged 57.3%, and it was expected to rise considerably last year on the strength of Boeing 707 load factors, which averaged between 60 and 70% for the year. Breakeven load factor on the turbojet is estimated at 52%.

In the last 11 years Air-India's payroll has climbed from 164 to more than 5,000, with available ton-miles per employe up from 11,768 to more than 20,000 by the end of last year. The airline has earned an operating profit for the past six years, and last year it recorded a net profit of about $520,000. Daily aircraft utilization, which stood at 8.5 hr. for the all-piston engine fleet and produced more than 59 million available ton-miles in 1959, can be expected to increase significantly as a result of the 10.8-hr. daily utilization reached with the Boeing 707s last year, Air-India operations personnel said.

Viscount Speed Cut Pending Crack Check

London—Corrosion cracks in wing spars of Vickers Viscount 700 turboprop transports of Central African Airways have caused Vickers-Armstrongs to advise 13 operators of about 80 aircraft to restrict indicated airspeed to 190 kt. and examine the wing joints within seven days.

Cracks can only be detected ultrasonically and the manufacturer will make arrangements for suitable equipment to be supplied where it is not locally available.

Cracks appeared in two of four Viscounts operated by Central African in the lugs of the main spar joint. Vickers cannot explain the cause so far because over 50 time-expired spars already have been routinely examined at the Weybridge plant without any signs of cracking having occurred.

Aircraft affected are those early models where the spar was built in DTD.363 alloy. Later versions of the 700 series used 1.65 alloy and these are not affected by the restrictions.

The U.S. operators of Viscounts are not affected, because their aircraft are of a later model. Trans-Canada Air Lines last week was inspecting 14 Viscounts out of a current fleet of 49 of the aircraft.

Schedules had not been interrupted, but some flights were slightly over scheduled times because of the speed restrictions.

MATS Airlifts Irish Troops to Africa

Wiesbaden—Air Force Military Air Transport Service Douglas C-124 transports last week began a two-way move of Irish troops between Africa and Dublin that represented the largest single MATS airlift registered since the Congo crisis began last summer.

The move, involving 19 Globemasters and scheduled to continue intermittently over a two-week period, was requested through the United Nations for the transport of 650 replacement Irish troops and 147,000 lb. of supplies to Kamina in Katanga Province from Dublin. Planes were to return to Ireland another 1,406 servicemen with more than five months of Congo service.

Aircraft involved were dispatched from the 15th Troop Carrier Squadron on rotational duty in Europe and the 1602nd Air Transport Wing, both stationed at Chateauroux Air Base, France. Each aircraft will require an estimated four days plus to complete the 12,000 mi. round trip between Kamina and Dublin.



Now, Rolls-Royce approves Texaco Synthetic Aircraft Turbine Oil 35 for its Dart turbo-prop engines

Behind this approval lies eight years of synthetic turbine oil development and testing.

Texaco Synthetic Aircraft Turbine Oil 35 has earned the approval of Rolls-Royce, the Federal Aviation Agency and Great Britain's Air Registration Board. It has (1) excellent gearload carrying ability, (2) its high temperature stability ensures clean engines—and long overhaul life, and (3) it *doesn't* corrode constructional and protective metals.

This ability to meet the aircraft industry's most vital needs is a major reason why Texaco products have been first choice as aircraft lubricants for the past quarter century. Some of the others? They're factors such as Texaco's special techniques for ensuring lubricant cleanliness. And Texaco's distinctive product containers—which minimize chances of error in handling and usage. Most important, there's the assurance of continued availability through Texaco's facilities plus the cooperation of Texaco's Aviation Engineers.

Texaco Inc., *Aviation Sales Department*, 135 East 42nd Street, New York 17, N.Y.

Tune In: Texaco Huntley-Brinkley Report, Mon. Through Fri.-NBC-TV

TEXACO
LUBRICANTS
AND FUELS

FOR PURE JET, TURBO-PROP AND PISTON-ENGINE AIRCRAFT

Supersonic Transport Program Launched

Washington—National program to develop a supersonic transport officially got under way last week with the earmarking of $5 million Fiscal 1961 funds for initial efforts to begin design studies on a Mach 3 commercial transport.

Approval of the initial funding by the Budget Bureau followed submission of a report recommending a national program, utilizing the Federal Aviation Agency, National Aeronautics and Space Administration and the Air Force to assist aerospace industry manufacturers, by FAA Administrator E. R. "Pete" Quesada.

This report confirmed earlier predictions (AW Oct. 31, p. 27 and Nov. 7, p. 44) that FAA would be designated to provide program leadership and fiscal support. Air Force would be called on for project management and NASA for basic research and technical support.

A joint report by Quesada and NASA Administrator Keith Glennan recommended initial Fiscal 1961 funding of $17.5 million, but Department of Defense, stimulated by recommendations from Deputy Secretary James Douglas, cut the program to $5 million, where it was approved with considerable reluctance by Bureau of the Budget. To get the program moving at the pace of the proposed development cycle, appropriations of about $18 million will be required for Fiscal 1962 and $32 million in the next fiscal year.

As a practical matter, the outgoing Republican Administration made little effort to pick up the proposed program. Its fate will be determined by the incoming Democratic Administration's attitude in implementing the proposed Fiscal 1962-63 funding plan.

The FAA report stated that the development of a commercial supersonic transport is now technically feasible, indicated it must be in the Mach 3 speed range to avoid early obsolescence and recommended "an immediate national program providing financial support, coordinated government leadership and a maximum of industry participation" for the timely realization of this goal.

World market for supersonic transports was estimated at 200 aircraft, of which a third would represent foreign airline purchases, with operational availability required for 1968-70.

The report warned that although the U. S. may not produce the world's first supersonic transport, its goal should be set at developing the world's first "economically competitive supersonic transport possessing safety and reliability characteristics equivalent to those of currently operating subsonic jet transports." It also warned that the technical problems associated with developing a commercial supersonic transport are more critical than those of purely military supersonic aircraft.

The national supersonic transport development program plans to use experience of both the B-58 Mach 2 and B-70 Mach 3 bomber programs as a technical foundation. Flight tests are already under way with a B-58 under NASA auspices developing data on the sonic boom overpressure problem created by acceleration to supersonic speeds at medium altitudes.

Although some levels of USAF and the secretary of defense's office proposed using the B-70 bomber development exclusively to produce the Mach 3 transport, this approach has been abandoned as official USAF policy in favor of supporting the joint interagency program proposed by Federal Aviation Agency.

It is estimated that the first prototype flight of the supersonic transport should be made in late 1965 or early 1966—about three years after the anticipated first flight date of the B-70 prototype—with the commercial progress margin narrowing until transports are produced for delivery to airlines in 1969, about two years after the B-70 is to go into service with Strategic Air Command.

Although the FAA report indicates the possibility of international cooperation on the supersonic transport development program, there is little actual likelihood of a joint Anglo-American program, and the French have definitely begun an independent program to produce their own supersonic transport. The decision of the U. S. to shoot for a Mach 3 transport will have repercussions on the British program, which is oriented toward a slower Mach 2.3 speed range involving simpler technical problems.

The FAA report recommended that only enough federal assistance be provided to permit industry to carry the project on with its own financial resources, and that provision be made for eventually recovering the government investment from the commercial sales profits. It also recommended that the airlines participate in the development program on a continuing basis to ensure that the aircraft produced meets their performance, operational and economic requirements.

Supersonic Study

Paris—French government has set aside $2 million for a feasibility study on a medium-range supersonic transport. Study will be made by Institute du Transport Aerien, a non-government organization. Sud Aviation, builder of the Caravelle, and Dassault, builder of the Mirage IV supersonic bomber, have an agreement to move ahead on a supersonic replacement for the Caravelle if the government decides to furnish the development money (AW May 2, p. 41).

New Helicopter Airline Organized

San Francisco—San Francisco-Oakland Helicopter Airlines plans to launch the first scheduled helicopter passenger service in this area Apr. 1 with two leased Sikorsky S-62s.

The newly formed helicopter carrier expects the turbine-powered S-62s to be delivered by April under terms of a lease-purchase agreement with Sikorsky Aircraft Division of United Aircraft Corp., according to M. F. Bagan, president of the new firm and a former vice president of Los Angeles Airways. An option for a third S-62 may be exercised in three to six months.

The carrier applied for a certificate last week and asked the Civil Aeronautics Board for "earliest action." CAB action need not delay inauguration of the service, since the airline has authority to operate the intrastate service from California Public Utilities Commission and needs only to meet Federal Aviation Agency requirements to qualify as an air taxi operator. CAB certification would be needed if the airline is to carry mail—with or without subsidy.

A CAB spokesman commented that the company would have to "get in line" behind more than 100 similar helicopter applications which the Board has delayed ruling on because of the extensive subsidy payments involved.

Bagan emphasized, however, that his company is firmly convinced the geographical locations of communities surrounding the San Francisco Bay area and their heavy populations will assure a self-sufficient service without federal subsidy aid.

Initial service calls for about 70 daily flights between 6:30 a.m. and 10:30 p.m., serving San Francisco International Airport, Metropolitan Oakland International Airport and the downtown centers of Oakland and San Francisco, plus Berkeley and Palo Alto. Schedules should provide an estimated 780 daily seats, Bagan said, at fares ranging between $4 and $8.50. Additional cities within a 100-mi. radius are to be added later.



Siegler Cloud Analyzer Radar fills the critical gap in air safety in the airport terminal area!

Until recently, airport weathermen could only *guess* depth and density of clouds *directly above the airport*—the most critical area in guidance of today's high performance aircraft.

Now a unique new radar—the new Cloud Analyzer developed by Siegler's Olympic Radio and Television Division—eliminates this gap in air safety. Provides continuous *knowledge* of height, density and upper limits of clouds directly over the airport, up to 60,000 feet.

Cloud Analyzer Radar, developed for the U.S. Air Force, is now in operation by the U.S. Weather Bureau at the National Airport in Washington, D.C., Hanscom AFB, Bedford, Massachusetts, Cape Canaveral, and will soon be in operation for the Department of Defense and the Federal Aviation Agency in the 433L Automatic Weather System.

The Olympic Division of The Siegler Corporation also produces the monitor and transfer system for the important TACAN program, and the AS-111 Radio Direction Finder.

Selection of Siegler for these and other major projects shows recognition of the superior performance of all Siegler divisions, under the basic corporate concept: *Progressive management of diverse activities with outstanding military, industrial, commercial and consumer capabilities — in order to bring to each of these fields the strengths of the others.*

CAREER OPPORTUNITIES are available for engineers and scientists. Write for complete information.

SIEGLER

THE SIEGLER CORPORATION
610 South Harvard Boulevard, Los Angeles 5, California

PLANT LOCATIONS: OLYMPIC RADIO AND TELEVISION DIVISION, LONG ISLAND CITY, NEW YORK • HALLAMORE ELECTRONICS DIVISION, ANAHEIM, CALIFORNIA • HUFFORD DIVISION, EL SEGUNDO, CALIFORNIA • MAGNETIC AMPLIFIERS DIVISION, NEW YORK, NEW YORK • BOGEN-PRESTO DIVISION, PARAMUS, NEW JERSEY • SIEGLER HEATER DIVISION, CENTRALIA, ILLINOIS • HOLLY-GENERAL DIVISION, PASADENA AND BURBANK, CALIFORNIA • VAC-U-LIFT DIVISION, SALEM, ILLINOIS • COMET MANUFACTURING DIVISION, LOS ANGELES, CALIFORNIA • COMMUNITY ANTENNA CO., INC., RENO, NEVADA

Liberia Falling Behind in Airline Race

By Robert E. Farrell

Roberts Field, Liberia—Lack of financing is preventing Liberian National Airways from participating in the rapid growth of airline operations now under way throughout West Africa.

Liberia, despite its close ties with the U. S. and the fact that it is by far the oldest independent nation on the West African coast, is fast slipping behind the region's newly independent states in airline growth. Some observers here feel that Washington, because Liberia is so closely identified with the U. S. by other West African nations, is suffering a propaganda setback by not helping Liberia keep pace with at least some of the newer nations around it.

U. S. money, in fact, was behind the airline's original creation in 1948. Then, a private U. S. group, including Edward J. Stettinius, former U. S. Secretary of State, financed a carrier called Liberian International Airlines. Company made eleven stops along the west coast, ranging north to Dakar and south to Leopoldville.

Liberian International Airlines was based on the belief that West Africa as a unit needed an air network and that the region should be considered as one for cabotage purposes. This assumption, however, was not accepted by the European colonial powers in West Africa and Liberian International folded in 1949, one year after its start. The Liberian government then took over the carrier as a national instrument and asked two American pilots to stay on and operate the line as Liberian National Airways.

Liberian National currently operates a modest domestic service with two DC-3s flying into five coastal strips and Roberts Field. The airline flies four days weekly, totaling about 15 scheduled hours. Hauling passengers is the line's main mission, with Liberian government personnel making up about one-third of the traffic. Firestone's rubber plantation is the company's next biggest source of passenger revenue.

Actually, the company's activity is declining somewhat as the country slowly develops its road network. Quite clearly, the carrier has to seek a larger region in which to operate if it is going to expand or even keep up its current pace.

This is admitted by Liberian President William V. S. Tubman, who would like to see the carrier go international. But President Tubman, despite the personal interest he takes in the airline, isn't likely to draw off any of the country's limited financial resources for airline use.

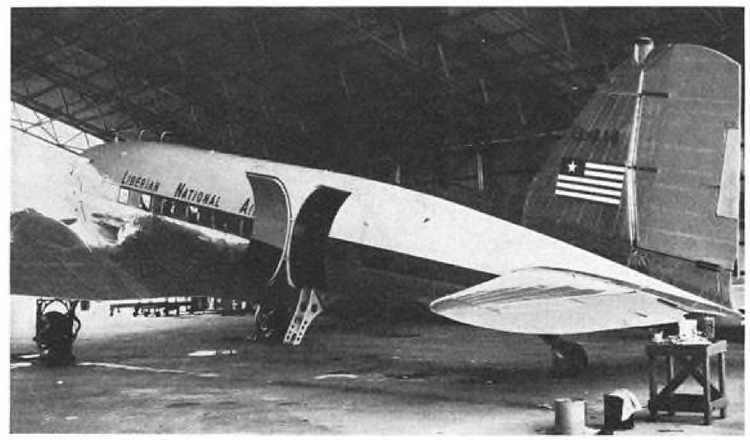
LNA's operation uses six pilots—five American and one British—and one mechanic. All pilots hold A&E licenses. Company also employs about 40 Liberians for maintenance and administrative chores. General Manager Fred Syphert and Ken Wagner, assistant general manager, have run the line since 1949.

In addition to ground duties both fly regular scheduled flights.

Syphert feels LNA can evolve via two different routes. It can continue to operate in its present modest fashion until the Liberian economy reaches a stage where additional air service is needed. This, he feels, will take a long time.

Or, the company can go international and attempt to make its way as a regional carrier based on growing West African air traffic.

Most aviation observers here, however, say it is unlikely LNA will go international, even on a limited basis, unless financing comes from sources other than the Liberian government. Meantime, airline operations in neighboring countries like Guinea, Ghana, Ivory Coast and Nigeria are expanding rapidly, often without regard to the heavy costs involved.





LIBERIAN National Airways DC-3 is shown in home hangar at Roberts Field, about 50 mi. from capital at Monrovia. Below, company headquarters and ticket office at Roberts Field.

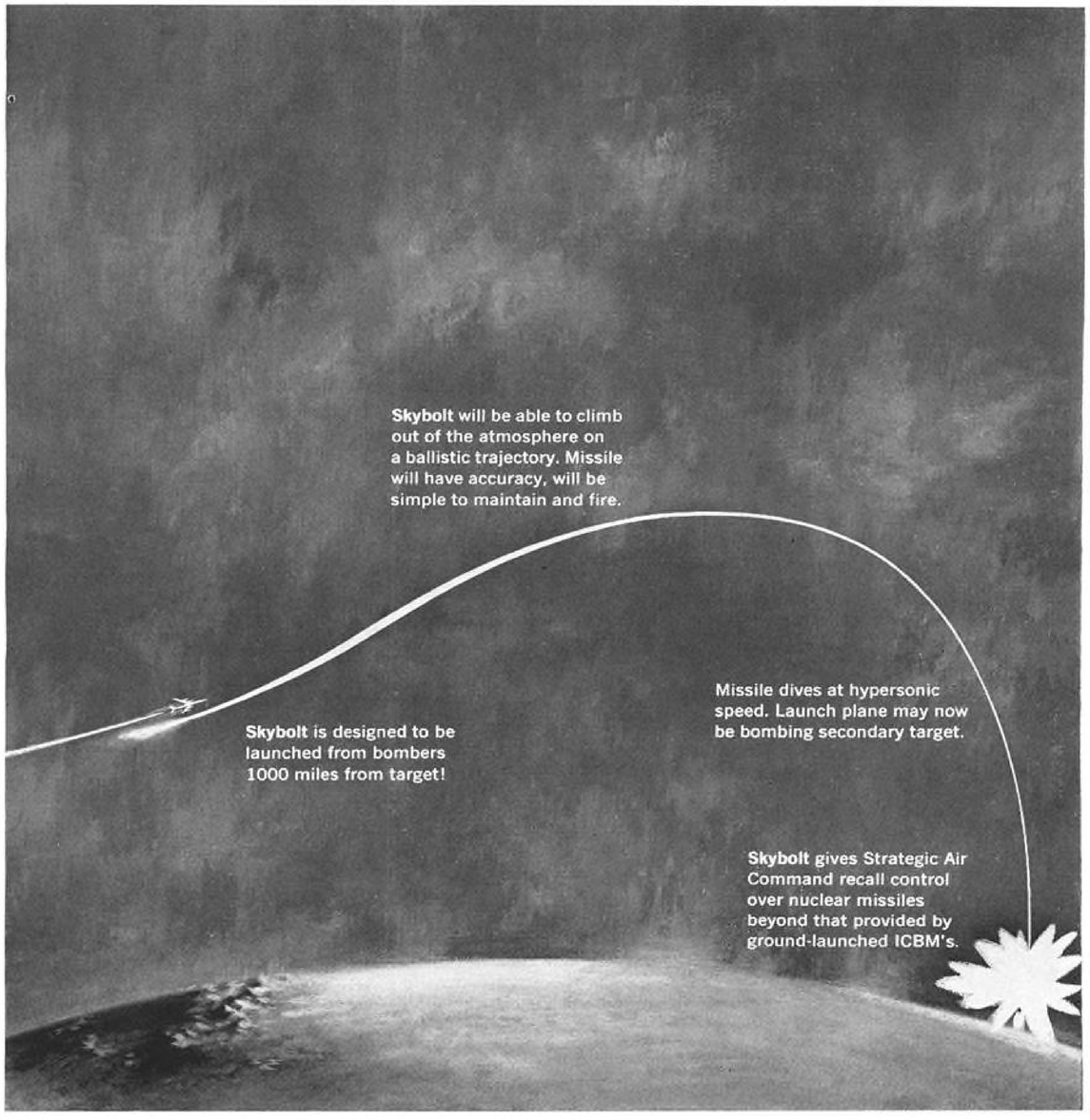
North Siberian Route Proving Flights Begin

Moscow—Aeroflot has made its first proving flight over the far northern trans-Siberian route from Moscow to Magadan on the Sea of Okhotsk. The Il-18 flying time was eight hours with an intermediate stop at Tiksi on the Laptev Sea coast.

The new Moscow-Tiksi-Magadan link is farther north than the Moscow-Syktyvkar-Norilsk-Yakutsk-Khabarovsk route on which Aeroflot started proving flights last July. Aeroflot's regular trans-Siberian airway runs from Moscow to Khabarovsk and Vladivostok via Sverdlovsk, Omsk, Novosibirsk, Krasnoyarsk and Irkutsk.

Announcing the Moscow-Tiksi-Magadan flight, Aeroflot said that construction of new airport facilities in the Russian Arctic had made long-haul commercial operations through the area desirable in view of the mileage saved compared with more southerly trans-Siberian routings. The Arctic airports reportedly have "the latest radar equipment for landing planes under the very worst weather conditions."

One of a series of advertisements in the public interest to show how Douglas works with all our military services and space agencies.



New Air Force Douglas Skybolt will extend role of manned aircraft in Space Age defense

Now under development, this new air-to-ground missile of nuclear capability could add years of usefulness to U.S. Air Force B-52s and the Royal Air Force Vulcan bombers. Four Skybolts can be launched from one B-52 at widely divergent targets. And since the missiles will be released as much as 1000 miles from target, the bombers carrying them will be practically invulnerable to attack.

DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • TRANSPORT AIRCRAFT • ANTI-SUBMARINE SYSTEMS • AIRCOMB® • GROUND SUPPORT EQUIPMENT

Airline Traffic—November, 1960

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Revenue Load Factor %
DOMESTIC TRUNK								
American	599,619	452,479	59.6	1,864,082	979,984	9,510,743	55,737,857	52.5
Braniff	175,116	83,291	55.0	425,742	161,404	648,129	9,216,620	44.9
Capital	272,455	110,041	50.8	525,260	288,341	461,981	11,795,123	46.8
Continental	96,867	59,771	42.8	200,371	110,124	477,368	6,516,534	35.1
Delta	281,772	153,472	59.4	543,141	315,333	1,173,156	16,773,708	49.6
Eastern	586,184	298,829	48.82	1,292,973	576,396	2,033,814	32,696,265	38.88
National	123,282	73,004	48.6	289,894	56,590	738,875	8,114,211	38.9
Northeast	119,068	41,044	48.6	137,858	47,369	215,899	4,321,039	42.9
Northwest	124,973	86,453	52.1	473,837	233,631	1,343,270	10,314,745	48.9
Trans World	367,938	301,850	54.9	1,422,568	713,640	4,043,330	35,112,142	45.8
United	616,311	427,522	58.3	3,398,771	973,060	5,858,658	52,247,863	50.8
Western	117,367	64,089	52.1	279,997	102,264	317,709	6,834,779	50.7
INTERNATIONAL								
American	8,364	8,688	53.2	12,051	942	313,828	1,221,431	49.7
Braniff	5,759	10,262	44.9	30,785	.....	133,208	1,257,016	41.2
Caribbean Atlantic	29,922	2,084	67.6	2,103	.....	6,612	208,464	68.3
Delta	1,473	1,933	32.4	1,559	.....	20,838	241,135	34.2
Eastern	35,031	51,879	46.13	141,364	.....	561,553	5,989,512	42.50
Mackey	8,952	1,959	48.1	.....	235	4,053	201,059	46.4
National	2,374	2,052	57.6	819	.....	4,650	226,701	59.5
Northwest	8,856	11,609	40.6	1,291,818	6,518	926,636	3,547,169	62.2
Pan American-Alaska	4,440	4,474	42.4	32,418	2,575	163,298	668,953	45.0
Atlantic	102,841	132,779	46.7	2,632,752	.....	4,898,306	21,535,933	46.7
Latin America	80,086	91,500	58.9	411,350	.....	4,554,723	14,263,731	59.4
Pacific	42,978	161,225	70.6	3,024,692	15,973	3,414,444	23,124,161	60.4
Panagra	10,168	17,396	56.0	86,416	.....	617,535	2,594,409	55.6
Resort[2]	.....	.....	.....	.....	.....	.....	.....	.....
Trans Caribbean	8,075	12,363	78.4	.....	.....	482,523	1,521,704	79.1
Trans World	22,795	71,833	46.7	1,606,794	.....	1,905,272	11,179,437	48.1
United	10,179	25,393	59.1	216,232	6,605	167,264	2,971,398	59.0
Western	5,592	8,698	71.6	8,991	.....	41,950	962,373	74.8
LOCAL SERVICE								
Allegheny	62,236	12,703	39.8	17,786	35,271	49,286	1,314,603	42.0
Bonanza	20,874	5,103	38.8	6,763	3,573	10,710	510,906	39.9
Central	13,139	2,581	37.4	8,162	4,236	11,990	271,512	34.2
Frontier	26,317	6,876	36.9	28,000	9,748	59,614	758,996	41.2
Lake Central	17,121	2,697	36.5	5,088	15,280	.....	278,262	39.9
Mohawk	55,598	11,398	45.3	18,629	19,226	21,264	1,144,695	42.3
North Central	69,569	12,097	41.27	36,609	41,873	46,649	1,293,325	42.84
Ozark	44,466	8,060	41.0	18,926	26,015	30,924	844,505	44.9
Pacific	38,855	9,030	49.4	15,255	4,035	9,071	889,346	43.9
Piedmont	37,494	7,812	43.1	13,249	14,298	20,971	796,427	44.4
Southern[1]	.....	.....	.....	.....	.....	.....	.....	.....
Trans-Texas	24,142	5,649	38.7	20,173	12,819	37,531	612,309	40.2
West Coast	28,000	6,835	41.34	14,117	5,960	18,074	687,593	41.58
HAWAIIAN								
Aloha	23,700	3,507	53.9	2,496	.....	6,809	290,328	44.2
Hawaiian	33,692	8,496	63.5	4,153	.....	160,074	926,283	61.9
CARGO LINES								
AAXICO[2]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	.....	.....	.....	387,234	387,234	63.0
Flying Tiger	4,187	21,345	66.6	25,849	44,747	8,109,750	10,314,750	70.3
Riddle—Domestic	.....	.....	.....	23,397	43,926	2,994,747	3,012,070	62.8
Overseas	.....	.....	.....	8,623	15	446,869	455,517	64.0
Seaboard & Western	1,130	4,489	100.0	990,287	.....	2,356,581	3,819,960	62.0
Slick	1,617	11,952	100.0	.....	.....	1,759,226	2,951,261	100.0
HELICOPTER LINES								
Chicago Helicopter	22,223	372	39.0	1,061	.....	.....	36,585	32.7
Los Angeles Airways	2,093	77	47.4	4,362	2,030	.....	13,667	57.6
New York Airways	11,775	255	50.1	1,469	683	490	26,847	49.2
ALASKA LINES								
Alaska Airlines	9,075	8,515	50.2	73,330	1,946	454,138	1,368,159	60.1
Alaska Coastal	3,489	355	51.1	4,128	.....	5,132	45,741	61.7
Cordova	1,007	183	37.3	4,806	.....	37,916	61,936	48.1
Ellis	3,448	206	46.4	1,874	.....	2,604	25,442	57.3
Northern Consolidated	1,350	460	30.8	47,192	.....	49,403	147,165	56.9
Pacific Northern	8,279	7,493	40.2	144,317	9,985	373,378	1,342,213	58.6
Reeve Aleutian	1,051	982	36.8	65,552	.....	67,992	241,931	61.8
Western Alaska	301	14	52.0	715	.....	460	2,567	50.0
Wein Alaska	2,352	493	28.3	41,644	.....	65,901	158,374	43.7
Avalon Air Transport	1,845	90	45.3	378	.....	496	9,396	49.9

[1] Not available. [2] No operations this month.
Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.



BRITISH ARMY ORDERS VIGILANT FOR TRIALS

ONE-MAN ANTI-TANK MISSILE

The only velocity guided Infantry anti-tank missile

■ Instant readiness ■ Higher accuracy than any comparable weapon ■ Lethal to the heaviest known armour ■ Smooth, direct and stable control ■ Only 5 hours simulator training plus 3 or 4 live rounds ■ Complete concealment in attack

For further details contact Vickers-Armstrongs (Aircraft) Limited. A Member Company of

BRITISH AIRCRAFT CORPORATION

100 Pall Mall, London S.W. 1, England

AIRLINE OBSERVER

► Airlines are optimistic that labor problems in the industry may be eased to some extent this year as a result of President-elect John F. Kennedy's appointment of Arthur Goldberg as Secretary of Labor. An attorney for the United Steel Workers and legal consultant to the AFL-CIO, Goldberg reportedly is a firm believer in averting strikes through arbitration and might be quick to invoke the powers of a presidential fact finding board in the case of airline strikes.

► **Failure of James M. Landis to win the presidency of the Air Line Pilots Assn. (AW Nov. 28, 1960) has started a grass roots movement among his supporters for the creation of a new pilots' union to be known as the Independent Pilots Assn. Majority of the IPA membership would be recruited from American, Eastern, Trans World and Delta pilots who gave early support to Landis. Recently appointed overseer of all federal regulatory agencies by President-elect John Kennedy, Landis told Aviation Week that while he was approached last month on the matter of a new pilots' union, the temporary nature of his term as a White House assistant has no bearing on the union issue and he would not be available to head the proposed IPA.**

► Airlines may soon face the loss of more radio frequencies as the volume of air traffic continues to mount. Federal Aviation Agency, which last year took several frequencies from the airlines and the Air Force, has told the Federal Communications Commission that total channels now being used for traffic control will soon become saturated and that by 1963 there will be a definite shortage of available radio channels. FCC replied that the problem may require more extensive frequency sharing or a reallocation of frequencies being used by other services.

► **Air Line Stewards and Stewardesses Assn. petition for an independent charter was rejected by the AFL-CIO last week, and closed door sessions continued in an effort to convince ALSSA to resume its affiliation with the Air Line Pilots Assn. The union severed all connections with ALPA last year after complaining that the pilots too often failed to support ALSSA in its contract negotiations.**

► Civil Aeronautics Board is intensifying its campaign to rid local service carriers of unproductive cities requiring heavy subsidy support. Ozark Air Lines was notified by the Board last week that several cities on its routes may be disallowed for subsidy under CAB's use-it-or-lose-it policy. The airline was given 20 days to submit traffic study figures on service at Austin/Albert Lea, Minn. and St. Joseph, Mo. and on segments between Des Moines and Sioux City, Iowa; Des Moines and Minneapolis/St. Paul, Minn., and St. Louis and Quincy/Hannibal, Mo.

► **Continental Air Lines' daily utilization rate of 10.8 hr. for Boeing 707s is leading all other U. S. operators of the 707. Rates reported by other airlines include 9 hr. for Pan American World Airways, 9 hr. for Trans World Airlines and 7.7 hr. for American Airlines.**

► British Overseas Airways Corp., is crediting much of a 31.4% gain in traffic last year to its Boeing 707 turbojet service. The airline carried a total of 748,900 passengers over its routes, compared with 569,942 in 1959, and flew a total of 54 million miles.

► **Air Transport Assn., has asked the District Court to make the Civil Aeronautics Board give more detailed answers why ATA cannot claim an attorney-client privilege on more than 100 documents CAB has demanded as part of its current investigation of the associations' procedures.**

► Capital Airlines' lease of two Boeing 720 turbojets from United Air Lines has been approved by the Civil Aeronautics Board. Lease rate for each aircraft, from Jan. 1 to Apr. 29, is $3,060 per day plus $266 per flight hour on two daily round trips between Cleveland and Miami and Pittsburgh and Miami. Aircraft will have United markings and be operated by Capital crews.

SHORTLINES

► **Alitalia,** the Italian airline, reports it carried 58,934 passengers on its North Atlantic routes during the first 11 months of 1960, an increase of 49.8% over the same 1959 period. Passengers were carried from Boston, Montreal and New York to London, Milan and Rome.

► **Boeing Airplane Co.** and Japan Aircraft Maintenance Co., Ltd., have signed an agreement whereby JAMCO will be the authorized Japanese maintenance agent for Boeing 707 and 720 turbojet transports. Boeing will train JAMCO technicians.

► **Eastern Air Lines** has purchased three specially built buses from General Motors Truck and Coach Division to carry passengers from Boston's Logan International Airport waiting rooms to aircraft. Distance from waiting room to parking area is 425 ft. during Eastern's modification program at Logan.

► **Icelandic Airlines** is now offering a 17-day excursion fare of $293.50 on its transatlantic route from New York to England, which the airline says is $56.50 lower than fares offered by other carriers. The fares are for travel on Douglas DC-6 aircraft which the carrier operates on its Atlantic runs. Icelandic reports it carried more than 35,000 passengers in 1960.

► **Japan Air Lines** is planning to introduce its Convair 880-22M turbojet service in July from Tokyo to Okinawa and Hong Kong, Tokyo to Taipei and Hong Kong and Tokyo to Hong Kong, Bangkok and Singapore. The carrier's 880s will replace Douglas DC-6B aircraft now used on these routes. Japanese airline is offering twice weekly round-trip all-cargo flights between San Francisco, Honolulu and Tokyo with Douglas DC-7F transports, and a third flight will be added in March.

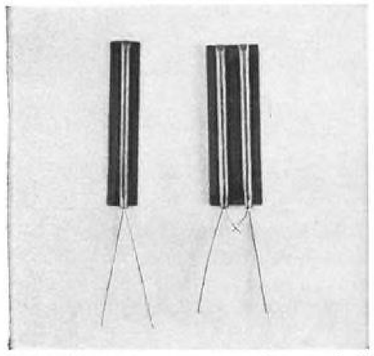
► **Trans-Canada Air Lines** reports it carried 3,440,000 passengers on its domestic and transatlantic routes during 1960, a 7% increase over 1959. Last year, the carrier flew 17.4 million freight ton-miles, a 15% increase, 2,855,000 express ton miles, a 7.6% gain, and 11,164,000 mail ton miles, a 2.3% increase.

► **Trans World Airlines** plans to introduce daily Convair 880 turbojet service on a route connecting Dayton, Chicago, Los Angeles and San Francisco Jan. 20. TWA has started a weekly Boeing 707-331 service between New York and Milan, Italy, Rome and Athens, Greece.

Microdot Acquires Micro-Test

Los Angeles — Microdot Inc. has entered the field of strain measurement devices through the acquisition of Micro-Test, Inc. of Santa Monica, California. Through this move, Microdot will manufacture and market the only weldable strain gage in the U.S. — a device that is capable of continuous operation at 800°F and dynamic test to 1500°F.

The weldable strain gage, used extensively in missile, space, and atomic projects, will be integrated with Microdot's existing pressure, force, and acceleration measurement capabilities.



Weldable strain gages, one-piece, etched wire filaments in swaged stainless steel tubes, are suitable for use from cryogenic to elevated temperatures. Photo shows typical gages in actual size.

The Micro-Test acquisition is in line with other current moves by Microdot to enhance and broaden the company's instrumentation capabilities. Other Micro-Test products to be offered by Microdot include: temperature sensors in 60 and 120 ohm resistances that are completely insensitive to strain, and hermetically sealed load cells with adjustable temperature sensitivity offered in ranges of from 5,000 to 50,000 pounds for both compression and tension-compression.

Microdot sees great potential for the application of these new devices wherever physical phenomena can be measured and controlled. The weldable strain gage is already being used in atomic reactors, the exterior of submarines, inside chemical vats, on pilings sunk into the St. Lawrence Seaway, and a wide variety of airborne defense projects.

MICRODOT INC.

220 Pasadena Ave.
South Pasadena, California

"WE HAVE NEVER REJECTED TERROR ON PRINCIPLE..."

The words are Lenin's.

Remember them... particularly when your contribution to defense—to the potential terror of space age war—chafes at *your* principles.

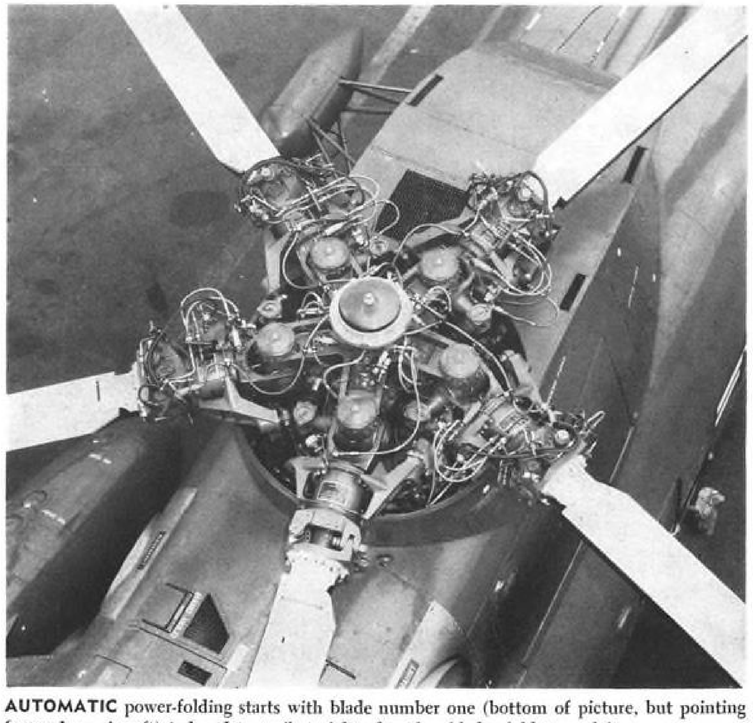
They'll help you know that what you do keeps fingers off buttons... that the real business of the defense business is survival.

©1961, MICRODOT INC.



SIKORSKY HSS-2 demonstrates some characteristics of water-based operations during taxi runs on calm surface.

HSS-2 Combines Sub Hunter-Killer Role



AUTOMATIC power-folding starts with blade number one (bottom of picture, but pointing forward on aircraft) indexed to trail straight aft; other blades fold toward it.

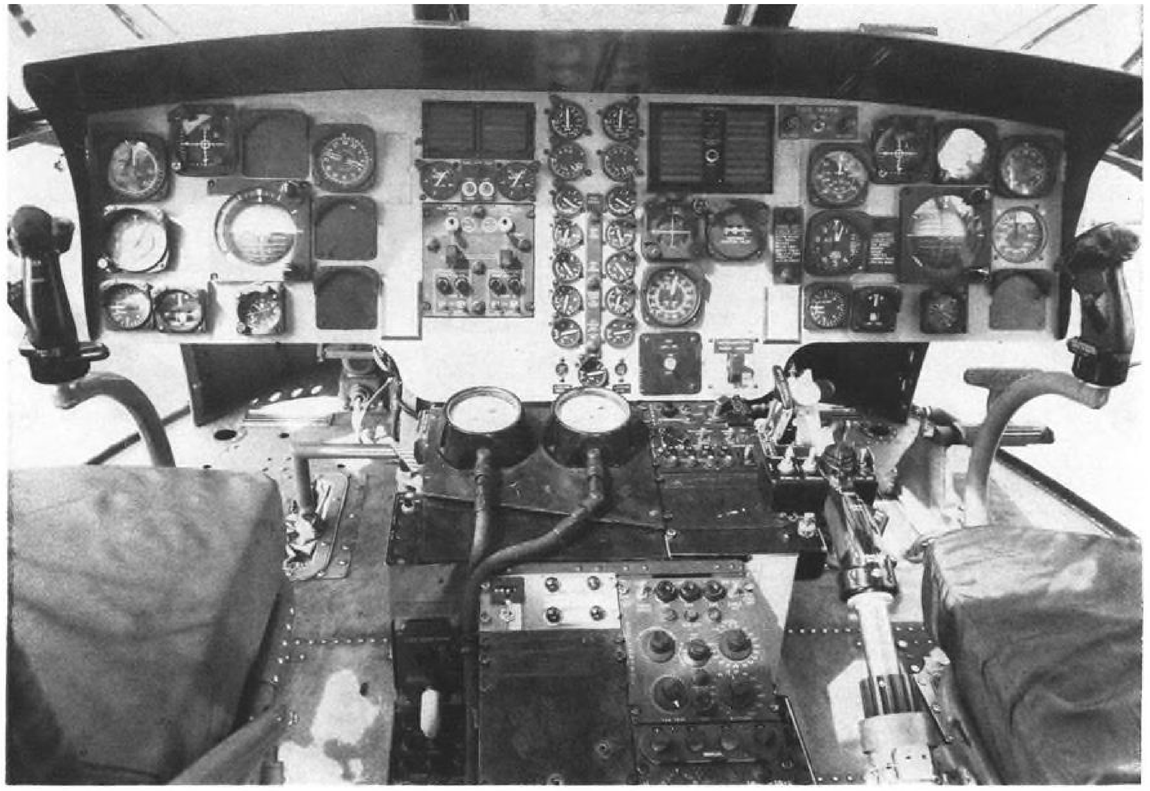
By David A. Anderton

Stratford, Conn.—Sikorsky HSS-2 twin-turbine helicopter has set new standards of aerodynamic and structural design, and is expected to do the same for anti-submarine warfare when it joins the U. S. fleet later this year.

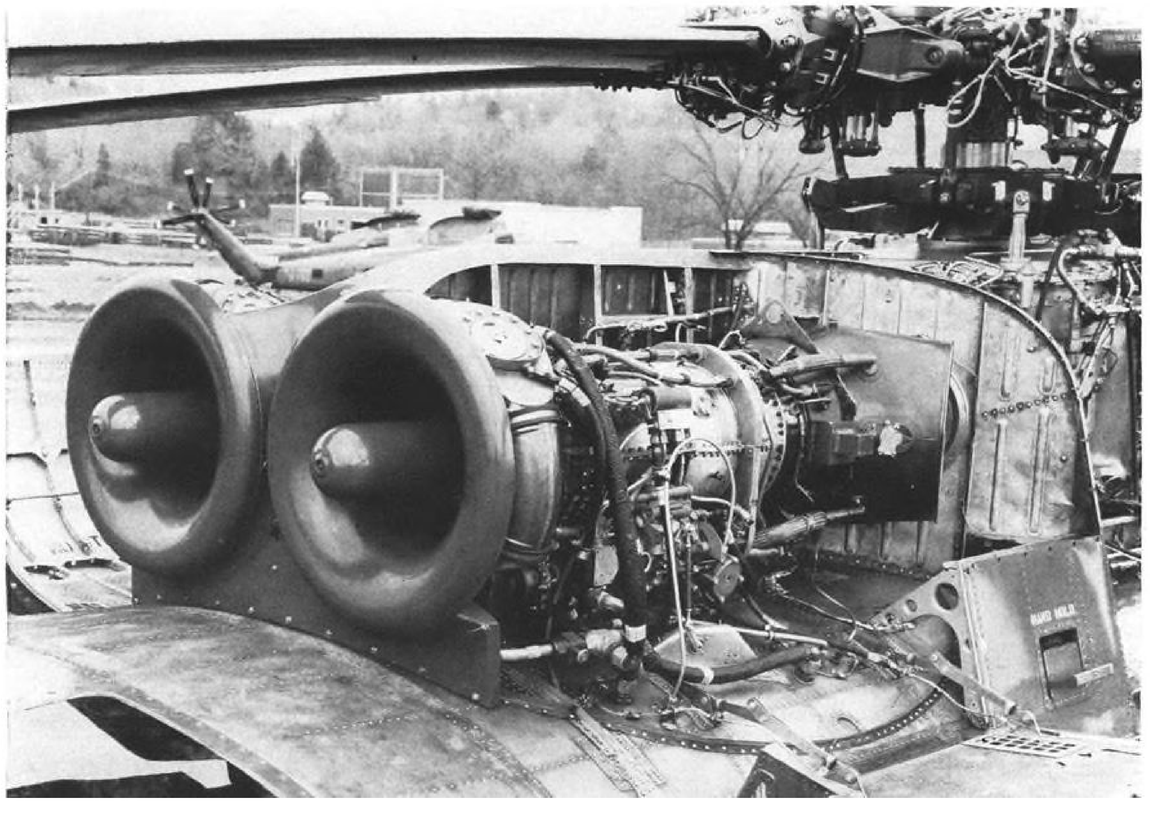
The big helicopter—"Hiss Two" in Navy parlance—already has flown faster than the existing world's record for its class. It was designed to a guarantee of 1,000-hr. life on all components. It can hover with 46% of its gross weight as useful load, an exceptionally high figure for a helicopter.

Its boat hull, navigation aids and instrumentation make it an all-weather subhunter. Its sonar is a big step up from earlier helicopter-borne equipment and gives the HSS-2 listening capability matching that of a submarine. Finally, it combines the function of the subkiller with its ability as a subhunter, and has demonstrated weapons delivery for all types of stores including nuclear.

It was a new kind of project for Sikorsky in a management sense, also. First of the company's weapons-system aircraft, the HSS-2 was carried through in a record three years from contact to fleet delivery, monitored by the weapons system task force, a man-

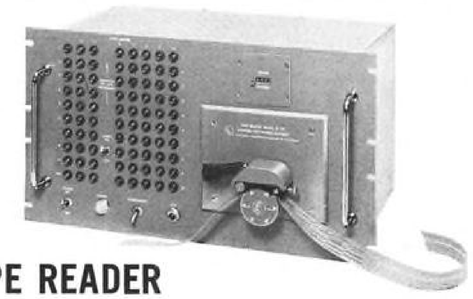


HSS-2 COCKPIT layout (above) shows automatic stabilization equipment on right side of console between seats; armament panel is forward at right. Collective pitch stick includes controls for sonar hoist and automatic hovering; cyclic stick includes ASE override. Twin General Electric T58-8 turboshaft engines (below) have bell-mouthed inlets, de-iced for all-weather operations. Lower section of engine cowling is hinged to drop down for use as work platform.



HOLE HEARTED

IS THE JOB DONE BY EECO'S LONG-LIVED TP-401 PUNCHED-TAPE READER



Looking for improved tape-ability? For sequencing automatic testing in ground support, or for the control of simulation devices, this ruggedized punched tape reader makes better, more reliable contact than any other reader because of unique springloaded pins.

Reads 80 bits per frame at 6 frames per second. Searches at 12 ips. Includes neon-lamp verifier panel for quick checking of new tapes. Uses 1" paper or tough mylar tape with standard eight-level 0.1" punching. Manual or remote stepping, 4-digit frame counter with reset, other desirable features.

Costs only $1,620 f.o.b. Santa Ana. (Or $1,490 for model TP-402 without verifier.) Send for Data File TP-401.

EECO also makes these other punched tape readers for special applications:

Model TP-813 13-channel programmer for airborne use. $990.

Model TP-201A 80-bit bi-directional programmer. $1,160.

Model TP-860 8-channel time base programmer. $875.

Automation Division
Electronic Engineering Company *of California*
1601 EAST CHESTNUT AVE. SANTA ANA, CALIF. KIMBERLY 7-5501
® TWX: SANTA ANA CAL 5263

Several important career opportunities are now open in EECO's engineering department. Call or write Merl Perkins.

EE 0-18

See EECo. on Display—Booth 2—Winter Convention of Military Electronics, Biltmore Hotel, Los Angeles, Feb. 1-3.

agement group at corporate level to match the organization of Navy's Bureau of Weapons.

Sikorsky engineering teams produced a twin-engine helicopter of conventional layout, powered by a pair of General Electric T58-8 gas turbines rated at 1,250 shp. each and driving a five-bladed rotor. Basic weight empty is 9,953 lb. and the addition of the useful load brings the initial gross weight up to 17,300 lb. Rotor diameter is 62 ft. Main rotor blades, and the entire tail section plus tail rotor, fold to meet carrier elevator dimensions and to reduce storage volume required on a hangar deck.

Normal crew complement is four: pilot and copilot, plus two sonar operators sitting aft with the sonar gear.

Fuel capacity is 4,504 lb. in normal tankage. Floats and the boat hull make the HSS-2 completely amphibious.

Program Status

HSS-2 has completed the last of five Navy Preliminary Evaluations (NPE) combining flight, avionics and weapons tests. Complete weapons system evaluation has been done at NAS Patuxent River, Md. Technical evalution of the Bendix AQS-10 sonar has been completed by Sikorsky at Key West under Bureau of Weapons monitoring.

The aircraft has been flown through structural demonstration at Patuxent River, and has passed cold-weather tests in the USAF climatic hangar at Eglin AFB. The standard range of ASW weapons has been dropped during tests at the Naval Aerial Torpedo Test Unit, NAS Quonset Pt., R. I.

An HSS-2 flown by Navy pilots has reached 162 kt. indicated airspeed during runs at 6,000 ft., equivalent to about 200 mph., an unofficial speed record for the class. Another HSS-2, also flown by Navy pilots, performed the required four-hour anti-submarine mission with 1,000 lb. overload. An open sea landing and takeoff have been made following an engine loss during hovering. Rotor folding and spreading was done during Hurricane Donna under extreme gust conditions.

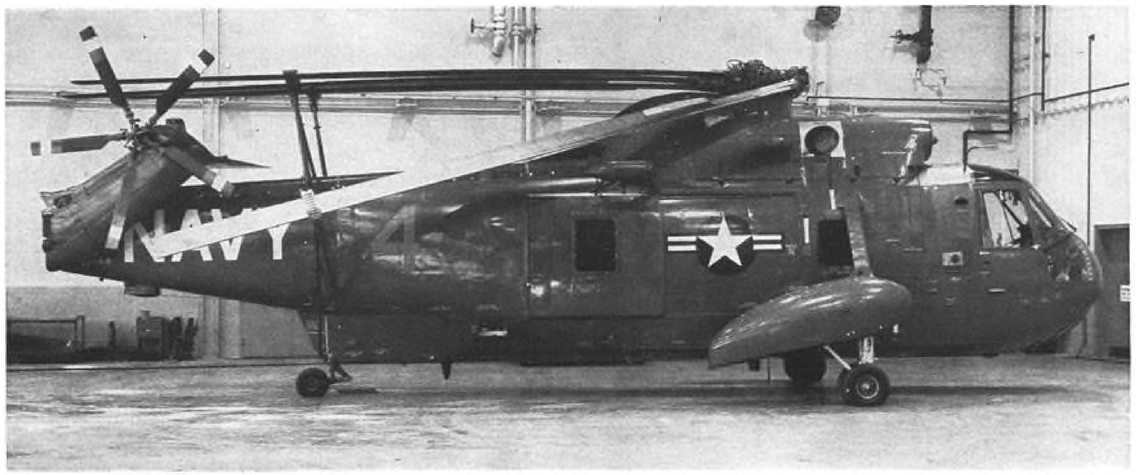
With three contracts for production of the Hiss-Two in the works and a fourth expected, Sikorsky is starting deliveries to the fleet for indoctrination and training programs early this year.

The helicopter was designed from the start as a weapons system, around basic mission requirements with ASW heading the list:

• **Anti-submarine mission** calls for four-hour duration with 10% fuel reserve and mission time divided equally between cruise and hover. Initial gross weight is 17,300 lb. Four-man crew, sonar and 840 lb. of weapons are carried.

• **Attack mission** specification calls for a 240-naut. mi. cruise at 132 kt. to target, drop of 840 lb. of weapons and return at most economical speed. Initial gross weight is 17,300 lb. Full sonar and crew are carried.

• **Minesweeping and tow missions** can be handled by the HSS-2, stripped of its weapons and the two sonar operators, but including the installed sonar gear. Provisions for the missions add 325 lb. to the empty weight, but removal of other items keeps the initial gross weight down to 16,348 lb. Towline tension at normal rated power and minimum fuel weight can be as high as 15,200 lb. with zero headwind, dropping to about 8,000 lb. in a 50-kt. relative headwind.



HSS-2 with main rotor blades and tail section folded has an over-all stowed length of 46 ft. 6 in. Folding reduces size of helicopter to meet aircraft carrier elevator dimensions and to reduce storage space needed on hangar decks.

Sonar System

Sikorsky engineers knew early in the program that the HSS-2 wouldn't be much of a forward step if nothing was done about existing sonar equipment. Sonar then installed in the HSS-1 used a 10-deg. search beam width and had to make 36 samplings to cover the circular area underneath the listening helicopter. The routine took about five minutes, entirely too long for an operation against a modern submarine capable of running submerged at upward of 30 kt.

Technology caught up in the form of the Bendix AQS-10 sonar, which searched on a 18-deg. beam width, first forward and then aft, completing the sampling in about one minute. Sikorsky built this into the HSS-2, and weapons system managers were able to work directly with Bendix and receive the gear as contractor-furnished equipment rather than through the old routine of manufacturer to Navy to Sikorsky.

Unofficial reports claim that the HSS-2 with AQS-10 sonar aboard can match current fleet submarines in listening capability.

To get into listening position, the helicopter has to hover while the sonar operators let down the sonar ball and make their search. Working against time, the transition from cruise flight to hover must be as fast as possible.

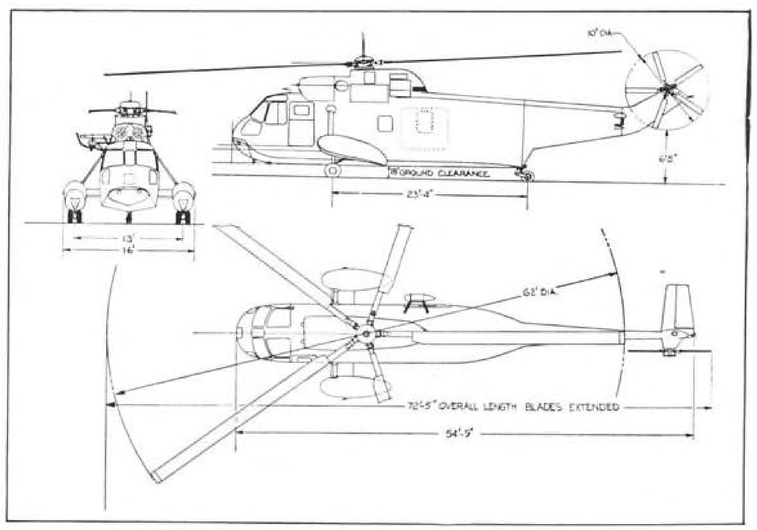
Automatic Transition

Even experienced pilots miss the hover about 30% of the time, and the inexperienced pilots have so much to do that they are too busy to see emergencies. So Sikorsky designers elected to make the transition into hover automatic. They developed a system that takes the helicopter from forward flight at a few hundred feet altitude to a hover at 50 ft. The transition is fully automatic, with pilot override capability for instrument flight, or if otherwise necessary.

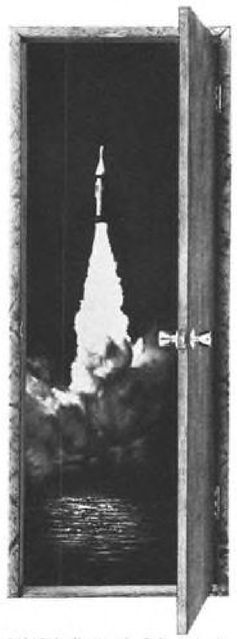
Automatic stabilization equipment (ASE) developed by Hamilton Standard Division is part of the HSS-2 system, to relieve the pilot or being four-handed during hovering. In addition, a sonar coupler is used with the system to hold altitude automatically, tied to the Ryan APN-130 doppler radar and the radar altimeter.

The sonar system is a sensitive one anyway; the sensing ball in the water must be held vertically and quietly. If it's tilted, it picks up the noise from the rotor downwash; if it's dragged, it generates its own self-defeating noise.

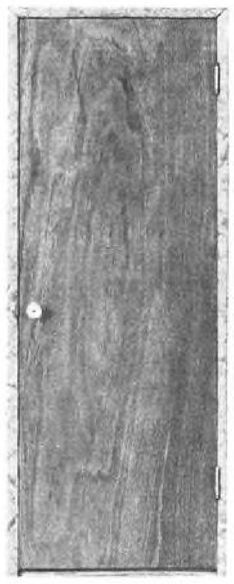
Dragging can be eliminated by automatic hovering, which fixes the heli-



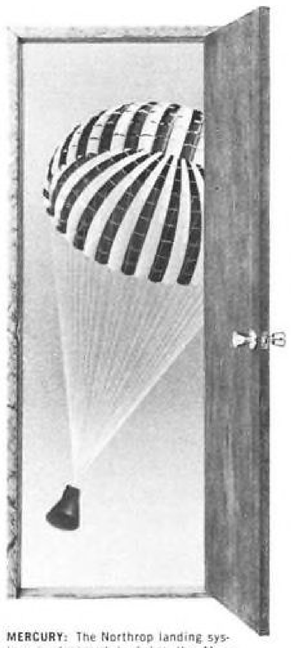
THREE-VIEW of HSS-2 shows characteristic lines of Sikorsky helicopter designs.



POLARIS: Northrop's Datico checks out Polaris at all levels of maintenance and operation.



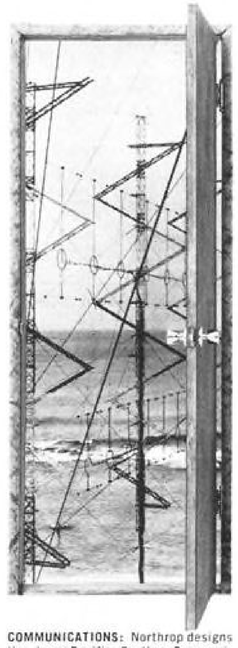
SKYBOLT: Guidance and navigation systems are being developed by Northrop for this new and highly secret air-launched ballistic missile.



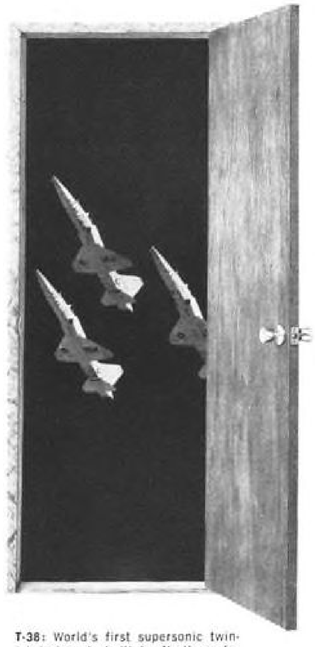
MERCURY: The Northrop landing system is designed to bring the Mercury astronaut down safely.



HAWK: Northrop produces airframe components, ground handling and launching equipment for this air defense missile.



COMMUNICATIONS: Northrop designs the trans-Pacific Scatter Communications Network and other worldwide communication systems for U.S. and free world governments.

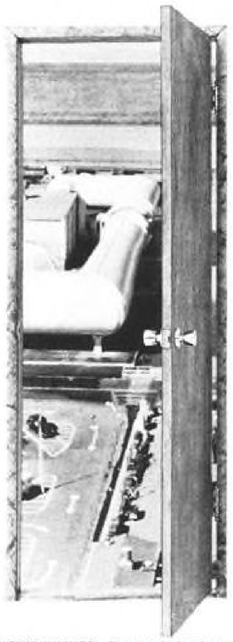


T-38: World's first supersonic twin-jet trainer is built by Northrop for the United States Air Force.

Northrop is now active in more than 70 important programs



X-15: Northrop produces Q-Ball, the flight angle sensor for safe re-entry of X-15 and other aerospace vehicles.



AERODYNAMICS: Northrop's Laminar Flow Control technique is designed to greatly increase aircraft range, flexibility, cargo and passenger capacity.



TITAN: Northrop supplies complete technical and industrial management to activate the T-2 Titan missile base.



TARGET MISSILES: Northrop has produced more than 50,000 electronically-controlled aerial targets, and surveillance drones.



COMMERCIAL METAL PRODUCTS: Northrop produces aluminum architectural shapes for many important industrial and commercial buildings.



SPACE RESEARCH: Northrop's accelerated space research programs reach into such advanced areas as maneuverability, rendezvous, space vehicle maintenance, space probes, and the survival of men in space.

Northrop Corporation, Beverly Hills, California • Divisions: Norair, Nortronics, Radioplane, Northrop International

Subsidiaries: Page Communications Engineers, Inc., Acme Metal Molding Company.

copter in space above a surface point. Trimming the cable for vertical can be done by the sonar operator, who compares the cable position with a gyro vertical reference. He can also trim visually by watching the water pattern beneath. In either case, he can command changes of about five to 10 deg. in the cable angle.

Lower hover altitudes than the chosen 50 ft. don't seem to be in the future for helicopters because of the effect of rotor downwash. At keel altitudes below about 30 ft. for the HSS-2, the rotor downwash picks up salt water and throws it, partly evaporated, into the characteristic flow pattern of a rotor operating near the ground. This swirling motion speeds evaporation of the salt water and flings the salt-saturated drops into the engine inlets where the salt is deposited. This ruins engines rapidly.

Hovering higher than 50 ft. means longer time for lowering the ball, and for raising it again to pick up and go to another station.

All-Weather ASW

Ryan's APN-130 doppler radar navigational system is the heart of the HSS-2's all-weather capability, supported by the usual navigation and communication aids, ASE, and rotor blade de-icing.

There are a couple of problems inherent in a doppler system that pose special operational questions. First, there is little or no doppler return to the helicopter over smooth water; second, the return falls off above about 300 ft. Consequently, navigation above 300 ft. over glassy seas is best done by standard techniques. The doppler pays off most of the time anyway, because the dipping has to be done below 300 ft. and there is hardly ever a flat calm.

Sikorsky engineers credit the boat-hull layout with a fair share of the all-weather capability of the HSS-2. They point out that pilots on ASW missions are reluctant to work at night over water, and do so out of necessity. Their confidence in the water-landing capability of the HSS-2 is expected to produce a more relaxed approach to the trying task of night ASW operations.

Reliability of these systems, which in the last analysis determines whether or not a pilot has an ASW weapons system at his command, is running high now. Specific figures are not yet available, because of the limited amount of flying time put in by Sikorsky and Navy pilots to date, and because the helicopters are not yet with the fleet.

But one indication is a Sikorsky comment on the ASE installation, which is now rated as reliable as landing gear.

The HSS-2 is a standard Sikorsky design in appearance, with the traditional single main rotor and tail anti-torque rotor. This lifting system is powered by a pair of General Electric T58-8 turboshaft engines, each military-rated at 1,250 shp. and with normal rated power of 1,050 shp. Changeover to the −8 engines occurred about the middle of the second production contract; prototype and early production aircraft had the de-rated −6 engine. Sikorsky is providing the torquemeter for the −8 engines as part of its gearbox design.

The all-steel rotor hub carries five all-metal interchangeable blades, pre-tracked at the factory. Rotor blade folding is automatic and powered, with the number one blade indexing to trail straight aft, and the other four blades folding toward it.

Component Life

Guaranteed life of these, as well as all dynamic components, is 1,000 hr., originally slated to be reached next year on a schedule set at the beginning of the program. Actually most of the components have already reached that level, with current exceptions including the gearbox for the −8 engine. But Sikorsky engineers feel confident of beating the dates on all of them.

All dynamic components are mounted above the fuselage, with a profusion of quick-opening panels and work platforms provided to make maintenance easy. About one-third of the rotor overhaul and maintenance tools are existing tools for other Sikorsky helicopters. The huge, special wrench used to turn the main hub nut no longer is needed.

Power Available

Advantages of the gas turbine powerplant for helicopters are so well known that repetition is unnecessary. The basic fact is that these engines have forced a discontinuity in the helicopter design curve. From that point, all helicopters were bound to be considerably better.

With one of the GE engines out, the HSS-2 can still fly on the other at weights up to 19,000 lb., almost one ton over the normal gross weight. With normal gross weight for the ASW mission, one engine will fly the helicopter at any speed between 40 and 100 kt., using the 30-min. contingency power rating. If the helicopter has an engine failure away from base, it can be flown back at gross weights up to 13,000 lb. on the remaining engine, including a hovering takeoff out of ground effect.

If both engines go at once—which has astronomical odds against it—the following autorotational landing produces about a 50-ft. ground roll. The landing gear, incidentally, has been checked out from full autorotation.

Lockout Control

The left engine has a lockout control which makes it available to furnish accessory power while the helicopter is on the ground and without turning the rotor.

Schematically, both engines normally drive through free-wheel units and the rotor brake to the main gearbox, and the accessories are driven from a power takeoff on the tail rotor shaft. In the HSS-2, there are two additional free-wheel units, one between the accessories and the tail rotor, and the other between the accessories and the left turbine. The lockout control keeps shaft power out of the main gear box and channels it directly to the accessories.

In use, the pilot can start the left engine and use it to bring all accessories to operating speed and output. He starts the right engine and uses that to bring the rotor to speed; only then can he cut in the left engine to rotor drive.

Design Organization

The HSS-2 was Sikorsky's first weapons system. Previous helicopters had been designed and built by the traditional techniques of engineering and supervised by the traditional techniques of management. But the HSS-2 was different—different enough to require a new approach to engineering organization and development if the tough project time scale was to be met.

Everett Delaney, who had been with the Hiss Two in preliminary design, moved out on the engineering floor with the helicopter as project engineer. Sikorsky top management organized a weapons system task force, a horizontal group at corporate level representing all departments, with Delaney as chairman. "We meet every day to make sure things get done on time," Delaney said. "We can do a more thorough job with the weapons system approach, and the danger signals come up sooner than under the old scheme."

This task force represents Sikorsky's matching of the organization in the Navy's Bureau of Weapons and is a super-supervisor of the project.

Delaney pointed out that the HSS-2 represented a lot of "firsts" for the

HSS-2 Dimensions

Length, blades rotating	72 ft. 5 in.
Width, blades rotating	62 ft. 0 in.
Height, blades rotating	16 ft. 8 in.
Fuselage length	54 ft. 9 in.
Width across floats	15 ft. 8 in.
Height of main rotor	15 ft. 4 in.
Stowed length	46 ft. 6 in.
Cabin Size: length	27 ft. 9 in.
height	6 ft. 3.5 in.
width	6 ft. 4.5 in.



Bell Prepares for HUL-1M Turbine Helicopter Tiedown Tests

New Bell HUL-1M, a 47J repowered with a 250-shp. Allison T63 turbine engine, is being readied for a 20 hr. tiedown trial period after passing an initial 3 hr. ground test (AW Jan. 2, p. 19). U. S. Navy bought two 47Js off-the-shelf for conversion to the Allison powerplant; second aircraft will be delivered to Allison for engine conversion. On paper, the T63 pushed the HUL-1M service ceiling from 12,100 ft. to 18,000 ft. at a gross weight of 2,850 lb.



company. It was Sikorsky's first weapon system, the firm's first FIRM (Fleet Introduction of Replacement Models) aircraft and the first helicopter to go through Navy's MEI (Maintenance and Engineering Inspection) program. The HSS-2 has been through five Naval Preliminary Evaluations. These are evaluations of the aircraft's systems by Navy pilots; last of these was a combined workover of flight characteristics, avionic systems and weapons.

Delaney also cited the amount of report-writing and meeting time connected with the project. Monthly reports are submitted to the Navy; there is a quarterly revision of the master management plan, an impressive pile of blue-covered documentation that traces every phase of the program along the time trail; and there are semiannual three-day meetings with the Navy covering any subject in the program.

Sikorsky laid out its most extensive test program to date for the development of the HSS-2. Sam Whyte, in charge of the enormous and specialized program, said the tests included static and fatigue runs on every component, in many cases to failure of the piece. Each of these parts was tested with its immediate attachment one step back into the main structure; for example, if a main blade with cuff was being run through its program, the sleeve fitting was attached to the cuff, and also to the testing machine so that the combined effect could be checked. In effect, this approaches systems testing.

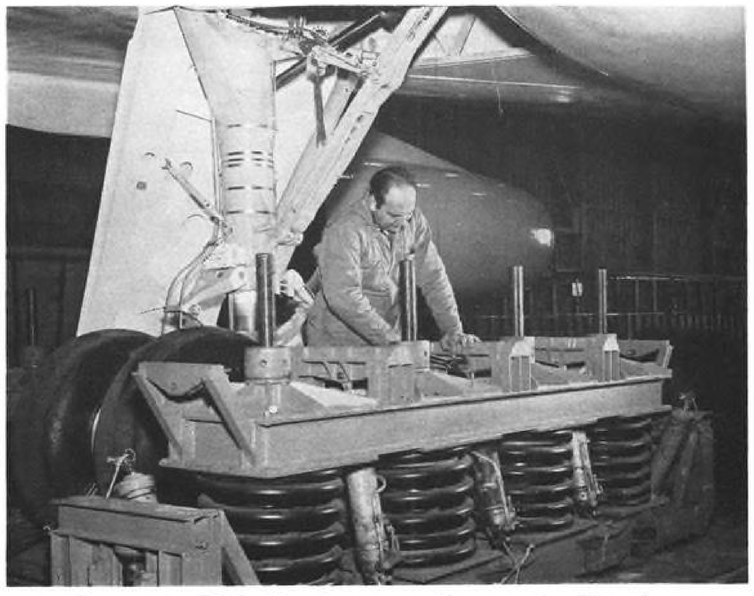
Components were fabricated and tested as assemblies, and then the assemblies were formed further into testable systems. Sikorsky built its own whirl tower to check the main and tail rotor; the aim was to get 3,000-hr. time on the main rotor and 2,000 on the tail.

Next step was to combine powerplant and rotors into a complete turbine testbed, including controls and cowling. This approximated the tiedown tests of a real aircraft, but by anticipating them, would have saved considerable time and money should changes have been found necessary.

Final preflight testing was done on the complete HSS-2 in tiedown, running through simulation of the operational cycle.

Final work on the test program is continuing, but is nearly completed. Whyte's technicians have run more than 100 main and tail rotor components and more than 75 main and tail rotor blade tests in the fatigue laboratory. They have subjected main, tail and intermediate transmissions to 2,000 hr. of bench testing, have checked the HSS-2 rotor system through 500 hr. on the turbine testbed and the complete aircraft through 450 hr. of tiedown testing.

The complex of testing facilities built by Sikorsky for this and other programs



Convair 990 Undergoes Dynamic Testing

Heavy springs mounted on this isolation platform are used to isolate the Convair 990 jet transport from the ground at its landing gear points to simulate airborne conditions at Convair's Dynamic Test Laboratory, San Diego, Calif. Electro-magnetic driver units are placed on wingtips, tail and control surfaces to shake the airplane.





SEALING UNLIMITED AT −420°F

through continual in-plant development testing of fluid regulators and controls

When you're dealing with temperatures ranging from near-absolute zero to several hundred degrees above zero . . . with fluids that have so minute a molecular structure as hydrogen and helium . . . with the critical space-weight factors of missiles . . . these are conditions that demand continual in-plant testing by the manufacturer. It's fundamental to reliable fluid system sealing, control and regulation.

That's why Hadley is so uniquely suited to development programs such as the new hydrogen engine, as well as other space vehicle and ground support systems.

As designers and fabricators of fluid control systems on many of the operational missile programs, Hadley has combined expert engineering with its own comprehensive functional and environmental test facilities to check out every stage of development.

You'll save time, money and insure critically reliable fluid control by checking Hadley first. Write for Information Brochure AW-1094-2.

b.h. Hadley, inc.

1427 SOUTH GAREY AVENUE, POMONA, CALIFORNIA
■ NAtional 9-5075 ■ TWX Pomona 7552

Openings exist for qualified engineers.

has to be seen to be believed. Where once a small room with a pair of shakers sufficed, now the fatigue and structural testing laboratory space compares in size with the assembly floor. But these are only part of the company-owned test facilities which played a major role in developing the HSS-2.

The 8,000-hp. whirl test tower was a major asset; so were the in-house test facilities available to Sikorsky through its parent United Aircraft Corp. "We couldn't have done the job without the whirl tower, the wind tunnels and the computers," said one engineer, adding that none of these facilities was particularly startling, but it was the first time Sikorsky had used so many of them so extensively.

"We learned from earlier programs," said Allan Poole, who handles government sales for the division. "The HSS-1 and -1N taught us a lot about flying and doing an ASW mission under instrument conditions; the HSS-1F gave us gas turbine experience; the HR2S contributed twin-engine experience and automatic blade folding."

In acquiring all this background, Sikorsky, in common with other helicopter manufacturers, has had to live with a lot of troubles caused by expensive maintenance, marginal or no single-engine operation, low over-all performance, and inadequate systems. But in the words of Carlos Wood, Sikorsky's engineering manager, the helicopter is now about where the Douglas DC-3 was when it entered airline service. It has suffered through the major share of its development pangs and a bright future appears to lie ahead. This is true generally, said Wood, but it's specifically true for the HSS-2.

PRODUCTION BRIEFING

Atomics International, a division of North American Aviation, Inc., has successfully ground-tested a prototype of the reactor for the SNAP 2,8 and 10 systems which will generate electric power in the kilowatt range continuously for a year. SNAP 10, which will be flight tested in 1962 or 1963, will use a thermoelectric converter to produce up to 2 kw. of electricity from reactor heat.

Pittsburgh-Des Moines Steel Co. will fabricate a Mach 7 high-temperature wind tunnel under terms of a $1,384,780 contract from NASA. The tunnel willl be used for research on hypersonic wing forms and components of aircraft and missiles. The gas fired combustion chamber in the 8-ft. tunnel will be able to generate temperatures up to 4,000F.

Norton Air Force Base, San Bernardino, Calif., has received a JC-121 (Lockheed Constellation) aircraft which will be used to monitor the Atlas ICBM guidance system from aloft. In the event of technical trouble with missile guidance, the aircraft will fly over the missile site so that its special electronic equipment can pinpoint the trouble area and then give positive checks on the reliability of the missile guidance system. The JC-121 will be maintained for immediate launch on a 24-hr. basis. A typical mission will last from 16-10 hr.

Waltham Laboratories of Sylvania Electric Products, Inc., has received a $250,000 contract from the Army to study the feasibility of a field Army ballistic missile defense system. Sylvania is a member of one of six contractor teams chosen by the Army for such studies and has teamed with the Aeronutronic Division of Ford Motor Co., on the project.

Collins Radio Co. has begun deliveries on more than $400,000 of electronic equipment to be installed on United Air Lines' fleet of 20 Caravelles. Collins equipment on the Caravelles includes communications, VOR, ADF, glideslope, marker beacon and passenger address systems.

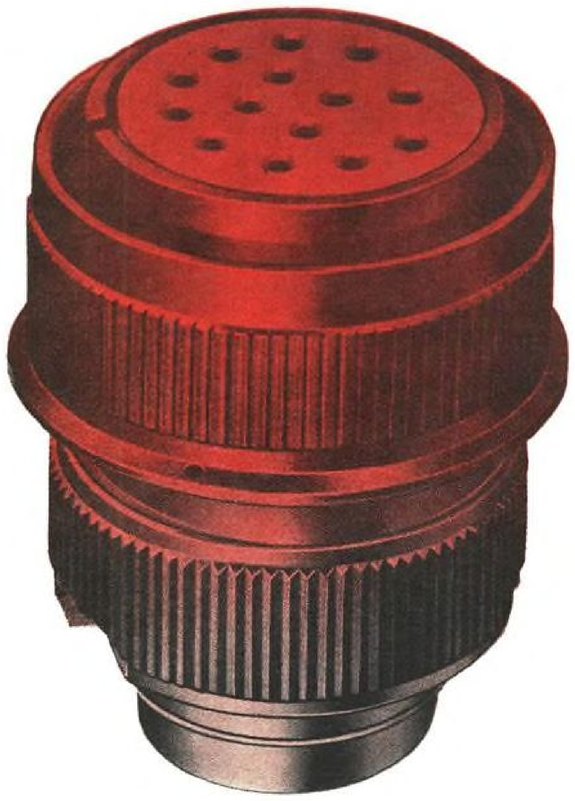
Consolidated Diesel Electric Corp.'s aircraft equipment division has been awarded a $3-million contract for aircraft towing tractors. The tractors are



Ski-Equipped Hercules Flies in Antarctica

Three Navy-Lockheed C-130 ski-equipped Hercules transports carried more than 400 tons of cargo, including 300 scientific and U. S. Navy support personnel, to the South Pole, Byrd, New Byrd and Beardmore stations from McMurdo Sound, Antarctica, from Oct. 29 to Nov. 29, often in −50F temperatures. Above, tons of cargo are loaded into the airplane at McMurdo. The airplane is shown landing at New Byrd Station below. The turbine-powered transports made more than 100 flights in the first few weeks of sub-zero operations out of McMurdo, after being flown there from New Zealand. Read Adm. David M. Tyree, Task Force 43 commander, said the airplanes are committed to a 1,600-ton airlift in 1961.





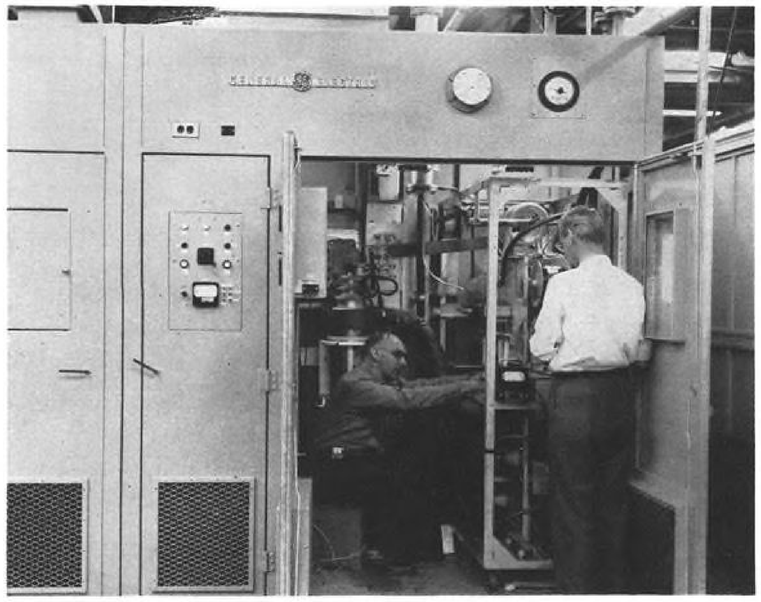
HIGH TEMPERATURE CANNON PLUGS

Whatever the application, Cannon's broad line of heat-resistant plugs provides the optimum protection to vital electrical circuits. Continuous or specified operation from 200°F to 2000°F—at aircraft firewalls or industrial facilities...for missiles or the most advanced spacecraft—we have a plug to solve your temperature problem. Another reason why you should consult the world's most experienced plug manufacturer... why you should consult Cannon for all your plug requirements!

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, Calif.

Write for literature on high-temperature plugs, or other Cannon products to:

CANNON PLUGS



High-Temperature Cell Tests Flight Structures

High-temperature test cell, for testing spacecraft and missile structures at re-entry temperatures, concentrates 7.5 million watts of radio frequency energy in a 100 sq. ft. area. The test unit, designated "Project Heat," was developed by General Electric's Technical Products Operation for installation at the Air Force's Aircraft Structures High-Temperature Laboratory, Wright-Patterson AFB.

four-wheel-drive vehicles with a pulling power of 25,000 lb., enough to handle a 500,000-lb. aircraft. Company defense backlog exceeds $25 million.

Westinghouse Electric Corp. will supply the main propulsion drive for an LPH vessel under terms of a $1.2-million contract from the Navy. The equipment for the ship, whose initials stand for "Landing Personnel Helicopter," consists of propulsion turbines, condensers and gears. Westinghouse has supplied similar equipment for the first two ships of this class.

Convair (San Diego) Division of General Dynamics Corp. has received contracts totaling approximately $8 million from Autonetics Division of North American Aviation, Inc., for production of an advanced airborne mapping radar. The radar will be part of the bomb-nav system on the North American A3J Vigilante. The new contracts, which are follow-ons to previous contracts, bring Convair's contract total with North American for radar equipment to nearly $20 million.

Consolidated Systems Corp., Monrovia, Calif., will supply additional missile scoring systems for Air Force QB-47 drones under terms of a $346,000 order from Lockheed Aircraft Corp., Marietta, Ga. The optical scoring systems include 16 mm. cameras which operate at 200 frames per second to photograph the trajectory of interceptor missiles as they dive on the drone (AW Sept. 5, p. 72).

Cubic Corp. has signed a $3-million contract with five organizations, chief among them Compagnie des Compteurs, Paris, which will provide missile-range instrumentation for the Sahara Missile Range (Colomb-Bechar) in North and Central Africa. Under the first phase of the program, Cubic will manufacture angle and distance measuring, and data handling, equipment for the range. Under the second phase, this equipment will be produced under license from Cubic by Compagnie des Compteurs.

Westinghouse Air Arm Division is studying electromagnetic and other techniques to make it difficult or impossible for enemy aircraft or missiles to attack the North American B-70. The study is being conducted under a contract from North American's Los Angeles Division.

Bendix Pacific Division of Bendix Corp. has received a $3,000,000 contract for the production of a sonar transducer system (SQS-23) to be installed on Navy surface vessels for anti-submarine warfare.



LISLE *Magnetic* **CHIP DETECTORS**

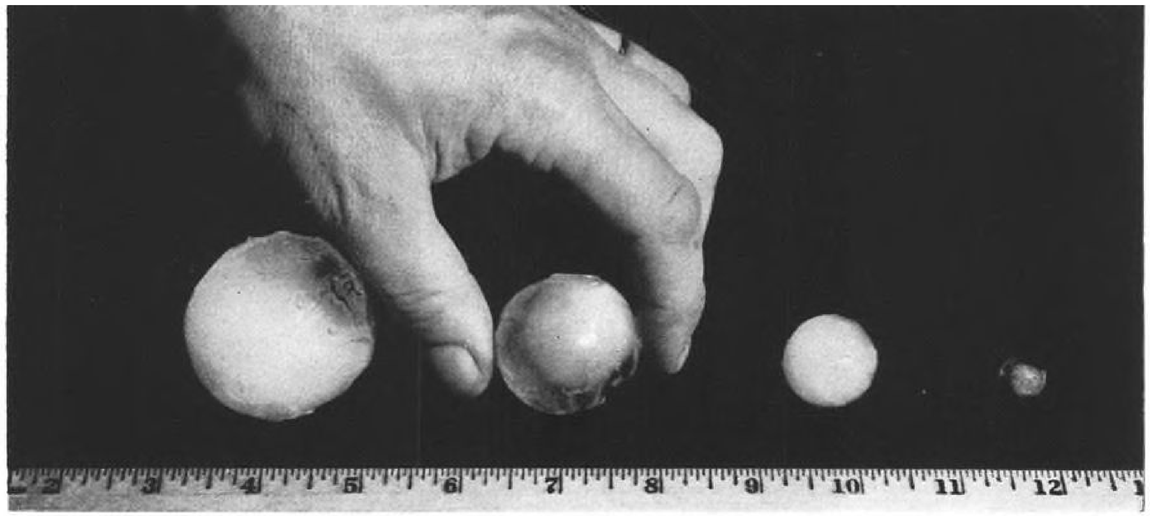
Lisle Magnetic Chip Detectors provide early detection of internal breakdowns, assuring constant protection against in-flight failure.

Ferrous particles in a lubricant are a proven indication of excessive wear or impending breakdown. The Magnetic Chip Detector attracts these particles which bridge an electrically insulated gap in the Detector, completing a circuit which activates a warning light on the instrument panel.

Lisle Chip Detectors are used today in jet and reciprocating engines, accessory drives, propellers, constant speed drives and hydraulic systems in commercial and military aircraft.

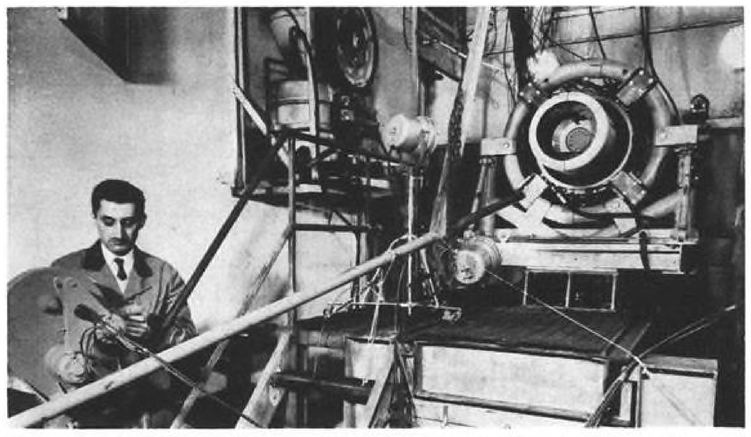
Write for Catalog and Samples for Testing

LISLE CORPORATION
Clarinda, Iowa

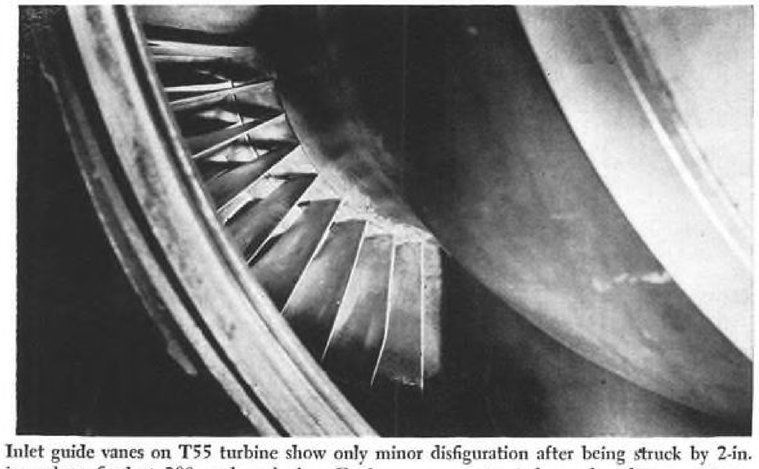


Avco Corp.'s Lycoming Division has completed hail ingestion tests on 2,220-shp. T55-L-5 gas turbine helicopter engine for Boeing-Vertol HC-1B Chinook now being developed for U. S. Army. Ice spheres (above) range in size from ½-in. to 2-in. in diameter.

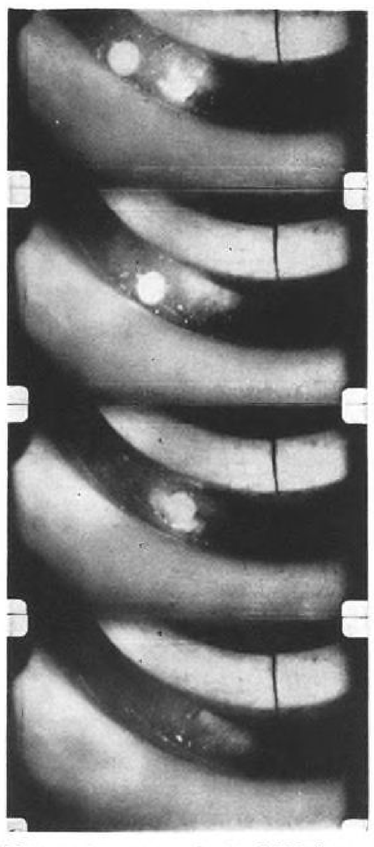
Lycoming Subjects T55 Turbine to Hail Tests



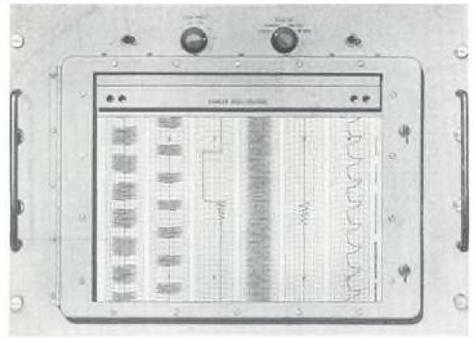
Spheres were fired directly at T55 inlet vanes from barrel of compressed air gun developed by Allison Division of General Motors (above). Motion picture camera is at lower left.

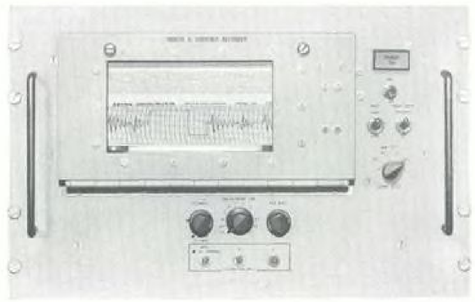


Inlet guide vanes on T55 turbine show only minor disfiguration after being struck by 2-in. ice sphere fired at 200 mph. velocity. Engine was run at rated speed and temperatures.

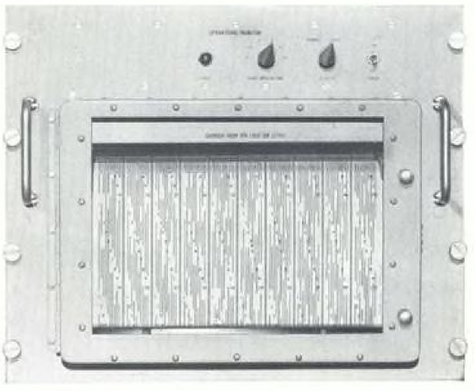


Motion picture sequence (at 5,500 frames per second) shows 1-in. sphere entering bell housing (top), then smashing against guide vanes before ingestion. Tests of a similar nature are under way on the T53-L-3 turboprop engine.









in direct writing recording systems

only Brush designs specifically for mil specs

From every nut and bolt to the shipping crate, fully militarized Brush Direct Writing Recording Systems are *originally* built to meet military specifications.

That's why they are performing every imaginable task of data acquisition and recording at U. S. and NATO installations throughout the world. These electric writing systems have proved their unexcelled reliability . . . from the Operations Monitor that will record 120 separate operations at the instant they occur . . . to the Analog and Sequence Recorder that simultaneously records both analog data and sequential events. And, they are built for maximum performance in the hands of non-technical personnel.

Brush equipment is already at work putting evaluation data in writing for a whole new generation of weapons. When the weapons become operational, Brush MIL Recorders are a vital part of the system. This experience is unique in the industry. *Before* prototype design becomes a problem—call, write or wire Brush for complete details.

brush INSTRUMENTS
DIVISION OF CLEVITE CORPORATION
37TH AND PERKINS CLEVELAND 14, OHIO

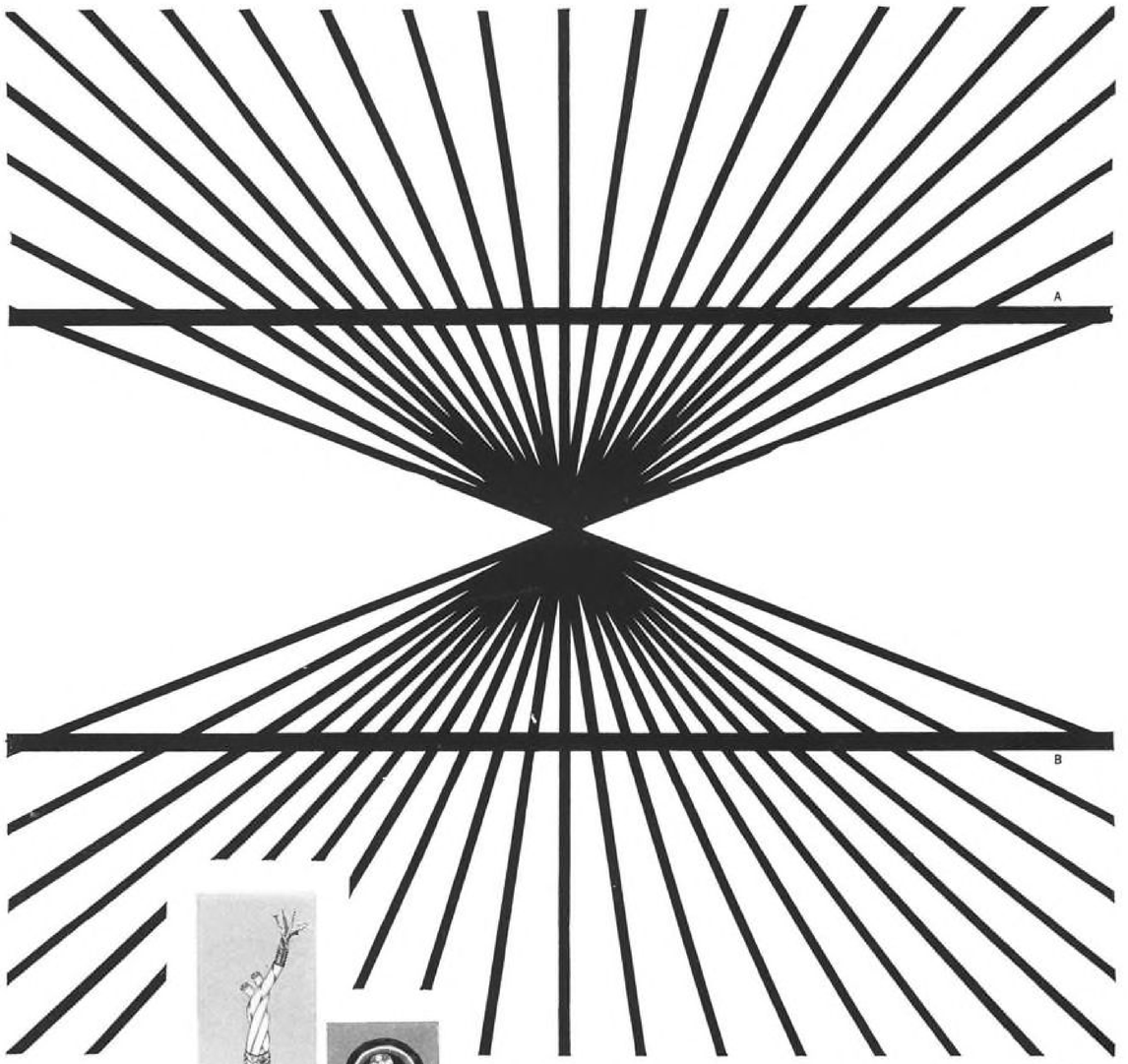


Air Force's T-39 Sabreliner exceeds design specifications

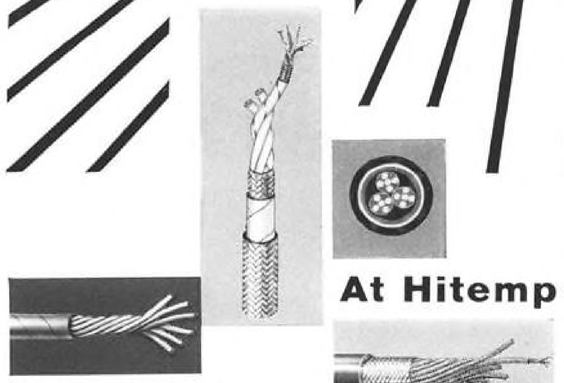
The T-39 Sabreliner, Air Force's first twin-jet utility trainer, bettered its design speed and range by handsome margins in a non-stop test flight over the Western United States. Designed to cruise at 500 mph over a range of 1720 miles, the swept-wing T-39 averaged 540 mph during an 1820-mile flight. Then it loitered for an additional half hour and landed with ample fuel reserves.

The Air Force has ordered 94 of the multi-purpose aircraft for use as radar, navigation, and jet-proficiency trainers—as well as high-priority cargo transports. The T-39 is an aircraft of exceptional all-round utility and economy—a compact workhorse designed especially for jet-age needs. It is being produced by the Los Angeles Division of North American Aviation.

THE LOS ANGELES DIVISION OF **NORTH AMERICAN AVIATION, INC.**



Are lines A and B parallel?



At Hitemp–Quality is not an illusion

Examine with the naked eye and handle several different brands of wire and cable. They look and feel identical, don't they? Their similarity with regard to quality, however, is just as much an illusion as the art form above.

Though different brands may be made with similar materials and equipment, one brand of wire and cable will outlast, outperform all others. That brand is Hitemp.

Why? Because Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

Hitemp products are for you, the wire and cable user who requires quality and reliability that is fact, not illusion.

Hitemp is a Division of Simplex Wire & Cable Co.

HITEMP WIRES CO.

1200 SHAMES DRIVE, WESTBURY, NEW YORK
1532 S. CALIFORNIA AVE., MONROVIA, CALIF.

RYAN'S VITAL ROLE IN THE AGE OF SPACE

There's a new look at Ryan—the look of a company which has pioneered in the aircraft and missile eras and is now geared for the challenging demands of the Space Age. Fast-moving, flexible, staffed with men who are skilled in solving problems *beyond the usual*—Ryan's two divisions and three subsidiaries complement each other in achieving breakthroughs in the new technologies of the Space Age. From Doppler navigation systems to multi-stage space probes to fresh concepts in data handling and electronic communications—Ryan continues to demonstrate its capabilities in the most advanced fields of design, development and fabrication. *New contracts, calling for years of design and development work, have created opportunities at Ryan for career engineers with abilities beyond the usual.*

RYAN ELECTRONICS

A division of Ryan Aeronautical Company, Ryan Electronics develops and manufactures electronic systems for aircraft, missiles, ships, and space systems. With plants at Kearny Mesa, San Diego (Engineering Center) and Torrance, Calif. (Production Center), Ryan Electronics is recognized as the world leader in C-W Doppler navigation. The Division's programs are making significant contributions toward solution of lunar landings, terminal guidance, gravitation control, and ECM.

RYAN AEROLAB

Aerolab Development Company, located at Pasadena, California, is a subsidiary of Ryan Aeronautical Company. Aerolab has developed more space probes and rocket-powered research models, including the Mercury Capsule model, which have been fired, than any other firm in the United States. Aerolab is a science team with quick reaction capabilities, and with special talents for solving advanced problems in Space.

RYAN TRANSDATA

A subsidiary of Ryan Aeronautical Company, Ryan Transdata, Inc. (San Diego) is developing methods for the automatic conversion of information to a form that will enable industrial and government executives and military commanders to make rapid, accurate decisions. Related applications include air traffic control, military command control and surveillance logistics control, and command control of space vehicles.

RYAN COMMUNICATIONS

Ryan Communications, Inc., a subsidiary of Ryan Aeronautical Company, is located at Canoga Park, California. Under development here are solutions to specialized communications problems of the military, government and industry. Fields include high-, very high-, and ultra-high frequency and microwave transmitting and receiving equipment, methods of coding modulation and multiplexing, and space-aided communications.

RYAN SAN DIEGO

As an experienced systems manager, Ryan San Diego can integrate and focus the special capabilities of all company units on the problems of missiles, drones and space vehicles. Ryan's rich background as a pioneer in the development of systems, such as the most widely used jet-powered, recoverable drone and the first jet VTOL research aircraft, extends over three decades. Long before the Space Age dawned, Ryan was developing capabilities to meet its challenge.

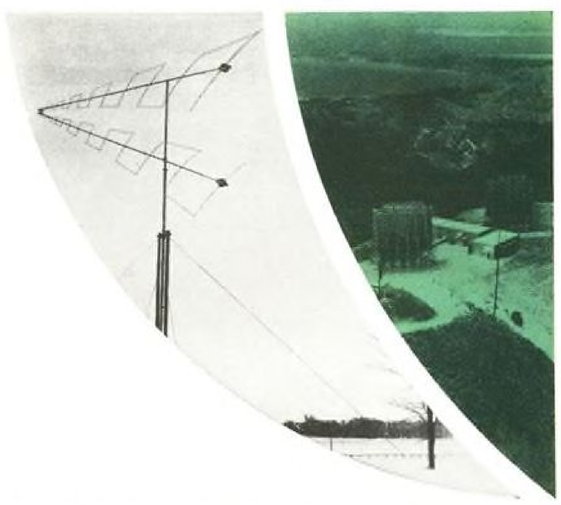
Tomorrow's Technology...Today!

RYAN
AERONAUTICAL COMPANY





the scope of alpha





FROM A CONCEPT TO DEMONSTRATED WORLD-WIDE CAPABILITIES IN LESS THAN TWO YEARS

Alpha Corporation in its systems engineering and management role is playing a vital part in highly diversified communications, instrumentation and control systems for government and industry.

Pacific Missile Range instrumentation, communication and data handling systems serve the nation's largest missile range, stretching from Point Mugu westward, by way of islands and range ships.

Satellite and deep space probe air transportable tracking and communications systems for NASA, JPL and the Signal Corps have been engineered to handle a wide range of missions.

Naval Tactical Data System makes possible rapid transmittal and display of radar, fire control and similar types of data simultaneously between all elements of a naval task force deployed at sea.

Short Order system provides positive two-way voice contact needed to control all airborne elements of Strategic Air Command through any of four widely dispersed HF single sideband station complexes.

Air Transportable Communication Central allows Marine Corps command post to route teletypewriter, voice and telegraph communications between landlines and self-contained HF single sideband station with complete switching flexibility.

Project Echo passive satellite communication experiment successfully transmitted voice, teletypewriter and facsimile between Collins at Cedar Rapids and Alpha at Dallas in joint company-financed tests of feasibility of satellite relay communication.

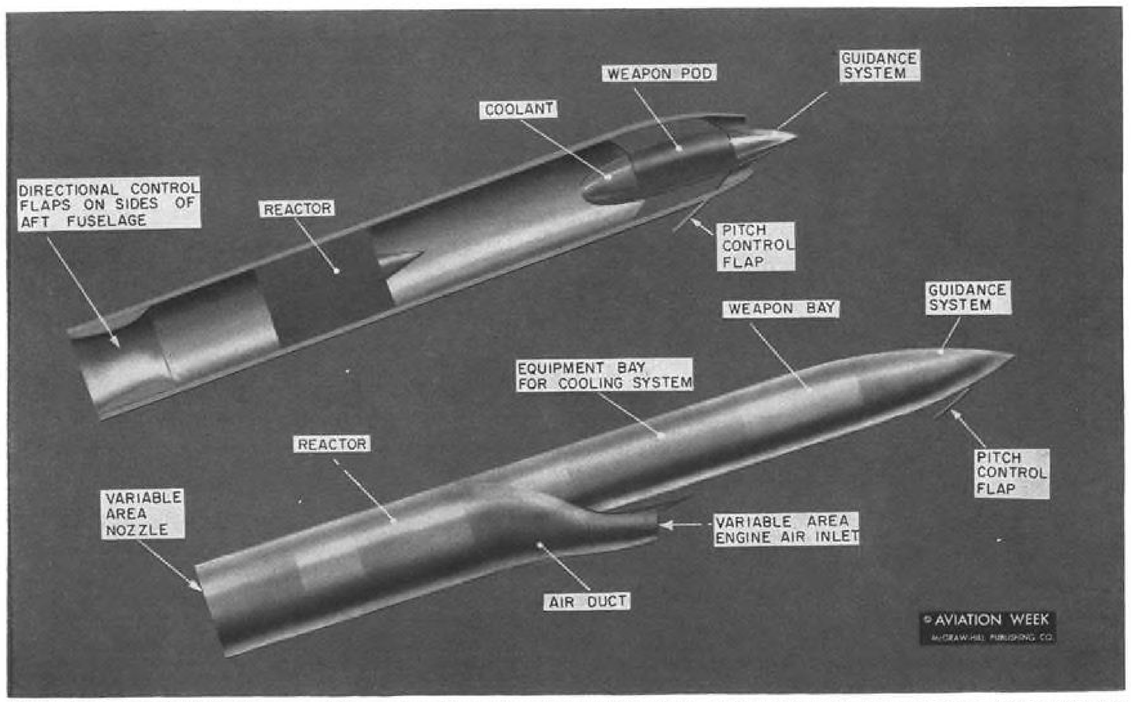
Far East Tropospheric Scatter System provides multiple channels for voice, teletypewriter and data communication between Formosa and Okinawa, a 410-mile over-water link in the Armed Forces Pacific Scatter Network.

Asiatic Petroleum 500-mile communication system combines Tropospheric Scatter and Microwave to link Shell Oil's Venezuelan Headquarters at Caracas with its refinery at Cardon, and its western oil operations area.

Alpha CORPORATION
A SUBSIDIARY OF COLLINS RADIO COMPANY

SYSTEMS DESIGNERS, ENGINEERS, CONSTRUCTORS, WORLD-WIDE
RICHARDSON, TEXAS • TELEPHONE DALLAS ADams 5-2331

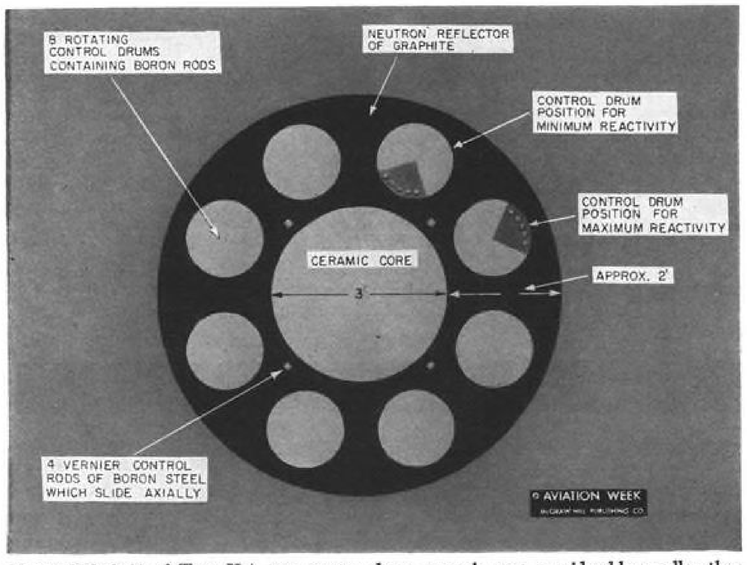
MISSILE ENGINEERING



ARTIST'S CONCEPTIONS of two possible configurations of nuclear ramjet vehicles designed for both high and low altitude flight are shown above. They undoubtedly will be wingless because the slender somewhat conical shapes have almost the same aerodynamic efficiency at Mach 3 as the best winged configurations. Elimination of wings reduces cooling problem during Mach 3 flight at sea level.

Special Report

Increased Potential Spurs Pluto Research



CROSS-SECTION of Tory II-A test reactor shows ceramic core considerably smaller than that needed on a flight vehicle. Core is the only part of this test unit that uses the same materials and design technique intended for a flight reactor.

This is the fifth of a series of articles on the various applications of nuclear power to aircraft and space vehicles.

Washington—Recent studies indicating much greater operational potential for ramjet-powered missiles than previously supposed are keeping Project Pluto concentrated on its original goal of proving the engineering feasibility of a U. S. nuclear ramjet engine in 1962, and have postponed development of any specific nuclear ramjet weapon system.

Pluto feasibility tests will determine just what performance can be delivered by a nuclear ramjet engine so that exact operational capabilities of proposed new weapon systems can be established.

The Project Slam (supersonic low altitude missile) concept, which has been studied by Air Force and industry in recent years, is but one of a variety of ideas in which all three military services currently are interested. No firm development schedule has been fixed for Slam, and it will have to compete with several other concepts by the time the nuclear ramjet is ready for use in a flight vehicle.

One Air Force officer has described Slam as merely "a specific proposal for an anticipated weapon system based on an assumed requirement."

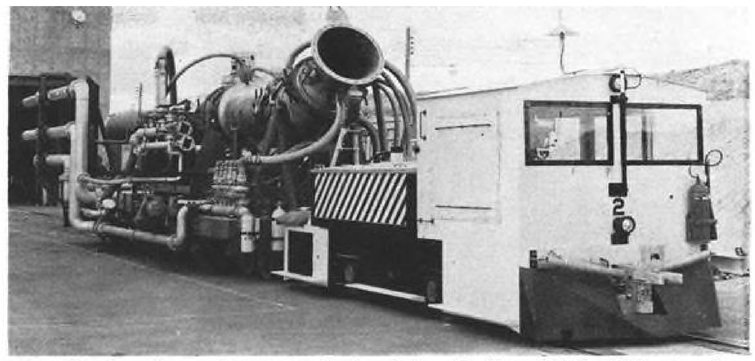
Optimism over technical progress of the nuclear ramjet development now is very high within the joint Air Force-Atomic Energy Commission Aircraft Nuclear Propulsion Office (ANPO), commanded by Brig. Gen. Irving L. Branch, which has responsibility for the Pluto project. ANPO personnel feel that the Tory II-A reactor tests, now planned for this month on a slightly slipping schedule, and the Tory II-C reactor tests planned for 1962, will provide realistic data on the major engineering questions involved in building and operating a nuclear ramjet reactor and its nuclear and air flow control systems.

Pluto has been a relatively low cost program which has moved constantly toward a single objective set down four years ago. Most of the project personnel apparently feel that this objective of proving engineering feasibility and collecting some definite design data is a worthwhile one which should not be vitiated by any type of program reorientation or expansion of objectives at this time.

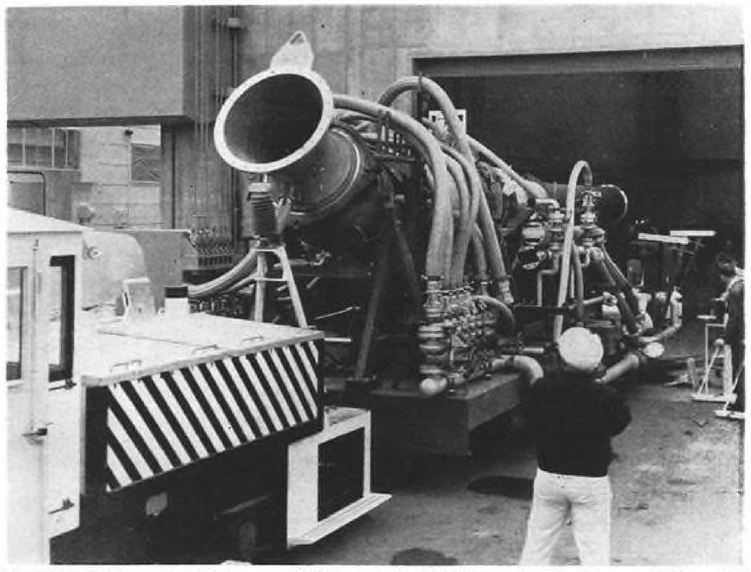
Pluto cost $65 million from its inception in 1956 through Fiscal 1960. Funding until the end of the feasibility program in 1962 apparently will continue at about the current rate of $15 to $20 million a year. This is an extremely low expenditure for a nuclear program of this type, partly because Pluto has received some benefit from research projects whose cost was charged against the nuclear aircraft program.

Major steps in the original Pluto schedule and the dates on which they were accomplished or are planned are:

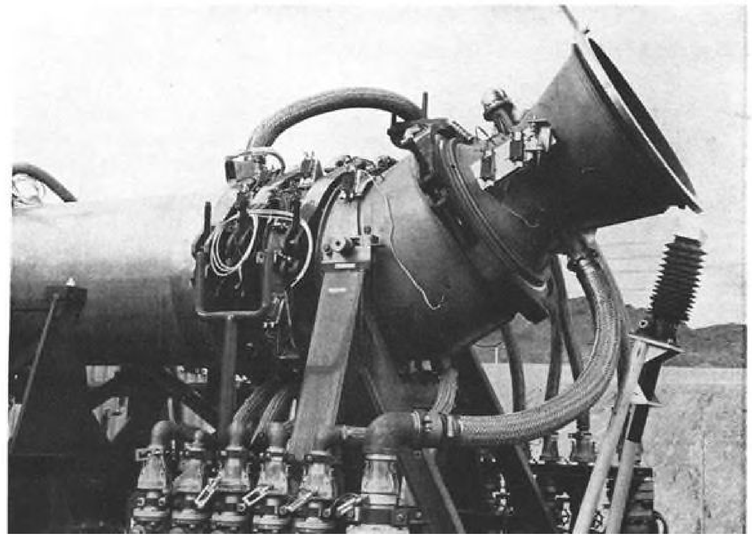
- **1956—Materials development** and reactor calculations programs were initiated. Materials selection for Pluto depended in large measure upon the materials development work funded under the nuclear turbojet engine programs for manned aircraft.
- **1958—Cold critical experiments** were performed to make certain that the reactor core and geometry calculations were proper and a critical mass had been achieved.
- **1959—Hot critical experiments** with several core assemblies were run in an oven to determine the change in criticality that occurs when the temperature of a reactor rises from normal room temperature to more than 2,000F. In general much more fuel is required during warm-up than during operation, after the temperature has stabilized out.
- **December, 1960—Tory II-A** experiments were begun to test a small power-producing reactor core under the air



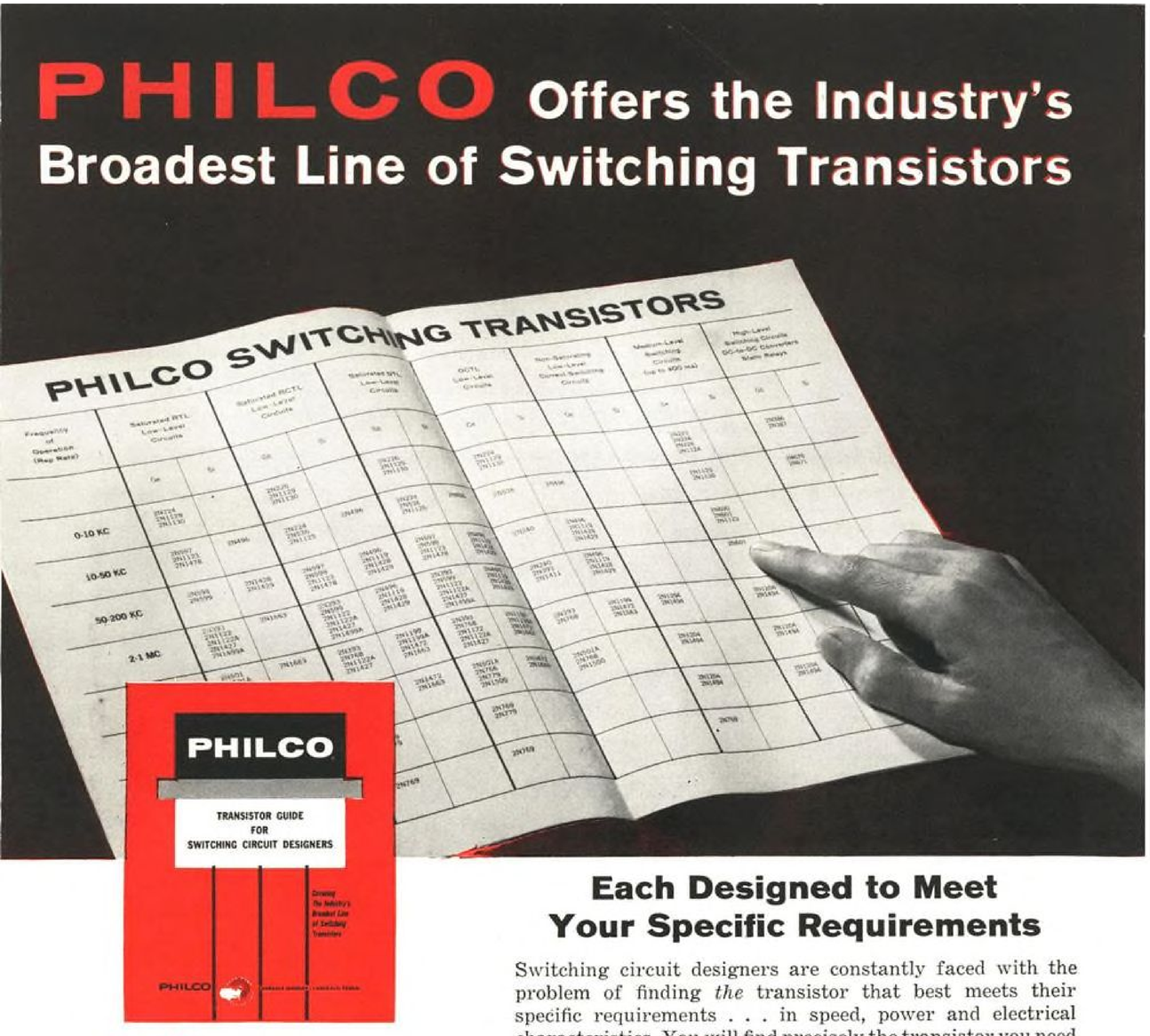
TORY II-A-2 nuclear ramjet test engine is a backup for Tory II-A-1. This view shows engine hooked up to 15-ton, standard-gage, battery-operated, 10-channel radio-controlled vehicle which moves engines between disassembly building and test pad. Marquardt nozzle, shown in foreground below, tilts upward 38 deg. Air velocity at throat of nozzle is Mach 1. Noticeable to left of engine (above) are pipes supplying light water for cooling nozzle during runs.



MARQUARDT nozzle, tilted upward 38 deg., is detailed below in this close-up of Tory II-A nuclear ramjet test engine. Extending to left is cylindrical casing around the reactor core which contains fuel elements supplied by General Electric's Aircraft Nuclear Propulsion Department. Hottest spot in the reactor will measure about 2,300F, it is estimated, and when exiting the core air will be at approximately 1,950F.



PHILCO Offers the Industry's Broadest Line of Switching Transistors



NEW! Transistor Guide for Switching Circuit Designers

To help you find the right transistor for your switching requirements, this brand new guide will be a valuable aid. It contains a complete selector chart, covering 42 different Philco switching transistors . . . descriptions of major types . . . their important parameters . . . helpful application information. A copy of this 8-page guide, plus a price schedule, is yours for the asking. Write Dept. AW11661.

Each Designed to Meet Your Specific Requirements

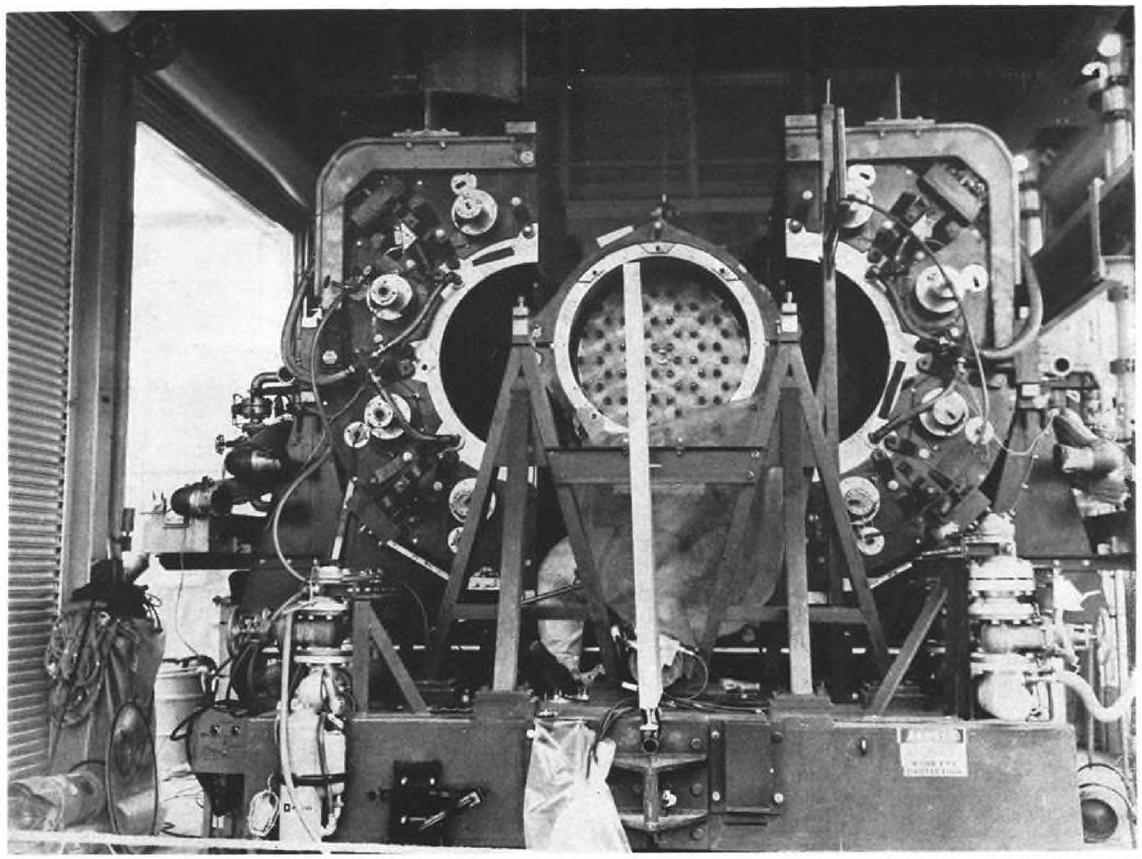
Switching circuit designers are constantly faced with the problem of finding *the* transistor that best meets their specific requirements . . . in speed, power and electrical characteristics. You will find precisely the transistor you need in the Philco line . . . for it is the broadest line of switching transistors in the entire industry. Unlike other manufacturers who offer limited lines of general-purpose switching transistors, Philco produces transistors that are specially designed to meet specific applications. Precise control of all parameters, made possible by Philco's exclusive Precision-Etch* process, permits extremely tight specifications with absolute uniformity. Don't settle for a transistor that is "almost right" when you can get one that is *precisely right* from Philco . . . at the same price!

*Trademark Philco Corp.

Philco Transistors are immediately available in quantities 1-999, from your Philco Industrial Semiconductor Distributor

PHILCO®
Famous for Quality the World Over
LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.



SPLIT graphite reflector is shown in this view of the Tory II-A nuclear ramjet test engine. Control vanes for the test reactor are visible, grouped about the nuclear core. The nuclear reactor is encased in a cylindrical housing.

flow conditions that would be experienced on a Mach 3 nuclear ramjet flight at sea level and at higher altitudes. None of the systems used during these tests, including the reactor control system and the water cooling, would be practical for a flight vehicle. Two cores will be tested during the Tory II-A series (see AW Dec. 19, 1960, p. 34 for details).

• **1962—Tory II-C** tests will involve a reactor with a flight type control system. It will be surrounded by a thin, flight-weight reflection of beryllium oxide to turn a large percentage of the neutrons back into the core. Reflector on the earlier Tory II-A is made of graphite, two feet thick.

Navigation System

The reactor development under Project Pluto is not the only currently sponsored work expected to feed into proposed nuclear ramjet flight systems. Virtually all of these systems are expected to have the capability of flying at very high speeds at sea level as well as at altitude. Consequently, all will need navigation systems that function properly in all weather during high speed flight near the ground. They also will require a terrain avoidance system that will control the vehicle's course, ensuring that it clears all obstacles during flight at altitudes as low as 500 ft. and speeds of Mach 3 and above. These vehicles also will require a considerable amount of new thinking in the area of dynamic design if they are not to be shaken to pieces by gust loads during the low altitude, high speed flight.

To meet these general requirements the Air Force has awarded a study contract to Chance Vought Corp. for a navigation and terrain avoidance system useful at low altitude and at Mach 3 or above, and several agencies are studying the aerodynamic and structural problems of flying in rough air under these conditions.

The navigation portion of the navigation and terrain avoidance system will be primarily a programed inertial unit. At regular intervals the terrain avoidance unit would determine the differences in height of prominent geographic features on the vehicle's course, and measure the distance to these landmarks. These height differentials and distances would be compared for three or four minutes with information programed into the guidance system, so that the vehicle's position and the guidance system's information could be corrected. System of this type is necessary to make low level attacks possible during weather in which it is not practical to use heavenly bodies for position checks.

Wingless Vehicles

Aerodynamically, there will be one main feature of all vehicles which fly well above the speed of sound at low altitudes. They will have no real wings —possibly a few short stabilizing fins, but no main lifting surfaces.

The vehicle's lift will be produced primarily by its fuselage. Theoretical and wind tunnel studies over the past several years have shown that fuselages of approximately conical shape have acceptable lift/drag ratios and therefore fairly low power requirements in the Mach 2 to 4 range. Around Mach 5 and above they are equal to the best



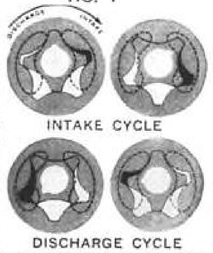
PUMP PRIMERS

ARTHUR A. NICHOLS

GEROTOR . . . AVIATION'S MOST ADAPTABLE PUMP

► The rather unusual qualities of the Gerotor pump which have kept it intimately associated with aircraft pumping applications from the days of the earliest superchargers for reciprocating engines, can best be summed up as *inherent adaptability and high reliability.*

FIG. 1



► **Structure and operation of the Gerotor pump is relatively simple. The moving elements are the toothed "Gerotors" — inner and outer. Both turn in the same direction and either one may be driven. The inner element always has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the inlet or suction port to the discharge port. (See Figure 1).**

► The designer thus has the advantage of several variables to secure a given capacity within his space limitations: *Gerotor diameter*—which governs the area of the pumping chamber—*Gerotor thickness* which, taken with area, determines chamber volume — *Gerotor RPM*, since this is a positive displacement pump. Thus, it is possible to vary the diameter, the length and the speed of the pump within certain overall limits to secure the wanted capacity.

► **Unlike conventional gear pumps the Gerotor needs only a *single shaft* — both elements are substantially concentric to it. These are mated to provide continuous, fluid-tight engagement without the crescent structure necessary in other internal gear pumps. Further, Gerotor elements can be stacked along a single shaft and mounted on a single AN pad to perform multiple pump functions: lube, scavenge, boost, etc. (See Figure 2). Such compactness allows the pump to be "submerged" in a gear box or sump and frequently the sump may be part of the pump housing.**

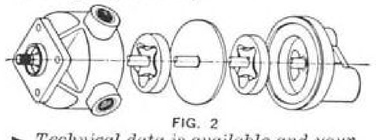


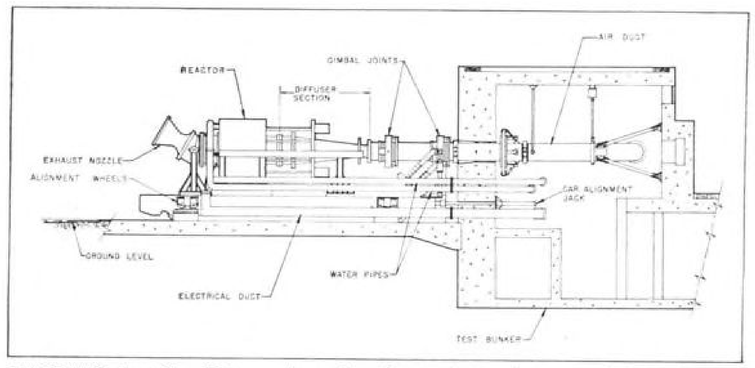
FIG. 2

► *Technical data is available and your inquiry is invited. Write:*

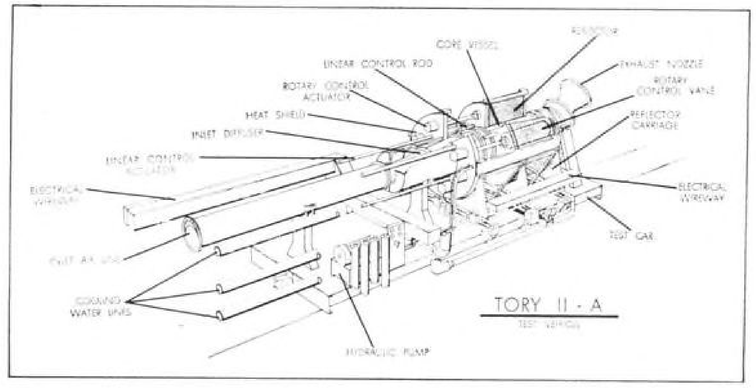
W. H. NICHOLS CO.

Makers of Zenith Metering Pumps and the Nichols Milling Machine "the miller that uses its head".

48 WOERD AVE., WALTHAM 54, MASS.



DIAGRAMS show Tory II-A experimental nuclear ramjet engine prepared for static firings at Nevada test site. Plans call for air supply to Tory bunker of 720 lb./sec. at Mach 0.1. Operating at full power, reactor will have an air supply adequate for static runs up to 90 sec.



winged vehicles in aerodynamic efficiency. In addition, the gust loading problem is substantially alleviated with the wingless configuration and the wing heating problem is eliminated.

In light of the public discussions of nuclear ramjet vehicles it seems probable that the maximum sea level cruise speed attainable today is about Mach 3 when the stagnation temperature of the air entering the vehicle is about 1,000F. The maximum cruise speed is determined primarily by the maximum reactor wall temperature, which can be above 2,100F using today's ceramic materials.

To develop maximum thrust from a reasonably-sized ramjet engine operating at this temperature, its forward speed must be Mach 3 to provide the proper ram pressure for the engine air. These engines are very sensitive to air temperature, and the available thrust-to-weight ratio increases rapidly with reactor wall temperature. As wall temperature increases payload can be increased, or vehicle size can be reduced to carry the same load.

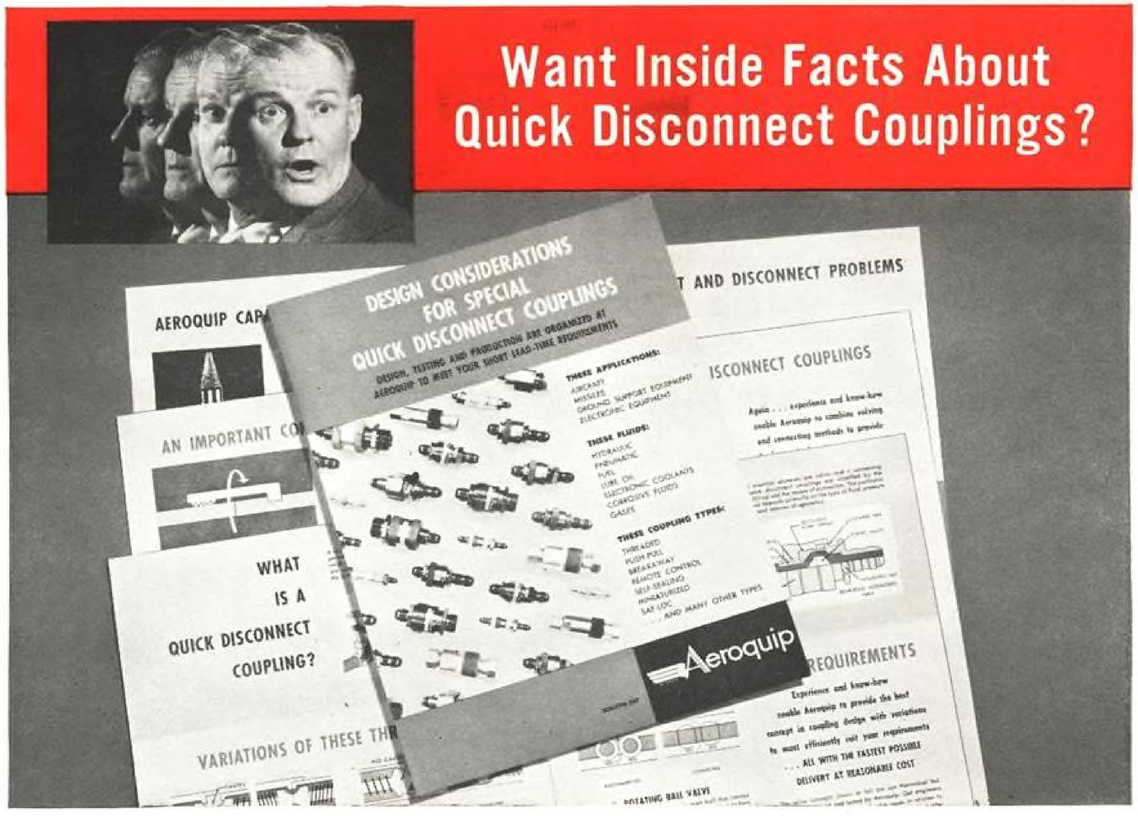
In general, projected nuclear powered ramjets of the Mach 3 variety are considered to have very large payloads for their total weight. A useful vehicle size probably will be in the neighborhood of 80 to 90 ft. in length and 8 to 10 ft. in diameter.

Enough work has been done in Project Pluto to establish firmly the type of reactor that will be used and the materials that will be used to construct it. Statements by Dr. Theodore Merkle of AEC's Lawrence Radiation Laboratory, where reactor work is centered, and by other project officials indicate that the reactor will be compact with a very high power density. It will be of the thermal homogenous type and its main structural material will be beryllium oxide.

Nuclear Reactor Types

Basically there are two types of nuclear reactor—thermal and fast reactors, each of which derives its heat from the fission of uranium atoms by neutrons. Fission in the thermal reactors is caused primarily by neutrons which have been moderated, or slowed down to the thermal energy level (below 0.3 million electron volts). Fission in the fast reactors is caused primarily by higher-energy or fast neutrons.

Fast reactors can be more compact and can have a higher power density than thermal reactors but they have the disadvantage of being much more expensive because they need more fuel of



GET THIS AEROQUIP BULLETIN!

What are quick disconnect couplings? How do they work? How can they improve fluid system design? You'll find answers to these and other questions in this new 8-page, fully illustrated Aeroquip bulletin. It covers the important design considerations—basic valving concepts, connecting methods and mounting methods. The advantages, limitations and variations of each design are factually defined.

This informative bulletin reflects the comprehensive knowledge and experience acquired by Aeroquip as the leading designer and producer of quick disconnect couplings. It shows why Aeroquip is capable of developing special quick disconnects to meet practically any requirement . . . why Aeroquip assures quickest reaction time to your fluid line connection-disconnection problems.

Write for your copy of Bulletin 254 today! Fill in and mail the coupon below.



For hydraulic, pneumatics, fuels, lube oils, electronic coolants, gases, corrosive fluids on aircraft, missile, ground support and electronic equipment.

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. & ABROAD

Return This Coupon For Your Free Copy of New Bulletin 254

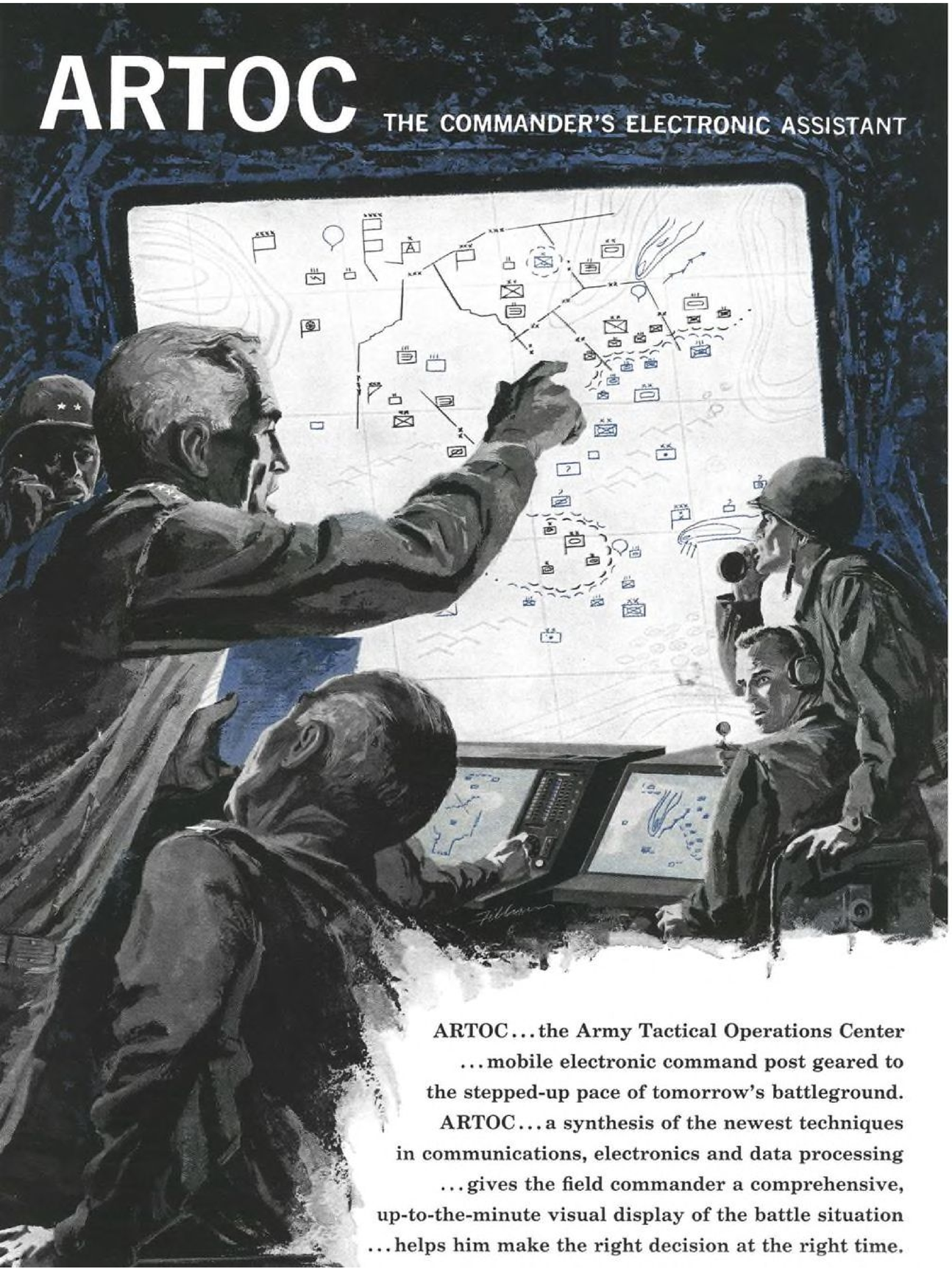
Get the WHY, WHERE, WHAT and HOW of Quick Disconnect Couplings. Send today.

Aeroquip Corporation, Jackson, Michigan AW-1
Please send me a copy of Bulletin No. 254

Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____
☐ I would like to talk to a sales engineer about an application.

ARTOC

THE COMMANDER'S ELECTRONIC ASSISTANT



ARTOC... the Army Tactical Operations Center ...mobile electronic command post geared to the stepped-up pace of tomorrow's battleground. ARTOC... a synthesis of the newest techniques in communications, electronics and data processing ...gives the field commander a comprehensive, up-to-the-minute visual display of the battle situation ...helps him make the right decision at the right time.



ARTOC... is being developed by Aeronutronic Division of Ford Motor Company for the U. S. Army Signal Corps. It is one of many Aeronutronic programs aimed at simplifying military and industrial problems through the use of an advanced computer and data processing technology. These programs—and many others related to advanced weapon and space systems—are underway at Aeronutronic's Engineering and Research Center in Newport Beach, California. They demonstrate Ford Motor Company's rapidly-growing capability in meeting the needs of science and defense in the changing world.

A booklet describing Aeronutronic's accomplishments and capabilities is available to you on request.

AERONUTRONIC

AERONUTRONIC DIVISION Ford Motor Company, DEFENSE PRODUCTS GROUP

Ford Road, Newport Beach, California

WEAPON AND SPACE SYSTEMS • COMPUTERS AND DATA PROCESSING SYSTEMS
MISSILE RANGE SYSTEMS AND INSTRUMENTATION • ADVANCED ELECTRONICS

Career opportunities are open for engineers and scientists

a higher grade. Thermal reactors can operate with less fuel because thermal neutrons have a greater capture cross section than fast neutrons. There is a greater probability that thermal neutrons will cause a fission reaction rather than escaping from the reactor core. High fuel cost of fast reactors of the size needed by the nuclear ramjet is the primary reason why Pluto will use a thermal reactor.

Once this type of reactor was chosen for Pluto, it was necessary to decide whether the fuel and the moderator material needed to slow the neutrons in the core would be mixed together homogenously or kept separate to form a heterogeneous reactor.

The homogeneous type of reactor core was chosen primarily because of the extremely high temperature needed in the nuclear ramjet. Metals could not be considered for use in the core of this high-temperature engine. It was therefore necessary to develop a ceramic that also was a good moderator. Heterogeneous reactor design would have required that this new material be developed for two uses—forming into large moderator sections, and as a coating for the uranium fuel elements, which cannot be exposed to the air at high temperatures.

Selection of a high-temperature, moderator-construction material for the homogeneous reactor core narrows down quickly to one choice—beryllium oxide.

Few other metal oxides or carbides can approach it when both neutron moderator qualities and chemical properties for resistance to oxidation are considered. It is reported by nuclear scientists and metallurgists that the materials choices for the nuclear ramjet reactor core are extremely limited within the foreseeable future.

Five years ago very little information was available on the properties of beryllium oxide, the methods by which it could be formed and by which nuclear fuel could be interspersed in a definite pattern within it. Today the USAF-AEC Aircraft Nuclear Propulsion group feels that beryllium oxide can be handled in every way that is necessary for the Pluto work. This is the result of a concentrated research program carried on with funds from the atomic-powered aircraft program as well as under Pluto. General Electric Co. is the contractor primarily responsible for the development of beryllium oxide-uranium, homogeneous moderator-fuel elements. These core elements have been tested in a power producing reactor at temperatures several hundred degrees higher than any metal fuel elements. The tests took place in the General Electric HTRE-2 (Heat Transfer Reactor Experiment) test unit at AEC's



One thing in common . . . reliable Kellogg Hydraulic Pumps*

Kellogg airborne hydraulic pumps are specified for reliable power on leading missiles and aircraft. In applications involving a broad range of operating conditions, Kellogg pumps provide both high performance and high reliability.

Unique design of the Kellogg variable stroke pump results in important inherent operating advantages:

• Fast response. • High volumetric efficiency (over 95% at rated pressures). • Simplified design for maximum life, minimum maintenance. • Highest HP/weight ratio. • Dependable operation under rapid changes in acceleration, torque and thrust loads, and at elevated oil temperatures. • Minimum size. • Exceptional contamination tolerance.

For greater reliability in hydraulic components or systems, contact our engineering representatives, Airsupply-Aero Engineering Company, Division of The Garrett Corporation. Offices in major cities.

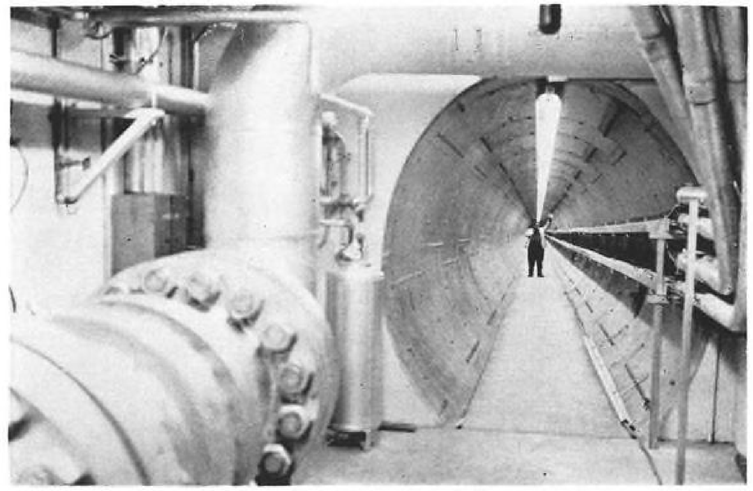
*Kellogg variable volume pumps range from 0.06 to 1.77 c.i.p.r., -65° to 450°F, to 5,000 psi, and to 18,000 rpm. Individual designs available for special requirements.

Variable Volume Pump Series	*Maximum Displacement Cu.In./Rev.*	*Weight Lbs.*	*Rated Speed*	*Max. Speed*	AND *Mounting Flange*
AP10V	1.77	17.5	3750	5000	10262
AP6V	1.00	9.7	6000	7300	10262
AP4V	.67	10.0	6000	7500	10261
AP2V	.38	6.5	6000	8500	10261
AP1V	.2	4.5	8000	12000	10261
AP05V	.1	1.9	12000	15000	10261
AP03V	.06	1.9	15000	18000	10260

A-6379

AMERICAN Brake Shoe COMPANY

KELLOGG DIVISION • 3151 WEST FIFTH STREET • OXNARD, CALIF.



SHIELDED tunnel runs underground 1,000 ft. to test building blockhouse, providing safe egress to the "hot" powerplant after a run and permitting safe disconnect of engine instrumentation and other equipment so that it can be taken to the disassembly building.

National Reactor Test Station in Idaho.

The ceramic core elements have had two basic disadvantages. The first is that they have leaked a significant percentage of their fission fragments. Two of these fragments are produced during each fission reaction, along with neutrons and gamma rays. They actually are lesser nuclei and they are usually radioactive and have a high energy.

Leakage of the fission fragments would not be a particular problem on an unmanned nuclear ramjet missile. It also would not be a hazard to persons standing on the ground along the flight path of a low-flying missile of this type because its great speed would distribute the fragments over a large area. These fragments would be a problem, however, on manned subsonic nuclear aircraft and on the ground along their flight path.

The second problem with the ceramic core elements is their brittleness. Beryllium oxide, very hard and brittle, does not yield under load as metal does. It cannot withstand large shocks and it cannot be heavily loaded while its temperature is changing.

Dr. Merkle has described the problem this way: "It is certainly true that most of the technology of western civilization rests on the fact that metals yield. In a given mechanical device, small and inevitable errors in design, fabrication and material properties can equalize under large loads because overstressed areas can yield without major loss of strength.

"On the other hand, the oxides and carbides, selected up to this point as suitable ramjet reactor materials, are all very hard, brittle substances. Even when these materials are fabricated in such a way that suitable strengths are obtained for high temperatures, they do not ordinarily possess the familiar yield characteristics of metals. Clearly, then, two areas of work are indicated—one, by ingenious design to minimize the need for yield in the material and two, by ingenious research to impart at least some 'give' to otherwise recalcitrant substances.

"All of this must be done, of course, without vitiating the high temperature and neutronic properties of these substances."

As a consequence, the mechanical design of the Project Pluto reactor is an extremely formidable task because the nuclear ramjet missile would experience heavy shock loading from turbulent air during Mach 3 flight at sea level. Mechanical design would also be complicated by thermal conditions in the reactor. Rapid heating of the core during warm-up to more than 2,000F will impose heavy thermal shock on the core elements and steady thermal stresses will result from unequal temperature distribution in the reactor during high power operation.

These serious mechanical problems are the focal point of the current design effort in Project Pluto. They will have to be solved in great degree, regardless of whether the first nuclear ramjet becomes a one-of-a-kind flight demonstration vehicle or a prototype for a weapon system.

Japanese Firms Plan Sidewinder Production

Tokyo—Tokyo Shibaura Electric (Toshiba) and three other firms will prepare for production of Sidewinders next year despite the fact that the Defense Agency is undecided whether to continue to import Sidewinders from the U. S. or make them locally.

With Toshiba as representative, the group—Fuji Precision, Tokyo Aviation Instruments, Japan Oils and Fats, and Toshiba—will send a mission in January to the U. S. to negotiate with Philco and General Electric through Mitsui Bussan Kaisha (MBK) for an engineering agreement.

According to tentative calculations of the Defense Production Committee of the powerful Federation of Economic Organizations (Keidanren), Japanese industry is capable of producing 400 Sidewinders and 200 Falcons a year. If Japan's air force decides to equip its aircraft with these missiles, 1,500-1,600 missiles would be needed.

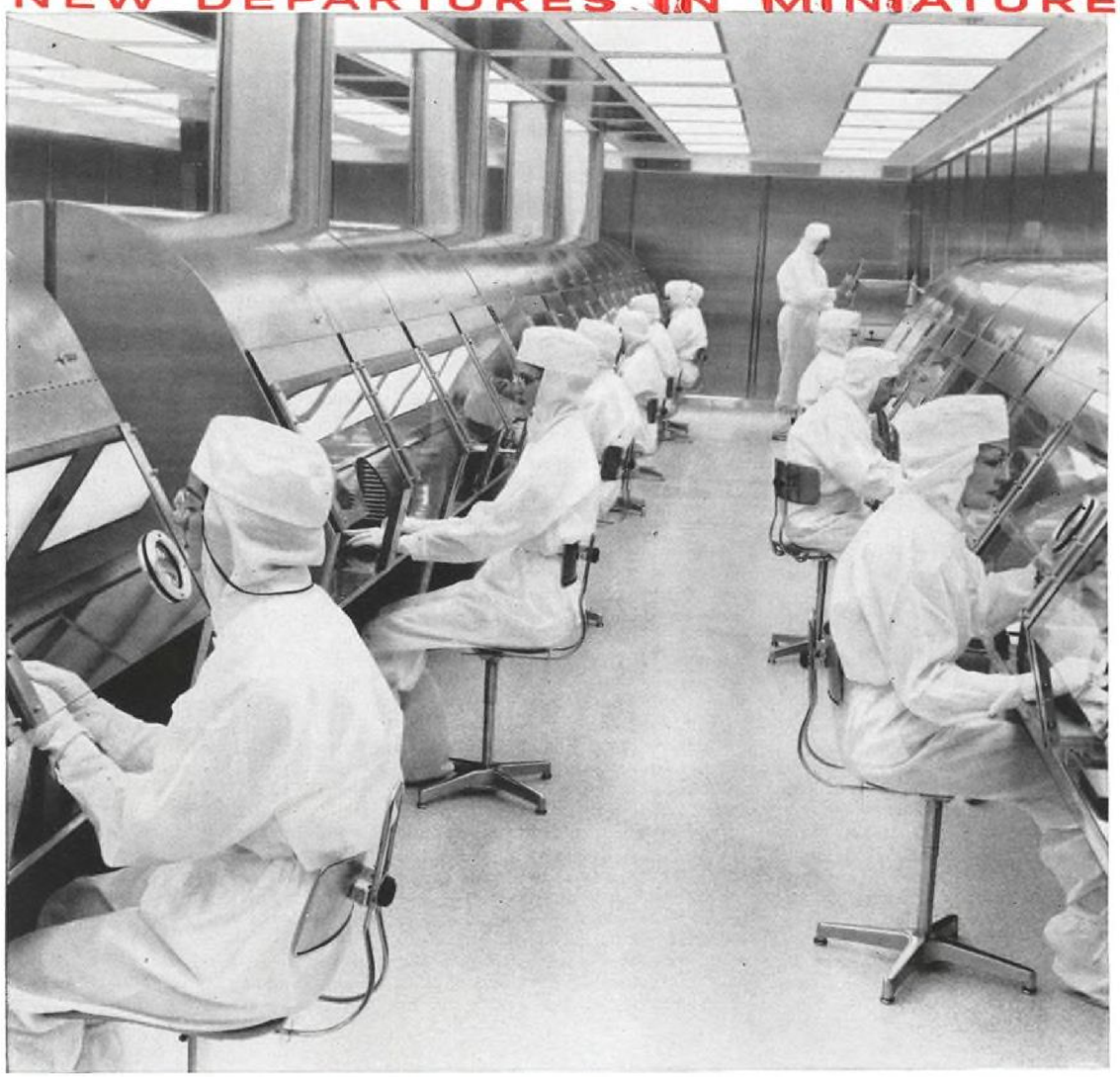
Missile development is already under way in Japan with Nike missiles being designed by the Mitsubishi group; other groups are undertaking to develop the Hawk, Bomarc and other military rockets.



Northrop Demonstrates OQ-19E Target Missile

Northrop Corp.'s Radioplane Division demonstrated its latest training target missile, the OQ-19E, to the U. S. Army in evaluation trials held at Fort Bliss, Tex. New design has a six-cylinder engine that gives it speeds of 240 kt. E-model can be operated with standard OQ-19 ground support equipment.

NEW DEPARTURES IN MINIATURE



ULTRA-CLEAN INCUBATORS FOR M/I* BALL BEARINGS

N/D'S NEW WHITE ROOM PROVIDES ULTRA-CLEAN ENVIRONMENT FOR M/I BALL BEARING ASSEMBLY

N/D announces a new White Room at Sandusky, Ohio incorporating the latest technological advances available today. This new room provides a virtually dust-free atmosphere so necessary for the production of Miniature and Instrument Ball Bearings of high reliability.

Environmental controls within the room hold temperature to plus or minus 1°... with maximum relative humidity only 40%. Final air filtration into room removes particles larger than 3/10 micron. A complete air change is made every three minutes. All authorized personnel entering the room are thoroughly bathed by air showers in two successive deduster chambers.

You can benefi. from New Departure's 25 years of experience in M/I ball bearing production by calling your nearby N/D Sales Engineer. Or write Department L.S., New Departure, Division of General Motors Corporation, Bristol, Conn.

*Miniature and Instrument Ball Bearings.



SEND FOR NEW DEPARTURE'S M/I BALL BEARING CATALOG TODAY. WRITE DEPT. L. S.

NEW DEPARTURE
MINIATURE AND INSTRUMENT BALL BEARINGS

Wag Tail Missile Adapted for ALBM Use

Washington—Decision to provide nuclear weapons to the North Atlantic Treaty Organization, if approved, could spark fresh interest in the Wag Tail, an air-launched ballistic missile which could be used by NATO aircraft against both ground and aerial targets (AW Dec. 5, p. 29).

The Wag Tail, developed under Air Force sponsorship by Minneapolis-Honeywell, was one of the victims of the slashing economy axe in the summer of 1957.

Originally the missile was intended as a low-cost air-launched ballistic missile for use against tactical surface targets. In the several years since Air Force halted program funding, Honeywell has continued the project with company funds and re-oriented it for an air-to-air mission.

The Wag Tail is designed to be fired in a rearward direction from a fast-moving aircraft. A fraction of a second later the missile maneuvers sharply upward into a ballistic trajectory, for surface targets, or continues its pitch maneuver until it is heading up and forward, for a bomber intercept mission.

Bomber Kill-Range

The Wag Tail takes its name from the appearance of the missile during its sharp snap-up maneuver immediately after launch. With an extremely high thrust-to-weight ratio and the absence of aerodynamic stabilization during initial portion of flight, the missile can quickly get up to within kill-range of a high-flying bomber.

The missile, which measures approximately 8 ft. long and 18 in. in diameter, would carry a small nuclear warhead detonated by a proximity fuse. The Wag Tail is roughly the same size as the MB-1 Genie air-to-air rocket and can be carried and handled on the ground with Genie equipment.

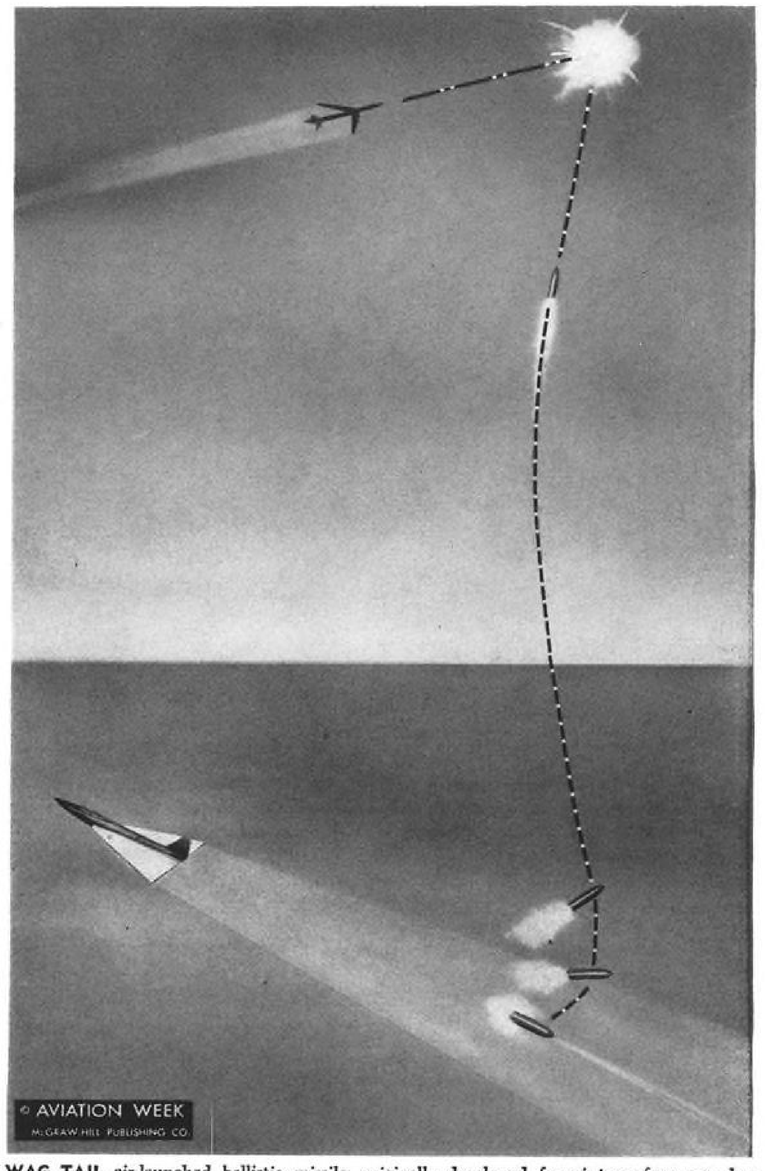
For air-to-surface missions, the Wag Tail's originally-intended application, the missile was conceived as an attractive alternative to low-altitude loft-type bombing (LABS). The LABS delivery technique requires a sharp, precise pull-up by the airplane and requires that it fly directly over or approach near to the target, which may be heavily defended. With the Wag Tail, the aircraft need not maneuver and the missile can be fired at targets offset from the aircraft's flight path.

The Wag Tail is a ballistic missile during powered portion of flight, achieving stability through an extremely tight automatic flight control system operating jet deflection vanes. This permits the missile to be launched in any direction without stability problems normally encountered with missiles employing aerodynamic stabilization that are fired in a rearward direction. After engine burn-out or cut-off, folded fins automatically pop out to give Wag Tail aerodynamic stabilization in the closing moments of its flight.

The original air-to-surface version was designed to use solid propellant engine, but the newer air-to-air version would employ storable liquid fuels.

The missile has three degrees of maneuvering control. A single jet-vane elevator controls pitch axis movement. Two separate jet vanes at right angles to the elevator move in the direction to provide yaw maneuvers, or in opposite directions for roll axis maneuvers.

The missile's high thrust-to-weight



WAG TAIL air-launched ballistic missile, originally developed for air-to-surface use, has been adapted for air-to-air mission. Missile, launched in a rearward direction, does a sharp back-flip to put it onto intercept course. Wag Tail uses simple, lightweight inertial guidance system, has extremely high thrust-to-weight ratio.

Research
Responsibility
Results

Hundreds of thousands of Aerotec disconnects, valves, flow indicators, pressure switches, and float switches have been produced for America's weaponry.



FROM SATELLITES TO SUBMARINES . . .

Aerotec components have proven their reliability under all service demands. This reliability results from a background of 16 years' experience in the design, development, and production of equipment to exacting specifications.

Use Aerotec's capabilities for the answer to *your specific requirements.*

Send details of your problem for our recommendations. Write us now. Our representatives are conveniently located for prompt liaison and service



AEROTEC INDUSTRIES, INC.
Aircraft Equipment Division, Dept. W, Greenwich, Conn.
PRECISION EQUIPMENT FOR AIRCRAFT, MISSILES AND NUCLEAR APPLICATIONS
West Coast Office: Culver City, California
Canadian Affiliate: T. C. CHOWN LIMITED, Montreal & Toronto
Other Aerotec divisions: ***Aerotherm Division,*** a pioneer in energy absorption, manufactures passenger and crew seating, lounges and accessories; ***Industrial Division,*** engineers, produces and installs dust collecting systems, gas scrubbers, fans, stacks and allied equipment.

ratio, in combination with an extremely fast-acting flight control system, enables it to pull 20g maneuvers. The missile has been successfully demonstrated in rearward firings from a transonic speed rocket sled. So far as is known, the Wag Tail was never flight tested, due to program cancellation for lack of funds.

An inertial system provides both flight stabilization and guidance for the Wag Tail. The use of inertial guidance for an air-launched missile against a moving aerial target might, at first glance, appear questionable. However, the missile's proximity-detonated nuclear warhead eliminates the need for extremely precise guidance and its extremely high speed gives very little time for a bomber to take evasive action to elude the Wag Tail's pre-launch guidance setting.

The inertial system consists of two displacement-type gyroscopes and three rate-type gyros, all mounted to the missile frame with no stabilized platform. The entire guidance/stabilization package is relatively simple and lightweight.

Wag Tail Missions

As the Wag Tail falls free from the airplane at launch, and the aircraft pulls ahead and clear, the missile's rocket engine is ignited, either by a lanyard or by a self-contained timing mechanism.

For the air-to-air mission, the missile quickly rolls through a preset angle into the "plane of action," then pitches upward onto the required intercept course as established by pre-launch setting of the pitch axis gyro. Within less than three seconds the missile can be headed forward and upward in near-vertical flight toward its target.

The angles of roll and pitch axis maneuver can be computed by the launching aircraft's radar fire control system, if it is so equipped. Otherwise, a small optical sight and computer are needed to calculate and set into the Wag Tail the required maneuver angles.

Ballistic Trajectory

For air-to-surface missions, the Wag Tail would be launched and fired in similar manner, except that the missile's roll and pitch axis maneuvers would put the missile into a ballistic trajectory aimed at the ground target. These angles would be calculated from optical or radar measurements of target bearing and range.

The range of an operational Wag Tail would depend upon its intended mission and desired payload. The Wag Tail was conceived as a family of air-launched missiles, using a common guidance technique, in which the rocket motor and warhead would be selected for the intended mission.

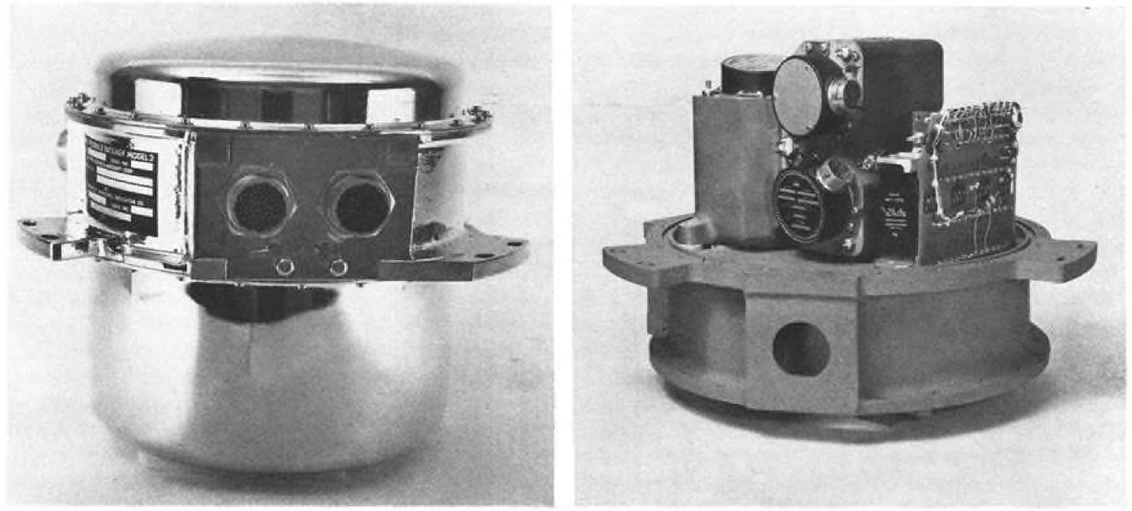


In a space vacuum, 13 thermocouple probes monitor temperatures and gradients in modules and across multiple thermal interfaces between dissipative components, mounting plates, satellite skin, and a water-cooled heat sink.

WAY OUT . . . AND COOL . . . are the electronic modules developed by Bendix Systems Division for satellite-borne communications systems. Through the use of beryllia, which is unique as an electrical insulator and thermal conductor, Bendix engineers have devised the most efficient configurations for transferring heat to the space environment. Such developments result from the team efforts of specialists in communications, microwaves, heat transfer, packaging, and advanced anti-jam techniques. Positions on this team are open to better scientists and engineers.

BENDIX SYSTEMS DIVISION
ANN ARBOR, MICHIGAN

THE Bendix CORPORATION



INERTIAL REFERENCE package employed for first time in recent Discoverer XVIII test shot helps guide Agena B space frame during ascent into orbit and then contributes to attitude control during orbital phase. Package weighs about 30 lb., occupies one cubic foot, is contained inside gold-plated covers (left). Gyro heater block housing accelerometer, three gyros and electronics is shown (right) removed from package, within the mounting plate, main structural member of the package. Inertial package was developed by Missile Development Laboratory, Aeronautical Division of Minneapolis-Honeywell.

Discoverer Tests Samos, Midas Guidance

By Barry Miller

Los Angeles—Major guidance and control system components projected for the Air Force's reconnaissance (Samos) and missile detection (Midas) satellites are undergoing extensive flight testing in the Discoverer test satellites. Thirteen of these vehicles orbited within the past two years are providing necessary shakedown data.

A system integrating these components was flown first in the Lockheed Agena A and later in the larger restartable Agena B vehicles. The latter vehicle is slated to be the basic space frame for the Midas and Samos satellites. As in the Discoverer series, Agena B will orbit with the payloads characteristic of either Midas or Samos.

The guidance and control systems of the Midas and Samos satellites will not be identical with those of the current Discoverer test series, such as an inertial reference package and an infrared horizon scanner, but some major components are expected to be common to both test and operational systems.

Task of the Discoverer guidance and control system is to guide the second-stage vehicle (Agena) into proper orbit and to stabilize it there for the remainder of its active life. The same system is believed to be capable of stabilizing Samos in its 90-deg. pitched-down position (AW Oct. 17, p. 28) for at least limited periods of time by altering location of the infrared scanner. What will probably be a more sophisticated attitude control system, capable of keeping Samos properly oriented in orbit for longer periods than the Discoverer series, probably will be developed for operational Samos satellites.

Lockheed Missiles and Space Division, prime contractor for the Discoverer, Midas and Samos satellites, is reported to be reviewing proposals for such a control system now.

Subcontractor Activity

The Discoverer system is assembled from components supplied by several subcontractors and integrated by Lockheed. As shown in an accompanying block diagram, it consists of the following components, according to the Air Force's Ballistic Missile Division, executive manager for the Discoverer program:

- **Ascent and dump programer** (guidance timer).
- **Orbital programer** (communications timer).
- **Accelerometer-integrator combination.**
- **Inertial reference package.**
- **Infrared horizon scanner.**
- **Gimbals for positioning** the engine.
- **Gas reaction jets.**

During the Thor-boosted phase of the ascent, attitude and trajectory are maintained by a torquing program applied to the Thor gyros. Signals from the Thor gyros are fed to the hydraulically-gimbaled Thor engine. Gyros in the inertial reference package of the Agena guidance system are closed about themselves, hence holding their own attitude during the boost phase. The Agena guidance computer, however, starts running at booster liftoff.

After Thor burnout, the Agena is separated from the Thor by firing explosive bolts and retrorockets on the Thor. The Agena pneumatic control system, consisting of six reaction jets in two rows of three at the rear of the vehicle, is energized and attitude is maintained to the gyro references in the inertial reference package. The exact time of separation of Agena from the Thor booster is established before launch and the separation command is programed into the Agena guidance computer. Separation time is selected to occur after the last possible Thor burnout time.

A torquing program set into the computer is applied to the pitch gyro so that the Agena is held in a near-horizontal attitude during this coast. The infrared horizon scanner located on the underside of the vehicle is turned on and provides a form of vernier correction for gyro drift in the inertial package and for programing errors. The scanner continuously rotates and senses any imbalance between the sky and earth it should see. It then sends torquing signals to the inertial package which initiates a change in vehicle attitude.

Any necessary changes in roll, pitch and yaw are accomplished during coast and subsequent orbiting by the six gas reaction jets. To produce a roll, the first jet in one row and the last jet in the other are fired. To produce a yaw, the middle jet on either side is fired. For pitch, two jets on one side are ingnited. Gas supply for the jets is Freon 14 and nitrogen.

Trajectory Deviations

Deviations from nominal trajectory are compensated by command from the ground on the basis of tracking data obtained with ground radar. Position and velocity data are processed into two commands transmitted to the vehicle during the coast phase. These two commands will:

- **Adjust the time** of Agena engine ignition from a nominal setting programed into the computer before flight.
- **Adjust the length** of the Agena engine burn by resetting the "velocity-to-be-gained" setting on the accelerometer-integrator combination. This will ensure that the vehicle reaches necessary velocity before injection into orbit.

At the end of the coast phase, Agena's ullage rockets are ignited and the pitch and yaw pneumatic channels are deactivated for the orbital boost phase. During burning period, attitude around the roll axis continues to be maintained by the reaction jets. Attitudes around other axes are maintained by positioning the engine thrust vector in pitch and yaw.

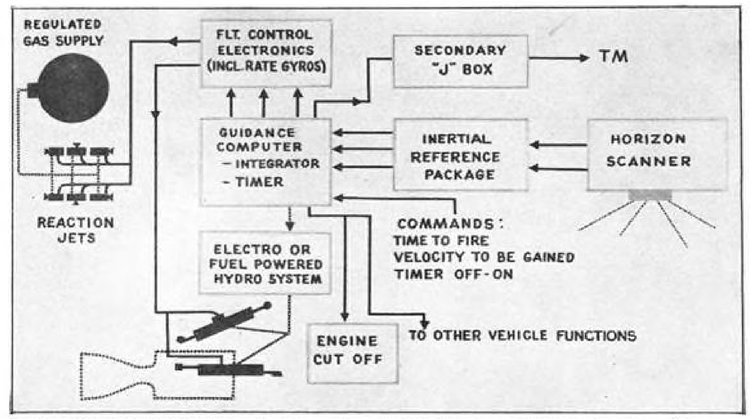
A pitch program is also maintained by providing signals to torque the pitch gyro to account for the changing geocentric rate during orbital boost. This program supplements operation of the horizon scanner during this phase.

The Agena engine is shut down by command from the integrator in accordance with the "velocity-to-be-gained" command computed on the ground and transmitted to the vehicle via the command link.

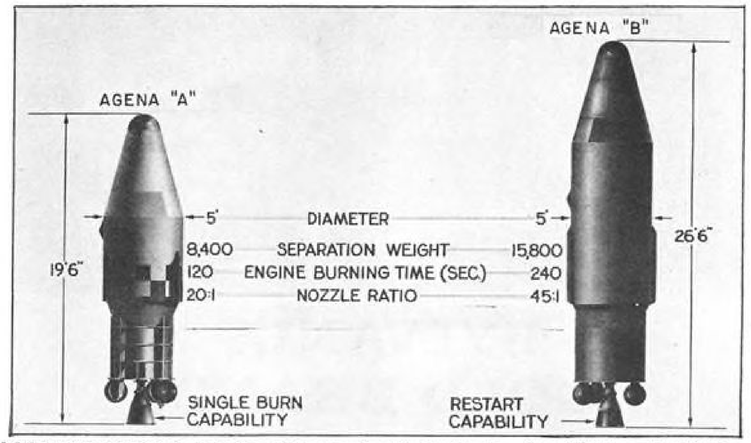
Orbital Attitude

After the vehicle is injected into orbit it is yawed through 180 deg. so that it orbits tail first with its longitudinal axis parallel to the earth's surface. After reorientation, horizon scanner gains are reduced to conserve control gas and sequencing is switched from the guidance to the communications timer.

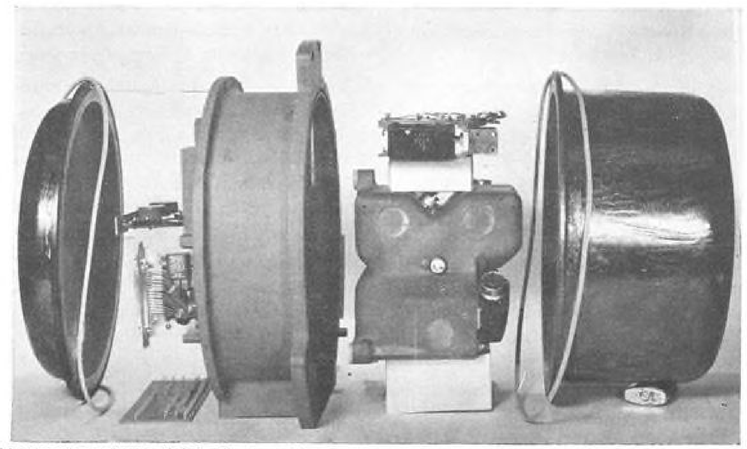
During orbital phase the pneumatic system, receiving signals from the gyros in the reference package, maintains the vehicle's attitude. The pitch gyro is torqued by a program so that its angular momentum vector rotates at or-



GUIDANCE AND CONTROL subsystem of current Discoverer satellite test series. Components supplied by several companies were integrated into a working system which with some radio command provides complete guidance functions for Agena B space frame after first stage Thor burnout and separation through second stage Agena B ascent, orbital attitude control and recovery phase.



LOCKHEED AGENA B contains guidance and control subsystem for attitude control during ascent, orbital and recovery phases.



MAIN ELEMENTS of 1-ft.-dia. inertial reference package are (from left) bottom gold-plated cover, magnesium mounting plate to which all subassemblies are attached, heater block which contains single-degree-of-freedom gyros and accelerometer and top cover (partly supported by cigarette lighter).



SYLVANIA GOLD BRAND TUBES

When the timetable says "now," Sylvania Gold Brand Tubes are ready to take to the air. Gold Brand reliability contributes significantly to the dependable performance of avionics gear . . . reduces forced "layovers," helps keep airlines on schedule.

Sylvania Gold Brand Tubes are specifically designed to fill critical circuit requirements. Severe turbulence, high altitude, long demanding hours are routine for Gold Brand Tubes. Sylvania subjects them to tests more rigorous than performance requirements. For example: GB-5726, double diode detector, and GB-5727, thyratron, undergo shock tests of 850g, vibrational acceleration tests of 2.5g for 96 hours, multiple life tests of 100, 500, and 1,000 hours. They are designed to operate to 80,000 feet and at bulb temperatures to 165°C.

Gold Brand subminiature, miniature and small power type tubes are all available promptly from your Sylvania Industrial Tube Distributor. Try him. Ask, too, for your copy of the Sylvania Gold Brand Tubes brochure. Or, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 101, 1100 Main Street, Buffalo, New York.

SYLVANIA

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

bital rate. The vehicle thus holds a horizontal attitude with respect to the earth's surface. Differences between the programed orbital rate and the actual orbital rate are compensated by slaving the gyros to the output representing the ratio of angular momentum to damping (H/S). The H/S output also compensates for gyro drift.

Before recovery, the orbital programmer restarts the dump programmer which then commands the dump sequence. In this operation the vehicle's nose is pitched down 60 deg. on signal by a programed pitch maneuver with the H/S turned off. Explosive bolts are fired, the capsule is separated from the Agena by springs and the capsule's retrorocket is fired.

Horizon Scanners

Horizon scanners for the guidance system are designed and built for Lockheed by the Advanced Technology Laboratories Division of American-Standard. Inertial reference packages were supplied by Reeves Instrument Corp. with Minneapolis-Honeywell providing backup. The latter company now holds a follow-on contract for the systems.

First flight of the Minneapolis-Honeywell system was in the recent Discoverer XVIII shot. Lockheed has a supply of the packages made by both firms and describes the inertial systems as being equal in performance and capability.

The Minneapolis-Honeywell package is a strap-down system—a low-cost unit which does not include a computer or gimbal capability. Unlike a normal inertial system, the strap-down system does not compute its position. It does not know where it is, but only where it is going. It takes advantage of the fact that it is flying a known flight profile.

The package occupies about one cubic foot, weighs approximately 30 lb. and has an internal pressure of 1.1 atmospheres. It contains three integrating, single-degree-of-freedom floated gyros, one for each of the three reference axes. In addition, it contains a single-degree-of-freedom linear, floated accelerometer which senses accelerations along the roll axis of the vehicle. The gyros, designed to be operated at 145F, are mounted in a gyro heater block and, along with the accelerometer, are equipped with seven heater elements inserted into the block. A temperature control amplifier precisely controls the temperature of the block.

Telemetry gear on the Discoverer satellite and the command link including a radar beacon are the responsibilities of Philco Corp., associate prime contractor for equipment and services. Philco also handles equipping of the ground tracking stations. ◆◆





COLLINS ENGINEERS can examine and obtain prints of any one of 230,000 company drawings in minutes using new automated microfilm system recently installed. Microfilm copy of every company drawing is housed at 12 conveniently located files, such as one shown at left. Engineer can examine drawing on viewing screen immediately and, if desired, make a print on the spot (right).

Microfilmed Drawings Filed on IBM Cards

By Philip J. Klass

Cedar Rapids, Iowa—Engineers and manufacturing personnel at Collins Radio Co. can now obtain a print of any one of 230,000 engineering drawings in a matter of minutes, if needed, where formerly it often required days or even weeks.

Every one of nearly a quarter of a million Collins drawings has been recorded on microfilm and mounted on IBM punched cards. Each drawing is duplicated on 12 microfilm punched cards, permitting Collins to set up complete, but compact, drawing files in a dozen different locations throughout its sprawling Cedar Rapids complex.

One is located in the engineering building, another in the fabrication part of the manufacturing building, a third in the engineering portion of the manufacturing building, a fourth in the publications building, another in the Collins plant at nearby Anamosa, Iowa, in addition to the master file and reproduction section.

Each of the "satellite" drawing files has one or more microfilm viewers which permit immediate display of the drawing from the microfilm. If a print is urgently needed, a light-duty copy can be made on the spot in a minute using a Thermo-Fax reproduction unit.

Normally, however, the print would be ordered from the master file/reproduction center which produces better quality prints at lower cost. (Each of the satellite print reproducers has a sign to remind users that master center can make prints for about half the cost.)

Fast Service

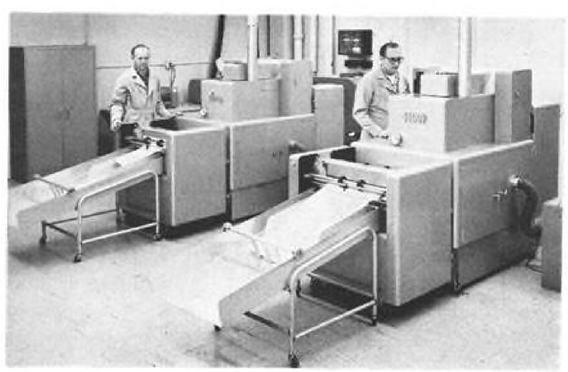
An order presented at the master center window is filled within two hours. For example, a drawing ordered between 2 p.m. and 3:30 p.m. will be ready to be picked up by 4 p.m., according to Norman Hime, director of the company's technical support division.

If the need is less urgent, an engineer can order the print by telephone, dictating it to one of three magnetic wire recorders. The recorded requests are read out several times a day. If a phone order is placed early in the day, the print will be ready the same day.

Both window and telephone placed print requests are transcribed onto punched cards and duplicated. One card, containing a printed record of the name and address of the person requesting the print, is attached to the print later and used to mail the print to the individual if he does not wish to pick it up. The duplicate card subsequently is used for analysis of the center's operations and to purge its files of drawings that are no longer used.

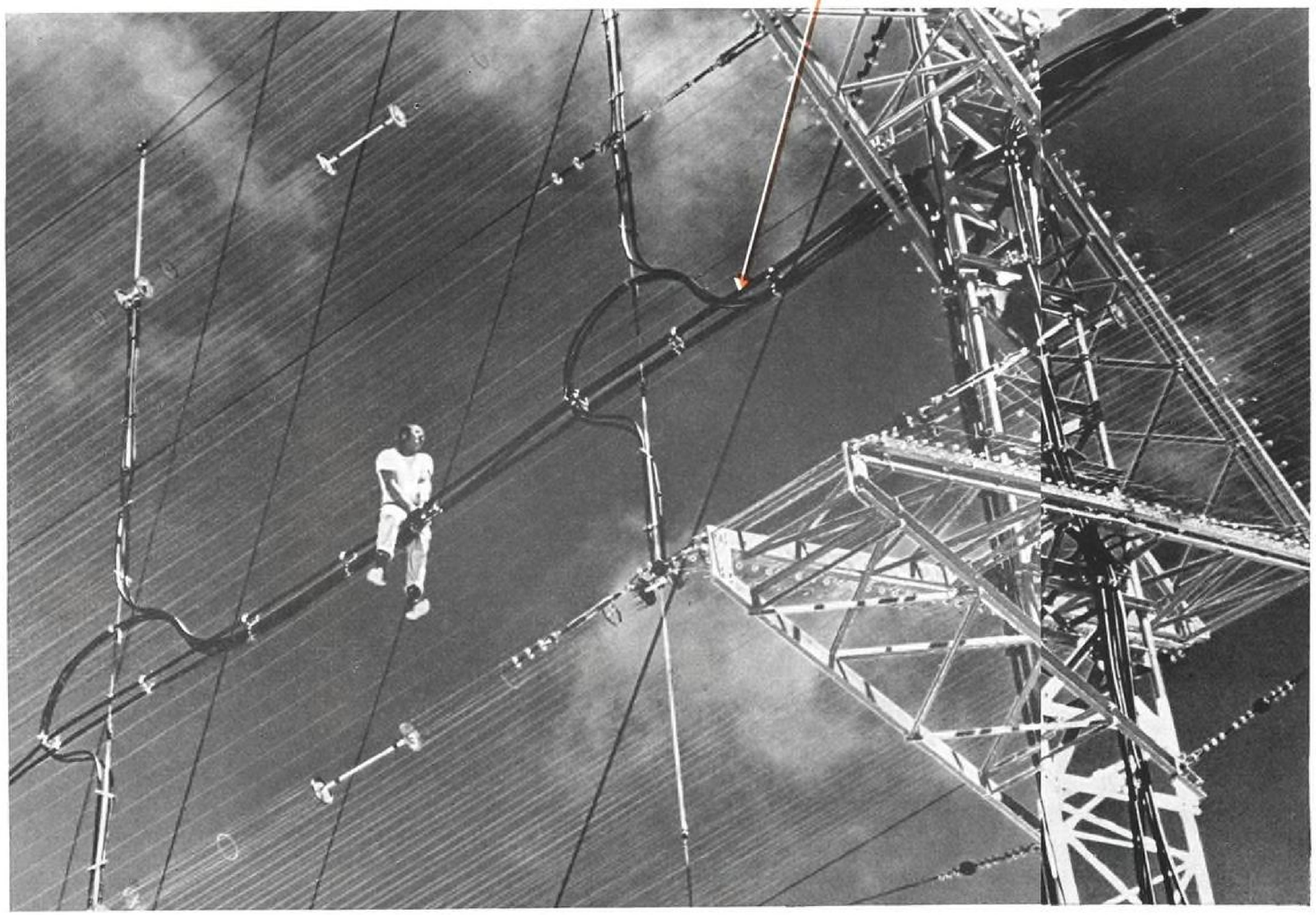
The new Collins system is not expected to provide a direct cost saving over the conventional procedures formerly used. But it is expected to pay off significantly in reducing delays and frustrations of engineers and manufac-

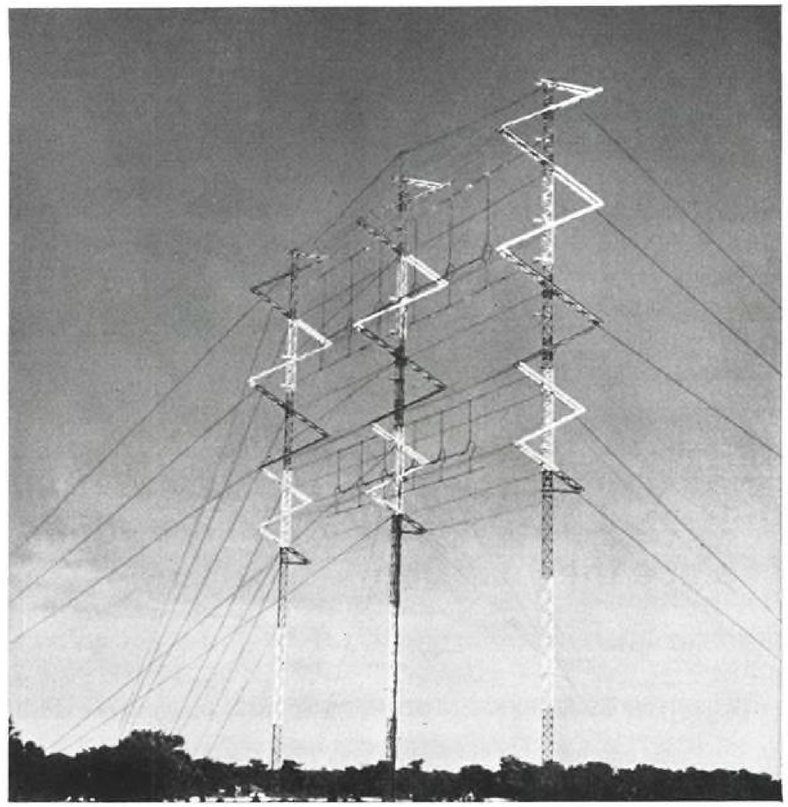


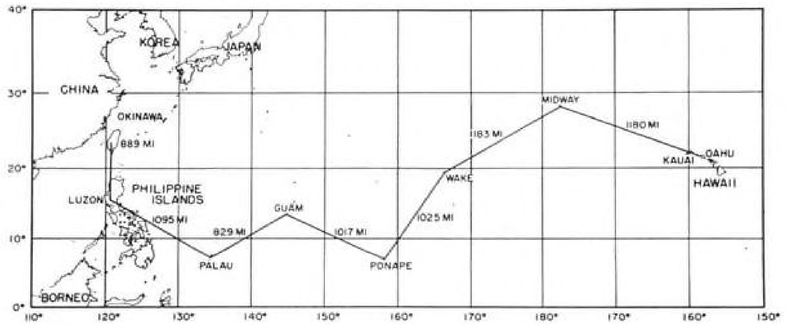


MASTER FILE/REPRODUCTION center can turn out higher-quality prints at lower cost within two hours, or less, after order is placed. At far left is battery of three wire recorders (arrow) which enables engineers to order prints by telephone. Photo at right shows two high-speed automatic Haloid Xerox printers which use microfilm cards to produce drawings at rate of 20 fpm.

Engineer inspects Styroflex® cable installed on an antenna array at one of Pacific Scatter Communication System stations shown at right.







Over 40 miles of *Styroflex® Coaxial Cable* help assure Pacific Scatter Communication System reliability!

More than 200,000 feet of Styroflex® coaxial cables are in active use as balanced antenna feed lines in the recently completed Pacific Scatter Communication System stretching from the Hawaiian Islands to Okinawa. This trans-Pacific system, one of the largest and most advanced of its kind in the world, uses ionospheric and tropospheric propagation techniques that produce over 99% reliability. An important part of the Strategic Army Communications Network (STARCOM), the system was designed, developed and constructed by Page Communications Engineers, Inc. for the U. S. Army Signal Corps.

Each of the nine stations in the network is equipped with the same major component parts—transmitters, exciters, multiplex terminals and antennas. The cables used in the 200- and 400-foot antenna arrays range from 7/8" jacketed Styroflex® cable to 3 1/8" jacketed Styroflex® cable. About 7,000 feet of 1/2" jacketed Foamflex® cable is also used in the system. The Styroflex® cables were spliced in the field by an inert-gas Heliarc welding process to assure noise-free connections required for successful duplexed antenna operation.

The extremely low inherent noise level and low attenuation of Styroflex®—together with this air-dielectric cable's stable electrical and mechanical properties—especially qualify it for the critical specifications of this STARCOM system. If your system requirements call for a cable with low loss and high reliability, investigate the successful record of Styroflex®!

(Photos courtesy of Page Communications Engineers, Inc.)

PHELPS DODGE COPPER PRODUCTS
CORPORATION
300 Park Avenue, New York 22, N.Y.



Not since the year One ● There's been no change in the scientific method. Only the tools are different. Our job—providing them ● Today a Beckman meter counts events from one a second to twelve billion per second. A Beckman ultramicro analytical system routinely measures cholesterol or chlorides in a split-drop of blood. Beckman high-speed computers can monitor and control everything from a process stream to a satellite launching ● These are the kinds of electronic components, instruments and systems that Beckman builds now...the standard, practical tools of the times. Research scientists, manufacturers, processors, the military – all, in turn, build progress around them ● One day the present science of electronics will be supplemented or replaced. Still newer technologies will need even more advanced instruments to implement them ● Our catalog for the future? We're working on it now.

INSTRUMENTAL • Beckman ® IN YOUR FUTURE

BECKMAN INSTRUMENTS, INC. FULLERTON, CAL. | ELECTRONIC COMPONENTS, INSTRUMENTS, SYSTEMS..FOR ANALYSIS, MEASUREMENT, COUNTING AND CONTROL | DIVISIONS: BERKELEY • HELIPOT • SCIENTIFIC & PROCESS INSTRUMENTS • SPECIAL PROJECTS • SPINCO • SYSTEMS | BECKMAN INSTRUMENTS INTERNATIONAL, S.A., SWITZERLAND • BECKMAN INSTRUMENTS, G.m.b.H., GERMANY • BECKMAN INSTRUMENTS, LTD., SCOTLAND

© 1960 B.I.I. BC 60143

turing personnel, according to Hime.

Previously, an engineer might request a print of a tracing which already had been pulled from the files to make a print for another engineer. An even longer delay might result if the tracing had been pulled from the master file for revision.

If an engineer merely wanted to look at a drawing for one bit of information, the print from the master file might be in use by someone else. "Too often," Hime says, "when an engineer wanted a drawing, he would only get excuses."

As a result, there was a tendency for engineers to stockpile their own private file of prints they might need in the future. This not only was costly, but might result in using a print which did not incorporate the latest revisions.

The system also accelerates the process of incorporating revisions in the original tracings. Previously, engineering had to request the tracing from the master vault. Today, the tracings can be retained in the engineering department. When a revision is made, the tracing is sent to the master file/reproduction center, which prepares a dozen new microfilm punched cards and returns the tracing to engineering within 24 hr.

Additional Advantages

Hime expects that Collins will find many other useful byproduct advantages of having all of its drawings in such convenient miniature form. For example, in engineering design meetings, a small pack of punched cards and a viewer perform the function that previously required large stacks of hard-to-handle drawings. When an engineer travels to a customer's plant for technical discussions, he can carry all necessary drawings in a briefcase, instead of requiring a suitcase.

Where previously it was necessary to file tracings and drawings according to their size in different parts of the master vault, the use of standard-size microfilm-punched cards permits all drawings to be filed in drawing/part number sequence.

Collins first began work on automating its drawing system in early 1959.

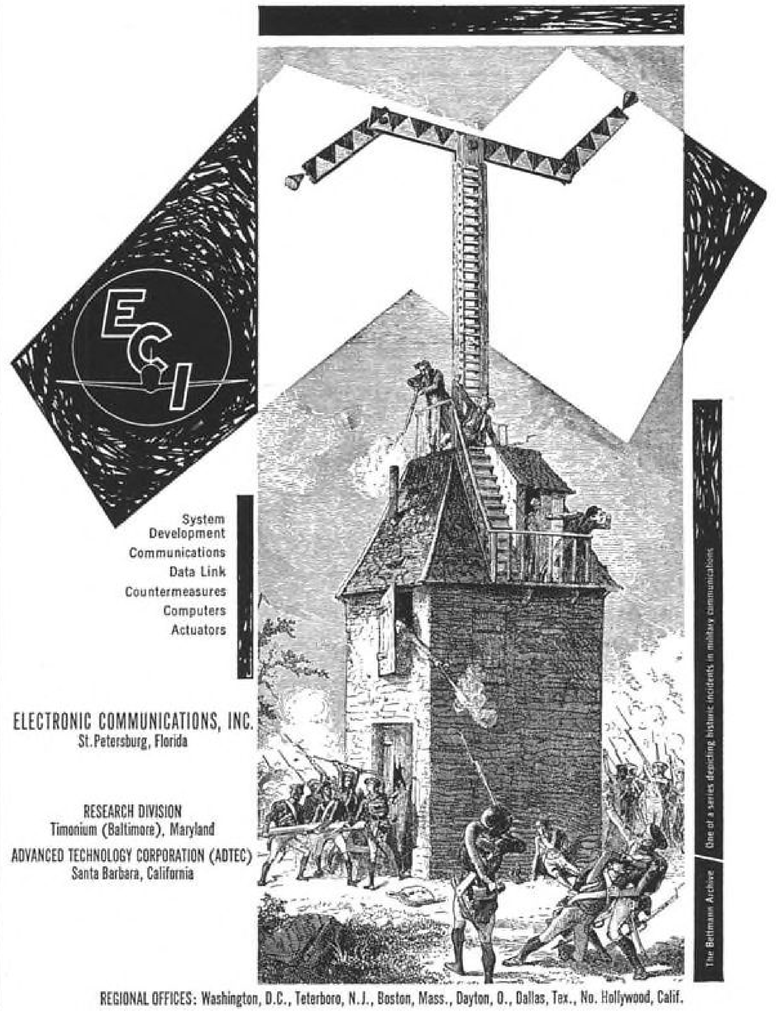
Company representatives visited Martin-Orlando and Westinghouse Electric at Pittsburgh, both of which had started to microfilm drawings. Shortly afterward Collins began placing orders for microfilming, card punch and reproduction equipment.

In September, 1959, the company began microfilming its existing backlog of 220,000 tracings and by January of 1960 had reached the point where the new system could be put into use on a limited basis. By the fall of 1960 the company had reproduced all of its drawings on microfilm and was on a current basis, permitting the new system to

LONG RANGE INPUT / 1794

News of the recapture of Condé from the Austrians was sped to the French Revolutionary Convention at Paris in a matter of minutes via Claude Chappe's amazing télégraphe aérienne, or relay aerial telegraph, Sept. 1, 1794. A new era in rapid communications had begun.

Today, instantaneous and completely reliable Electronic Communications insure the immediate and continuous interchange of intelligence throughout the Free World. ECI is proud of its initiative and responsibilities in the design, development and manufacture of high precision electronic equipment to the critical specifications required in various aerospace and surface roles vital to our National Defense and to scientific achievement. An example is ALRI—Airborne Long Range Input—a program where ECI communications and data link equipment fill an integral and essential requirement in linking USAF's advanced early warning system to SAGE—our continental defense network.



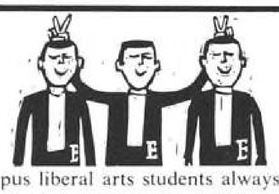
ELECTRONIC COMMUNICATIONS, INC.
St. Petersburg, Florida

RESEARCH DIVISION
Timonium (Baltimore), Maryland

ADVANCED TECHNOLOGY CORPORATION (ADTEC)
Santa Barbara, California

REGIONAL OFFICES: Washington, D.C., Teterboro, N.J., Boston, Mass., Dayton, O., Dallas, Tex., No. Hollywood, Calif.

PROBLEMATICAL RECREATIONS 49



On a certain campus liberal arts students always lie and engineers always tell the truth. A stranger meets 3 students and asks the first if he is studying liberal arts. The first answers the question, but the stranger doesn't hear him. The second student then says that the first denied being a liberal arts student. Then the third student says that the first is really a liberal arts student. How many are liberal arts students? Can we decide which? —*Of ancient origin*

PRINTAPIX is the proprietary name for our direct-writing CRT. With a resolution of 1000 lines per inch and 5 x 10^6 bits per line, its printing speed is determined only by how fast you can pull paper in front of the printing aperture.

ANSWER TO LAST WEEK'S PROBLEM: All squares end in 1, 4, 5, 6, or 9 and are of the form 4n or 4n + 1. Any two of the endings may be expressed in the following forms, viz., 100z + 11; 100z + 44; 100z + 55; 100z + 66; or 100z + 99; but none of these forms, with the exception of the second which is the form 4n, satisfy the conditions of a square number. Therefore the solution ends in three 4's. The least square number that may end in three 4's can be of the form $(10\pm2)^2$. Hence with n = 4, we have the solution 1444 or $(38)^2$.

LITTON INDUSTRIES
Beverly Hills, California



Is Noted For:

- **20 YEARS OF SERVICE** to military and commercial aircraft/missile manufacturers supplying **MS-NAS-AN** fluid line fittings and all *special fittings* including swivel, adjustable and positioning fittings.
- **ENGINEERING AND TECHNICAL ABILITY** that has eliminated inter granular corrosion and eutectic melting problems in fittings. (Data available upon request.)
- **CUSTOM ENGINEERING** and design for fittings of all materials.
- **QUALITY CONTROL** through *complete* engineering and test facilities.
- **PROMPT DELIVERY** from Dania, Florida or Whittier, California.

WRITE OR WIRE. DEPT. A-1.
The AIRCRAFT FITTING COMPANY • 701 N. Fed. Hwy., DANIA, FLORIDA

DISTRIBUTORS INQUIRIES INVITED



Stored-Logic Computer

First stored-logic computer, the AN/UYK-1, developed by Ramo-Wooldridge for Navy Bureau of Ships, is able to perform a variety of functions, including radar target processing, trajectory computation, navigation, fire control, system checkout and data processing. In the stored-logic design, sequences required to perform instructions are stored in the core memory, which can be easily changed, instead of being wired into the computer. Machine is organized as a parallel 15-bit word computer, but can be operated using 30 or 45-bit word lengths, with fixed or floating decimal point. Eight UYK-1s will be delivered to Navy in mid-1961.

completely replace the original tracings.

Currently, an average of 1,200 new tracings enter the system each month for conversion to microfilm-punched cards. When a new tracing is received from engineering, it is photographed on 35 mm. film using Eastman Recordak equipment. Standard size reductions are 15, 24 and 30:1. Drawings too large to be reduced to a single film frame are segmented onto several frames.

A master punched card is prepared which contains significant information about the drawing, drawing number, revision number, part name, nature of drawing (manufactured part, tool drawing, parts list, etc.), number of cards (for large drawings) and the corresponding microfilm frame identification.

Twelve duplicate copies are then made using an "aperture card" which provides an opening into which the film frame subsequently is inserted. Each of these duplicate aperture cards also has an identification showing its ultimate file destination, i.e. engineering, fabrication, publication or other, according to Robert F. Miller, supervisor of the operation.

When the film has been inserted, the aperture card is verified to be certain that the correct film and card have been mated, after which the aperture cards are distributed to their respective files.

The cards are inserted, and extracted, manually. Machine handling could be used, but the 600-700 drawing requests per day at Collins' Cedar Rapids plant are not sufficient to justify the use of machines.

Prints are made at the master file/reproduction center from its aperture cards using one of two types of Haloid Zerox printers. The Haloid Copyflo 24C is a continuous roll type machine which works from a stack of aperture cards, turning out prints at a speed of about 20 fpm. The other type, a Haloid 1824 step printer, works from pre-cut sheets and is used for short-order service. Collins has two printers of each type. Machines can also make reproducible prints on thin semi-transparent stock.

Motorola ADF Shows Rapid Needle Response

Culver City, Calif.—Motorola Aviation Electronics, a subsidiary of Motorola, Inc., has completed development of an improved version of the automatic direction finder ADF-12, formerly produced by Lear, Inc.

Designated the ADF-T-12, the instrument has been completely redesigned to incorporate all-transistorized circuits and solid state devices for lighter weight and improved reliability.

Motorola's ADF performed very satisfactorily on both standard broadcast radio stations and low frequency homers during a recent flight evaluation by AVIATION WEEK. Most noticeable feature of the indicator is the rapid response of the needle in pointing to the station. Main reason for the rapidity of needle movement is that the ADF-T-12 uses no movable loop to which the indicator needle is remotely slaved. The system uses a fixed loop permanently imbedded in epoxy which is coupled to an automatic goniometer (resolver) in the azimuth indicator.

The complete ADF-T-12 weighs 8.5 lb. and consists of the following:

- **Receiver,** covering frequencies from 190 kc. to 1,750 kc. Dimensions are 8.28 x 6.25 x 2.81 in. and total weight is 5 lb. The receiver has a push-to-test switch which takes the needle off bearing and allows a check of the rapidity with which it returns to bearing.
- **Azimuth indicator,** which measures 3.25 x 3.25 x 7.50 in. The servo amplifier can be mounted to the rear of the indicator as an integral part or mounted separately if panel depth is limited. Weight of the unit is 3.2 lb.
- **Fixed loop** with dimensions of 7.13 x 4.25 x .63 in. Drag caused by the loop is very slight since loop housing extends only $\frac{3}{8}$ in. below the underside of the fuselage. Weight of the loop is 1.3 lb.

Extensive laboratory testing has been given the unit, Motorola says, as well as flight tests in company aircraft. Production will be in the recently completed facility in Culver City.

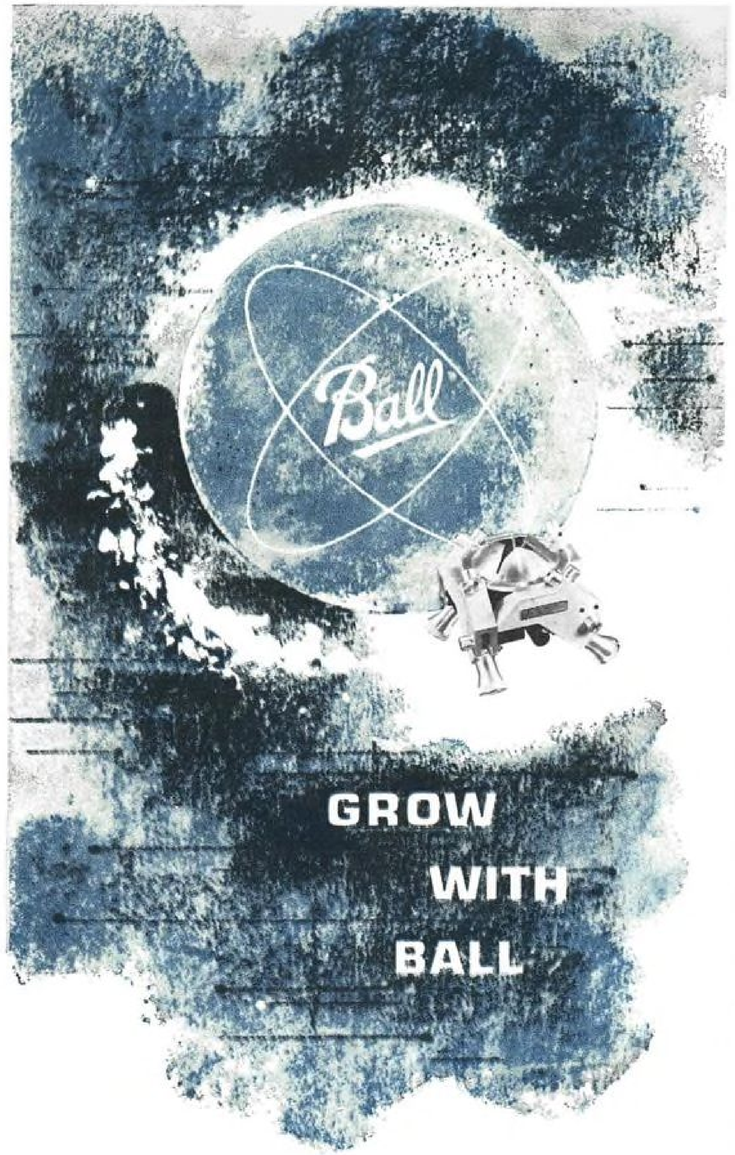
FILTER CENTER

► **Boeing to Market Medical Gear**—Special medical equipment for monitoring human physiological phenomena is to be marketed by Boeing Associated Products, a newly formed organization which will sell commercial products developed from research and development at Boeing Airplane Co. The medical instruments will consist of amplifier, power supply and transmitter inserted into pockets of a narrow vest wrapped around a subject's chest. Each item will weigh 3 to 10 oz.

► **"Kabanov Effect" Becomes Retroactive**—Soviets, who credit their Nikolai Kabanov with the discovery of the backscattering of high frequency radio waves from the ionosphere, now say that he "was the first to offer a correct explanation of these phenomena which were observed by him before they were made public. The results . . . by which he proved his explanation were reported in 1947 and it is by virtue of this date that priority is claimed for his discovery." Soviets do not explain why it required 13 years for the "discovery"

Shipboard Radar Presents 3-D Target Information

Three-dimensional shipboard radar, giving target bearing range and height from a single antenna, which will be installed on all Navy cruisers, guided missile frigates and destroyers, is shown atop masthead of the missile cruiser USS Galveston. Built by Hughes Aircraft Co., the radar is called "Frescan" because it uses shift of frequency to accomplish vertical scanning. Antenna itself need not be gyro-stabilized against ship's rolling and pitching motions which are corrected for by a computer. In combat information center (right), target bearing and range are shown on scope at left, while one at right shows target height and range.





Opportunity... new brochure shows the capabilities and facilities which have enabled Ball Brothers Research to make such outstanding achievements in the satellite and related fields...shows the variety of company projects in research, development, and fabrication...shows why Ball Brothers Research presents an opportunity for scientists and engineers with above average abilities.

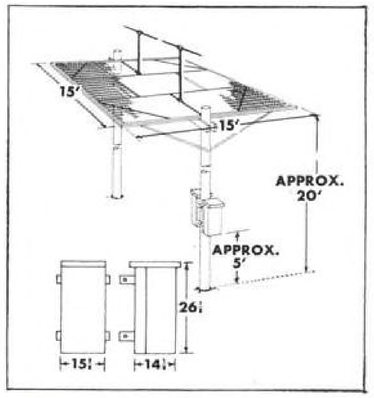
WRITE FOR YOUR COPY TODAY

Prime Contractors to the NASA, AIR FORCE, and NAVY

BALL BROTHERS RESEARCH CORP.

DEPARTMENT R-5
INDUSTRIAL PARK—BOULDER, COLORADO
Hillcrest 2-2966

A Subsidiary of Ball Brothers Company, Inc.



Dual Marker Beacon

New dual marker beacon station, Model 492B, for use as an ILS approach marker or a low-power airways beacon, consists of two transmitters and accessory equipment including automatic changeover equipment in event one unit fails. Power output is 0.5 to 5 watts. Frequency stability is within 0.01%, according to firm: Wilcox Electric Co., 14th & Chestnut, Kansas City 27, Mo.

to be publicized and its importance acknowledged, or for Kabanov to be honored for his work (AW Dec. 26, p. 78). Soviets also ignore completely early U.S. work in back-scatter which was reported several years ago.

▶ **Transistor Sales Show Gain**—Semiconductor manufacturers report that transistor sales, for September, measured in units, were up 50% over same month of 1959, while October sales were up 39% over same month last year. Dollar sales for September were 36% above 1959, while those for October were up only 17%, reflecting lower per-unit prices. Average transistor price in October, 1959 was $2.55, while the same figure this year was $2.13. For the first 10 months of this year, manufacturers sold 102.4 million transistors, an increase of 38% over the previous year. Dollar sales to date total $248.1 million, an increase of 24% over 1959.

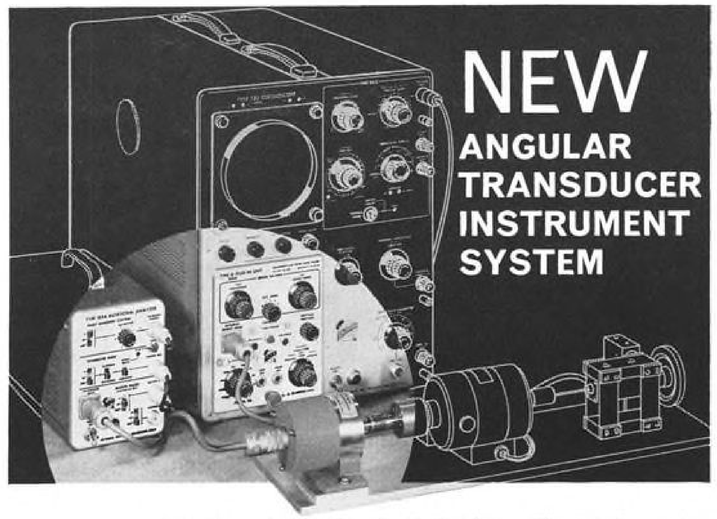
▶ **Soviets Study Electronic Gyro**—An electronic rate-gyroscope, operating on principles similar to those used in a charged particle accelerator, is under study by Soviet scientists. A discussion of the theory of operation, by A. Bialecki, is contained in USSR's Pomiary, Automatyka, Kontrola, No. 10, October, 1960, p. 386.

▶ **New Telemetery Technique for Saturn**—Flight tests of the Saturn space launch vehicle will employ a new telemetry technique, single sideband subcarriers on an FM carrier, which is expected to provide a 10-fold increase in data capacity and up to a 30 db. gain in signal-to-noise ratio over that obtainable with standard FM/FM telemetry. Telemetry data accuracy is 5%. Three companies which are major contributors on the new development include Collins Radio, Lenkurt Electric and Motorola. Collins is providing highly selective filters, Lenkurt is producing the ground de-multiplexing system and Motorola is designing the frequency synthesizer circuits. Ground-based equipment is identical to conventional FM/FM equipment except for the demultiplexing system. New telemetry system provides 45,000 cps. bandwidth, which will be divided into 15 channels of 3,000 cps. each.

Huge Space Antenna Under Study—Four companies will conduct a four month study to investigate feasibility of a 200 to 250 ft. tracking antenna expected to increase communications capacity with deep space probes by as much as 30-1 over present facilities. Study is sponsored by National Aeronautics and Space Administration's Jet Propulsion Laboratory. Four companies, selected from 17 bidders, include: Blaw-Knox Co., Hughes Aircraft, North American Aviation (Columbus) and Westinghouse electric.

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

- **Lear, Inc.**, Santa Monica, reports a $2.4 million award for MC-1 automatic flight control system for use on KC-135 jet tankers, from Air Material Command.
- **Convair Division** of General Dynamics has received an $8 million contract for production of advanced airborne mapping radar for North American's Autonetics Division for bombing-navigation system used on the A3J attack bomber.
- **Houston Fearless Corp.**, Uniconn Division, $700,000 contract to produce HIG-5 gyros for Crosley Division of Avco, for B-52 fire control systems.
- **Sperry Gyroscope Co.**, $2.3 million contract from Air Force for production of remote attitude indicators for use on F-105, T-38, T-39 and B-52H. Second contract for $1.1 million covers flight director computers for use with the indicators.
- **Telecomputing Corp.**, Cook Batteries Division has received $487,089 contract for primary silver-zinc batteries for Minuteman missile guidance and control system, from North American Autonetics Division.
- **Collins Radio Co.**, Cedar Rapids, $3.6 million Air Force letter contract for additional communication-identification-navigation (CIN) systems for F-105D. Company also reports an $835,650 Air Materiel Command award for horizontal situation indicators.

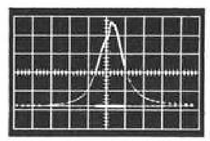


Instrumentation for the wheel-balancing application shown includes the two units of the ROTAN system—Type 182A Angle-Encoding Transducer and Type 183A Rotational Analyzer—working in conjunction with a linear variable differential transformer and a Type Q Plug-In Unit in a Type 533 Oscilloscope.

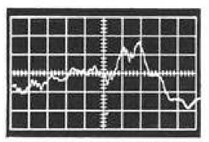
TEKTRONIX®

A Type 182A Angle-Encoding Transducer and a Type 183A Rotational Analyzer comprise the new Tektronix ROTAN system. Designed to study rotation-associated phenomena in machinery, the two ROTAN units adapt an oscilloscope to provide horizontal trace deflection proportional to angular displacement of a rotating shaft. The ROTAN system generates a horizontal sweep representing shaft angle—at speeds from essentially zero to 20,000 rpm. Transduced data, such as velocity, pressure, acceleration, or vibration (applied to the oscilloscope vertical input), appears on the crt screen correctly referenced to this instantaneous angular position.

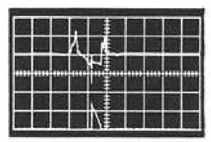
TYPICAL ROTAN DISPLAYS



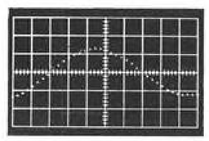
Diesel engine cylinder pressure *vs.* crank angle. 360° display with 10° intensity markers. Intensified portion is the 50° sector covered by the main sweep, starting at 160°.

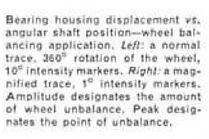


Vibration *vs.* crank angle. 360° display of a 4-cycle, 1-cylinder gasoline engine.

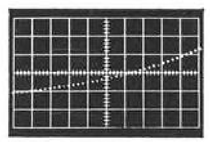


Ignition *vs.* crank angle. 360° display with 10° intensity markers. The upper trace is the secondary voltage and the lower trace is the secondary current.





Bearing housing displacement *vs.* angular shaft position—wheel balancing application. *Left:* a normal trace. 360° rotation of the wheel, 10° intensity markers. *Right:* a magnified trace, 1° intensity markers. Amplitude designates the amount of wheel unbalance. Peak designates the point of unbalance.



Price, ROTAN System, **$850.00**
(f.o.b. factory)

Call your Tektronix Engineer for a demonstration of the ROTAN system in your own application.

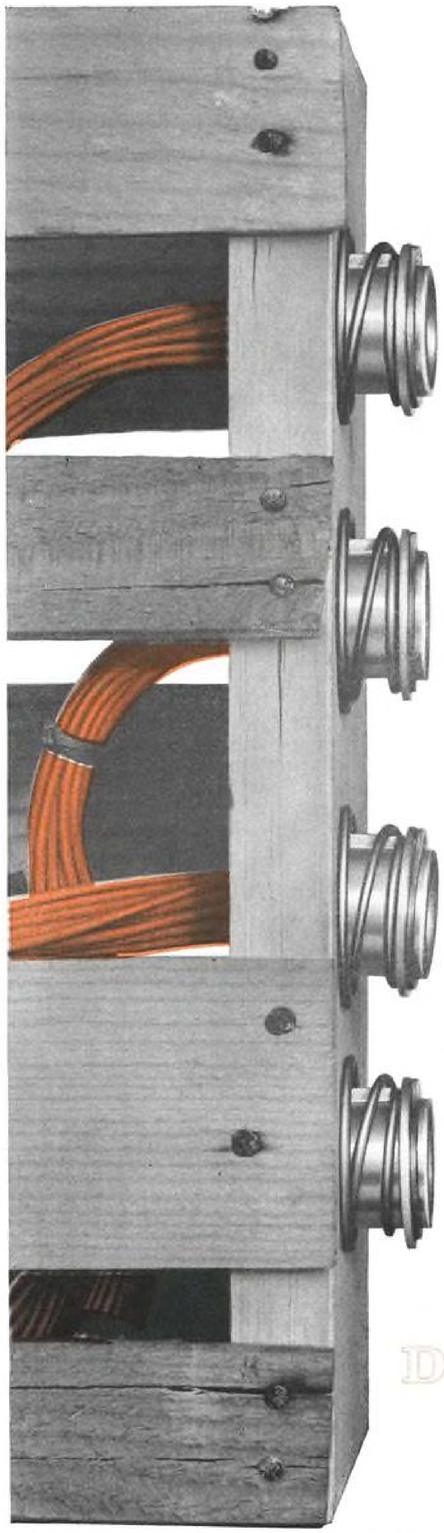
Tektronix, Inc.

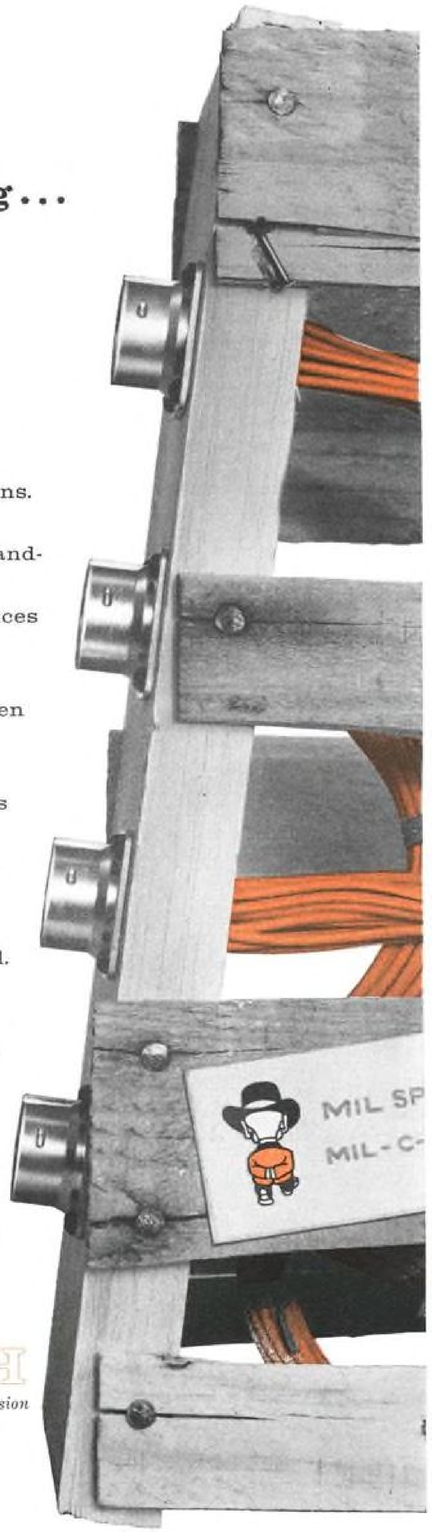
P.O. Box 500 • Beaverton, Oregon • Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson, Md.) • Boston (Lexington, Mass.) • Buffalo, N.Y. • Chicago (Park Ridge, Ill.) • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo. • Detroit (Lathrup Village, Mich.) • Endicott (Endwell, N.Y.) • Greensboro, N.C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission, Kan.) • Los Angeles, Calif. Area (East L.A. • Encino • West L.A.) • Minneapolis, Minn. • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale, Ariz.) • Poughkeepsie, N.Y. • San Diego, Calif. • San Francisco (Palo Alto, Calif.) • St. Petersburg, Fla. • Syracuse, N.Y. • Toronto (Willowdale, Ont.), Canada • Washington, D.C. (Annandale, Va.)

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.





Self-Aligning . . . Even with Commercial Tolerances

Vegetable crate construction is generally frowned upon for complex modular installations. But, with Deutsch self-aligning rack-and-panel connectors, commercial tolerances between mounting hole centers are perfectly okay. When the drawer is slid home, each spring-mounted plug floats into engagement with its receptacle. Spring pressure then maintains an environmental seal. For complete information on this easy-to-mount line of cylindrical and rectangular rack-and-panel connectors contact your local Deutschman today or write for Data File H-1.

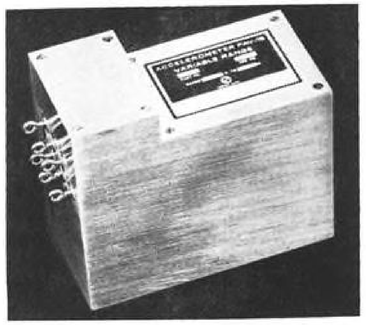
DEUTSCH

Electronic Components Division
Municipal Airport
Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

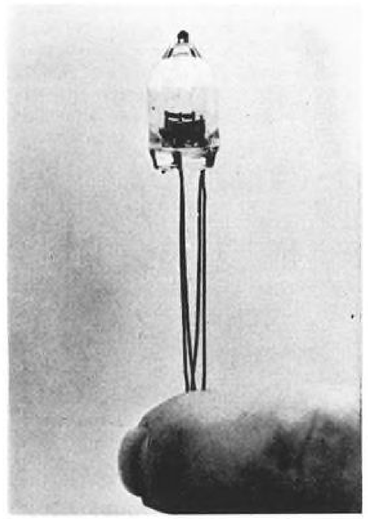
NEW AVIONIC PRODUCTS

• **Variable range servo** accelerometer, Model PAV-1S, has threshold resolution of better than one part in 100,000. Accelerometer weighs 3 oz., operates on ± 15 v.d.c. ± 10% at ± 7 ma. or 28

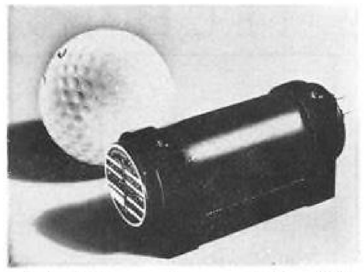


v.d.c. ± 10% at 15 ma. It provides ± 7.5 v.d.c. output or 0 to 5 v.d.c. at 1.5 ma. for telemetry applications. Manufacturer: Palomar Scientific Corp., 4039 Transport St., Palo Alto, Calif.

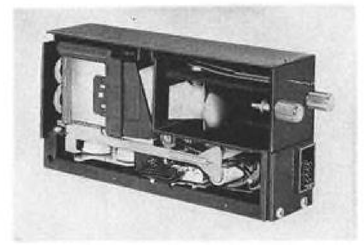
• **Subminiature "Crowbar" tube,** Type WC-28, is a cold-cathode trigger tube for use where a high pulse current of several hundred amperes and a short time delay of a few microseconds are required in overvoltage and overcurrent protection of circuits. Tube is rated



from 350 to 3,000 v.d.c. on the anode with a hold-off voltage of 3,500 v.d.c. Peak cathode is from 10 to 1,000 amp. Grid pulse amplitude modulation is 230 v. minimum for duration of 10 microseconds maximum. Manufacturer: Electronic Industries, Inc., 18 Marshall St., South Norwalk, Conn.

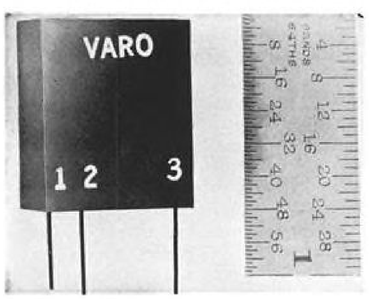


• **Subminiature rate gyro,** Series 7601, electrically driven, uses a volumetric compensator to maintain damping factor at any value between 0.5 and 0.9 over temperature range of −54C to 84C. Gyro, which weighs only 6½ oz., consumes 1½ watts motor power, operating from 26 v., 400 cps., single, two or three phase power. Manufacturer: Lear, Inc., Instrument Division, Box 688, Grand Rapids, Mich.

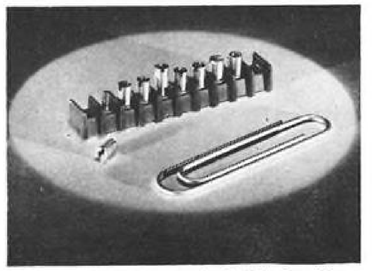


• **Alpha-numeric readout** accepts any binary coded decimal code up to 6 bits, translates and displays the proper character. It can be connected directly into computers, instruments, display boards and numerical controls and does not require auxiliary translators, relays or diodes. It displays up to 20 1⅜-in.-high characters per second; requires as little as 10 milliwatts per bit signal power. Manufacturer: Industrial Electronic Engineers, Inc., 5528 Vineland Ave., North Hollywood, Calif.

• **Microcircuit AGC Preamplifier,** Model 8,500, occupies only 0.1 cu. in., weighs 3¼ grams, consists of low-noise six-stage audio amplifier, a d.c. automatic gain control amplifier and associated AGC diodes, encapsulated in epoxy resin. Voltage gain is 80 db. minimum below AGC threshold and fre-

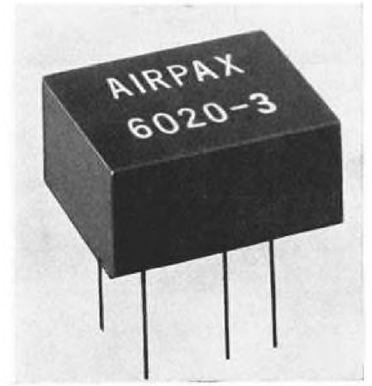


quency response is 400 to 20,000 cps. at 3 db. points. Harmonic distortion is less than 10% at 1 kc. Microcircuit dimensions: 0.70 x 0.65 x 0.22 in. Manufacturers: Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.



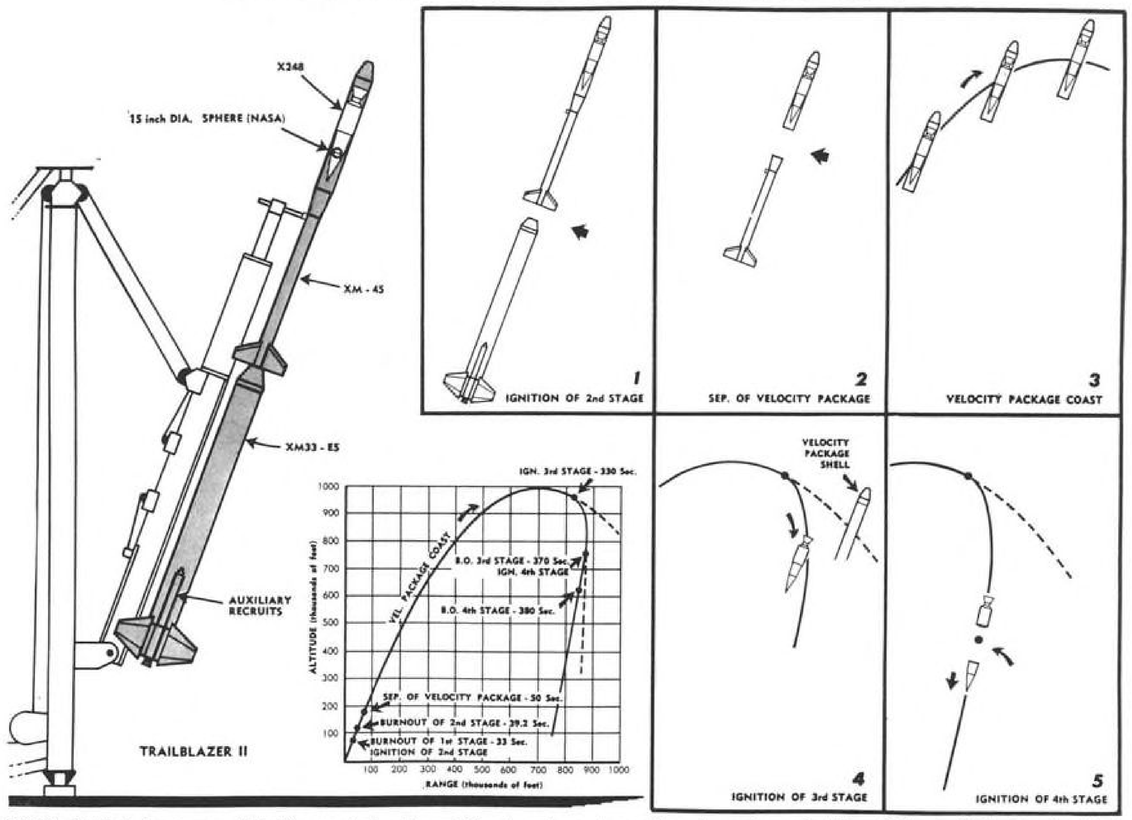
• **Subminiature terminal block,** Type 409-1802, measuring 4⅜ in. long, can accommodate up to 21 terminals plus mounting holes. Threaded stud and slotted nut terminal is incorporated to facilitate connections and disconnections. Barrier design provides extra long leakage paths. Design details are available upon request. Manufacturer: Kulka Electric Corp., 633-643 Fulton Ave., Mt. Vernon, N. Y.

• **Transistor chopper** for printed circuits, Type 6020-3, operates over a chopping range of d.c. to 100 kc. Drive voltage can be 2 to 20 v. peak square wave or 5 to 20 v. peak sine wave. Units



operate over temperature range of −55C to 125C. Peak signal voltage can be as high as 30 v. and maximum signal current is 3.0 ma. Manufacturer: Airpax Electronics Inc., Cambridge, Md.

• **Deposited film potentiometer,** providing resolution better than 0.01%, can be operated at high ambient temperature and severe vibration and shock. Potentiometers, measuring 1-1/16 in. in diameter, are available in single or ganged types. Manufacturer: Servomechanisms, Inc., Mechatrol Division, 1200 Prospect Ave., Westbury, L. I., N. Y.



BASIC physical phenomena of bodies re-entering the earth's atmosphere at speeds up to meteor velocities will be studied using the Trailblazer II solid-propellant rocket being built by Atlantic Research Corp.'s Space Vehicle Group. Rockets will be fired from NASA's Wallops Island, Va., site and studies will be made principally by Lincoln Laboratory under USAF contract for ARPA. Rocket uses Thiokol Castor and Recruits, Grand Central Lance, a Hercules-Allegany 248 and a NASA spherical motor for which NASA will contract later (see box opposite). The 248 and spherical motors fire downward along launch trajectory (above) to create high velocities needed for studies.

Trailblazer II Will Launch Re-entry Tests

By William S. Reed

Pasadena, Calif.—Four-stage Trailblazer II being built here will propel small bodies into the earth's atmosphere at velocities equal to those of low-speed meteors for studies of re-entry phenomena affecting detection, tracking, communications with and defense against ballistic missile warheads and spacecraft.

The studies also will contribute to nose cone materials and design research. Two upward and two downward firing stages will provide velocities up to 25,000 fps. at a nominal cost compared with the expense of collecting data from larger and more expensive ballistic missile re-entry bodies.

Atlantic Research Corp.'s Space Vehicle Group, headed by H. F. Halstead, is engineering and fabricating Trailblazer IIs for six firings that will begin this spring at National Aeronautics and Space Administration's Wallops Island, Va., test site. The group also will provide field services. Work is being done under a $500,000 contract from Massachusetts Institute of Technology's Lincoln Laboratory.

Technical Direction

Technical direction is being supplied by the Flight Physics Branch of the Applied Materials and Physics Division at NASA's Langley Research Center. Trailblazer II is a direct outgrowth of a six-stage downward firing rocket developed by the Flight Physics Branch and other elements of Langley for earlier re-entry physics studies (AW Oct. 26, p. 54). Lincoln Laboratory is conducting various phases of the studies under Air Force contract for Defense Department's Advanced Research Projects Agency, which has overall direction of this research under Project Defender.

ARC's Trailblazer II is a four-stage, solid-propellant rocket approximately 50-ft. long. First and second stages fire upward, boosting the two upper stages to approximately 200 mi. altitude.

Third and fourth stages fire downward in rapid succession to accelerate test re-entry bodies to the maximum velocity attainable at the highest altitude possible.

First upward firing stage consists of a Thiokol Castor XM-33-E5 plus two auxiliary Thiokol Recruit Motors. At burnout 33 sec. after launch, the vehicle will be at approximately 70,000 ft. A Grand Central Rocket Lance XM-45 second stage carries the vehicle to its apogee in excess of one million feet. Burnout is 90 sec. after launch at an altitude of 110,000 ft. Maximum velocity of the two upper stages at Lance burnout is about 8,200 fps., gradually slowing as the vehicle coasts to apogee.

The two downward firing stages, referred to as the "velocity package," are separated from the second stage motor at peak altitude. Approximately 330 sec. after launch, the first downward firing stage, a Hercules-Allegany 248 motor, ignites and drives downward the final stage, a NASA 15-in. spherical motor which propels the re-entry body. Timing devices within the velocity package can be set to vary the firing interval in order to attain maximum velocity at either high or relatively low altitude. The spherical motor is an outgrowth of a 5-in. motor developed by NASA for Trailblazer I.

Trailblazer is designed to be fired over the Atlantic Ocean at an angle elevated 80 deg. from the horizontal. No control or guidance will be sought over the vehicle after launch. Stability will be achieved by spinning the first two stages at rates varying from six to 10 rps. This will be controlled by varying the angle of incidence of Nike-type fins on each stage. Same rate of spin will be imparted to the third stage by two spin rockets, having one second firing times, placed perpendicular to the longitudinal axis of the vehicle.

Downward Firing

Rather than attempt a complicated method of aiming the last two stages downward by turning the vehicle back toward earth, the velocity package rockets are fired in the reverse direction of the booster stages. Second stage separation in the rarified upper atmosphere is assured by a pneumatic bellows which forces the two units apart at a rate variable from 8 to 30 fps. Actual value of the separation rate will be established from available telemetered information gained from the first flight.

Data on re-entry will be sought only incidentally on the first test flight, since the main interest will lie in checking, correcting and calculating vehicle performance parameters.

Relative angle of the vehicle of 80 deg. to the horizontal will be maintained throughout its flight. This angle of less than 90 deg. is chosen not only for safety reasons, but also to cause the downward-firing stages to be propelled back toward Wallops Island, lessening the distance over which data will have to be telemetered. Horizontal distance from the launch point at the time of third stage firing will be approximately 900,000 ft., and the re-entry body probably will re-enter the atmosphere about 750,000 ft. out from the launch site.

Trailblazer will maintain its 80 deg. inclination because of the calculated interaction between the shift in its center of gravity as propellants burn and the change in aerodynamic center of pressure due to increased velocity and change in dynamic pressures. Although it would seem that the vehicle might lack the necessary stability augmentation, previous firings by ARC of the Argus weather rocket and the 20-ft. long Iris upper air research rocket indicate that the methods of calculation are correct.

Trailblazer velocity packages will be used not only to study re-entry physics, but individual experiments also will be made to determine effects of various shapes, materials, and other factors on the radiated energy, plasma formation, flow fields, and other phenomena associated with hypervelocity re-entry. Plans also call for the installation of a "gun" in the nose of the re-entry body from which a pellet can be fired when the body is at maximum velocity to simulate a low-speed meteor.

The NASA 15-in. spherical motor is expected to have many applications in space because of its high mass ratio. Not only will a sphere hold the greatest volume in a given space, but a spherical case lends itself to high strength with low structural weight.

Instrumentation requirements on the velocity package will be severe because of the heavy attenuation of radio signals that occur at ordinary VHF telemetry frequencies during re-entry. Absorption of radio energy in the plasma shield, reflection of energy at the interface between the plasma and free space and in some cases the tuning of the vehicle antenna are some of the effects with which the telemetry must cope.

Lincoln Laboratory's ground instrumentation at its Arbuckle Neck Field Station, adjacent to Wallops Island, includes three tracking radars equipped with recording, data processing and printout facilities. Radar cross section, spectral distribution and total radiation from the re-entry vehicles and their environment are measured at various frequencies. One antenna serves as a combined UHF and X-band radar and another is an S-band tracking system. Still other measurements are provided by radar equipment at Lincoln's Milstone Hill site in Westford, Mass.

Optical Measuring Systems

Optical measuring devices include meteor cameras and a Schmidt spectrographic camera, and a 48-in. tracking spectrometric telescope is being built. Narrow-field, optically-tracked systems and wide-angle, field-of-view systems are used to measure the ultraviolet, visible and infrared spectra. Meteor cameras are used as backups to the radars for position and velocity information.

These field tests support other theoretical and experimental studies being done by Lincoln in various laboratories, including NASA's Ames Research Center ballistic facilities and an auxiliary hypervelocity range at Lincoln's Lexington Field Station.

The studies include physical changes in the flow field, mechanism of the shock phenomena that occur when the vehicle travels into and through the atmosphere, electronic characteristics of the plasma sheath, and techniques for determining the flow field with electromagnetic probes.

Ground testing of the Trailblazer II from the interface between first and second stage forward will be conducted by ARC's Space Vehicle Group. Both the bending and vibration testing of the complete unit will be done here, with all components, complete with inert propellant, subjected to testing. First stage booster will not be included in static tests here. Interstage connectors, separation mechanism, fairings, etc., will be manufactured here and shipped east to ARC for assembly at Wallops Island.

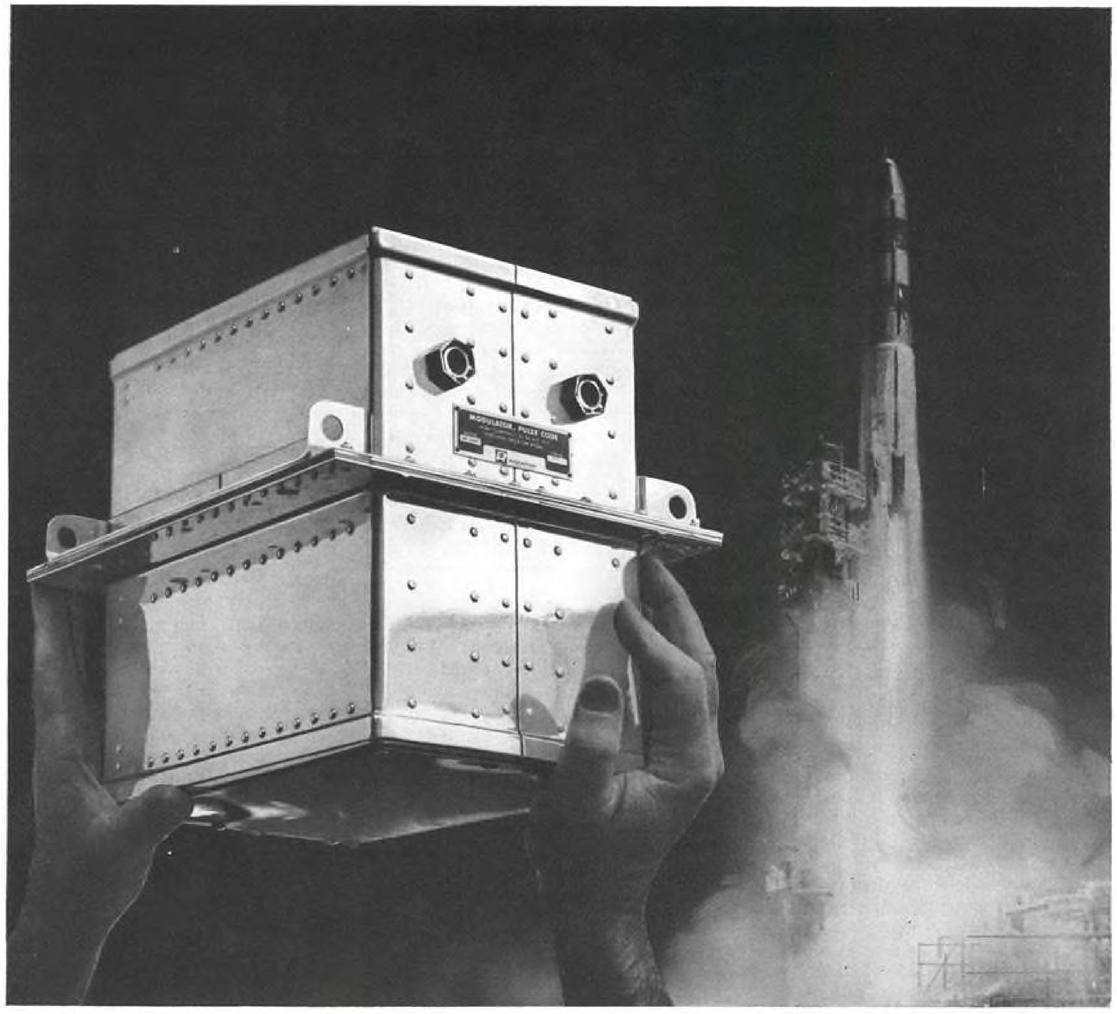
NASA Spherical Motor

Langley Field, Va.—Fifteen-inch diameter spherical rocket motor developed by National Aeronautics and Space Administration for the Trailblazer II downward firing rocket has had four completely successful static tests. NASA intends to let contracts to industry for case construction and for production and loading of propellants.

A fifth static test of the motor will be followed by a launching in a single-stage rocket from Wallops Island, Va., in March. If the flight test is successful, the engine will be considered ready for use in Trailblazer development flights. NASA will build only enough 15-in. motors to get the development flights under way. Specifications for the case and propellant contracts are now being written. NASA cast all the propellants for an earlier 5-in. spherical motor used in the Trailblazer I, and Ryan's Aerolab Development Co. built several cases.

Commerce to Publish Soviet Bloc Research

Office of Technical Services, U. S. Department of Commerce, will publish a bi-weekly "Soviet Bloc Research in Geophysics, Astronomy and Space," replacing its former weekly, "Information on Soviet Bloc Geophysical Information." The publication will present brief summaries and extracts of Soviet bloc literature on astronomy, meteorology, oceanography, terrestrial geophysics and upper atmosphere and space research. Subscription rates are $16 within the U. S., $20 foreign. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.



THEY RELY ON RADIATION FOR UNUSUAL CAPABILITIES IN TITAN'S PCM* GUIDANCE TELEMETRY

Production quantities of Radiation's PCM Telemetry systems, being delivered for TITAN I & II, represent a major contribution to the state-of-the-art. Techniques developed in this continuing program will provide the basis for PCM's larger role—and ours—in the next generation of missiles.

In present missileborne systems we have completely integrated data processing and PCM telemetry, in rugged, space saving units. First of their kind, the "unitized" solid state packages offer virtually unlimited design flexibility.

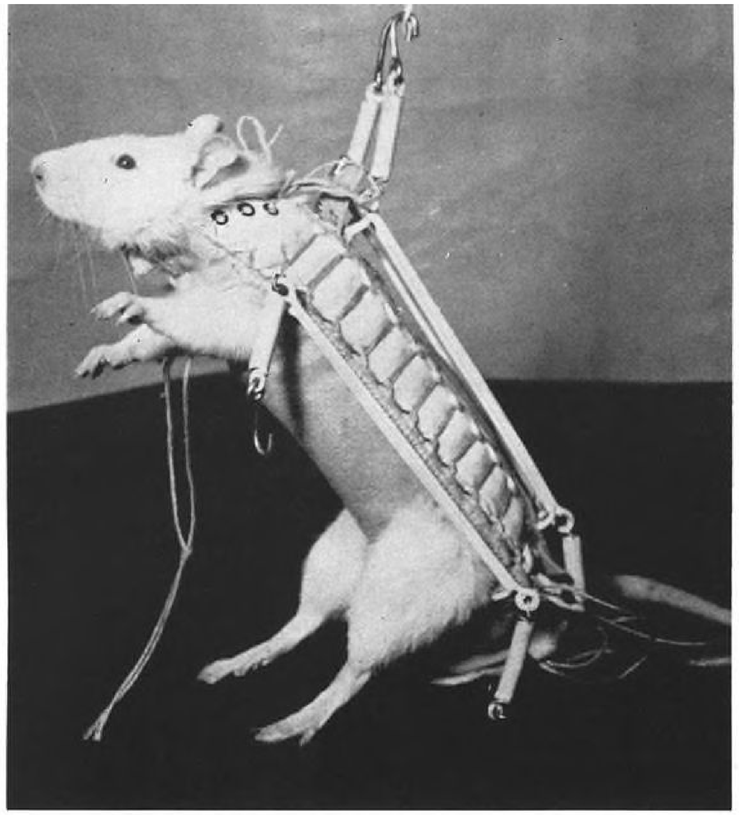
The Advanced Titan system, for example, is capable of coding a *24-bit computer word* 3200 times per second, processing 64 analog inputs and 40 bi-level digital inputs. The system weighs 20 lbs., occupies ⅓ cubic feet, and has a predicted MTBF of 1300 hours. Radiation-built ground support equipment includes a pre-launch Input Simulator and a Ground Checkout Rack Test Fixture for ground synchronization and de-coding. Accuracy and reliability are attested by the system's impeccable performance record during test sled runs at Holloman AFB.

The design innovations by which digital and analog equipments are integrated in this system, and the use of PCM techniques to yield maximum data, are typical of Radiation's systems capabilities. The capabilities are at work today in major satellite and missile programs, and in industry. They are ready to work for you now.

First step: Write to Radiation Incorporated, Melbourne, Fla. for "Capabilities Report." AW-1.

*Pulse Code Modulation

RADIATION INCORPORATED



French Plan to Send Rat Into Space

This white rat will be sent into space in the nose cone of a French Air Ministry Veronique vehicle in February; special nose container has been built by Sud Aviation. French plan four such shots, with recovery of the rat planned. The 5,000-lb.-thrust Veronique is being considered as a second stage in possible Franco-British space projects (AW Dec. 26, p. 25).

Soviets Plan More Animal Flights

Moscow—Soviet scientists feel the danger of cosmic radiation has not been sufficiently studied, but Academician M. M. Sisakyan says the Aug. 19 flight of Sputnik V paved the way for continuing biological flights.

One of two dogs carried on the flight has had a litter which shows no apparent genetic effects, according to Pravda. The capsule containing the biological specimens was recovered after the 18th orbit, but the orbital altitudes were well below the inner Van Allen radiation belt—they ranged from 190 to 211 mi.

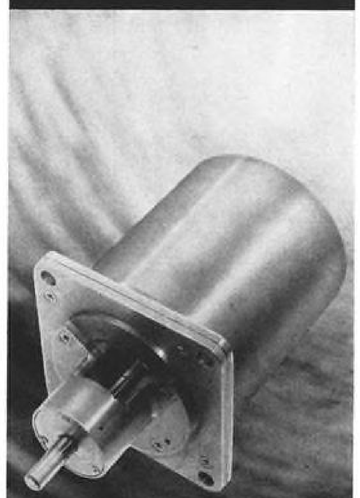
Sisakyan, secretary of the biology department of the USSR Academy of Sciences, said the Soviet space program will concentrate "great attention" on research in biology, physiology and radiogenetics in 1961.

Another scientist, Ukrainian Academician B. V. Gnedenko, said work is under way to build a talking robot which would report "in a human voice" experiences of interplanetary flight.

Sisakyan and Academician L. I. Sedov made these general observations which indicate a steadily growing concern for safety in manned space flight:

- **Although Soviet satellites** could have carried a human passenger, additional experimental launchings will precede manned flight.
- **Meteor danger** is so slight it can be ignored.
- **Weightless flight study** is inconclusive, but indications are that man can bear the transition from accelleration to weightlessness better than the reentry transition of weightlessness to deceleration. Psychological problems are expected to be magnified in weightless flight, and artificial irritants may be necessary during long-term flight.
- **Efficiency**, as well as comfort, is related to temperature, and the optimum environmental temperature must be maintained.
- **Cabin pressure** should range from 760-405 mm. of mercury, with 20-40% oxygen.
- **Pilot escape system** has been reliably proved in which a man can survive catapult ejection velocity of 2,548 mph. at 25-mi. altitude, and 1,243 mph. at 50-mi. altitude.

Electromechanical Components and Systems Capability



AIRESEARCH MOTORS OPERATIONAL -425° TO +600°F

Specialized aircraft motors developed by AiResearch operate at temperatures from −425° to +600° F. ambient. The range of this compact, lightweight, ½ H.P. motor is −65° to +600° F.

AiResearch diversification and experience provide full capability in the development and production of electromechanical equipment and avionic controls for aircraft, ground handling, ordnance and missile systems.

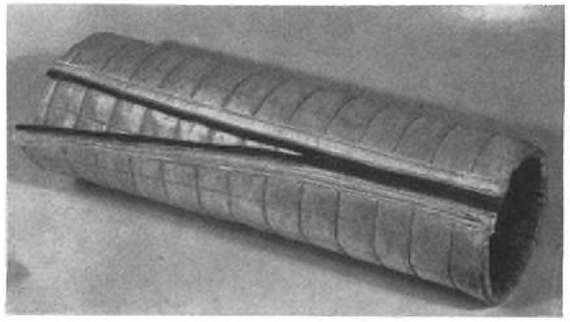
A.C. and D.C. Motors, Generators and Controls • Inverters • Alternators • Linear and Rotary Actuators • Power Servos • Hoists • Electrical Pyrotechnics • Antenna Positioners • Positioning Controls • Temperature Controls • Sensors • Williamsgrip Connectors • Static Converters.

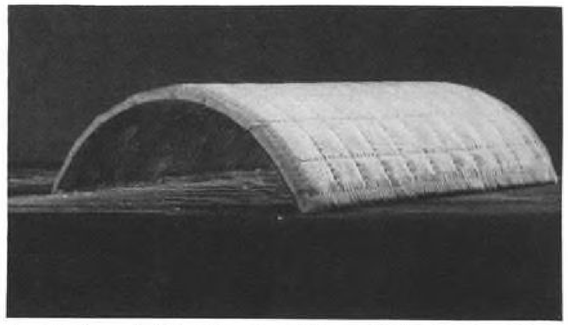
Your inquiries are invited.

THE GARRETT CORPORATION

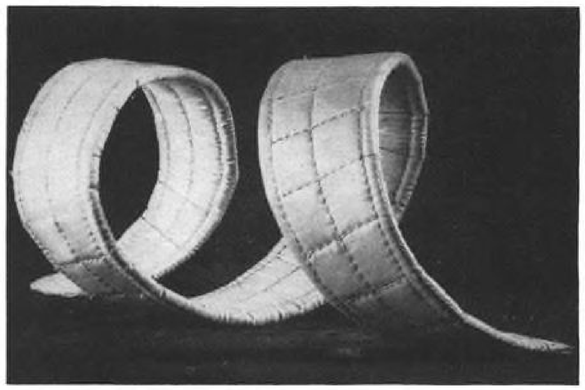
AiResearch Manufacturing Division

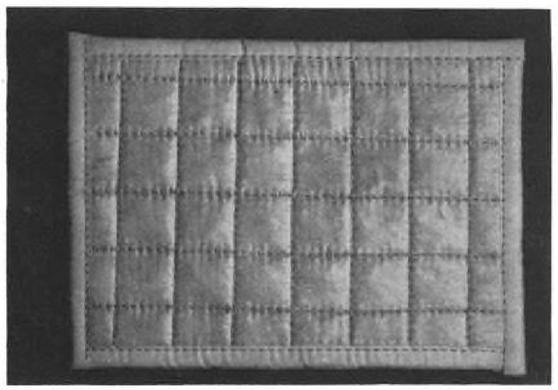
Los Angeles 45, California





FLEXIBLE MIN-K may be fitted with slide fasteners (above left), or bonded to a rigid backing sheet (above right). The insulation, stitched between glass cloth facings, also is furnished in tape form for spiral wrapping about ducts (lower left).





Flexible Insulation Protects Scout Servos

New York—Insulation around the rocket exhaust nozzle of the National Aeronautics and Space Administration Scout research missile is the first application for a flexible-blanket, high-temperature insulating material. The blanket insulation has a thermal conductivity lower than that of still air.

The flexible insulation, called flexible Min-K, is used on the Scout first-stage rocket nozzle to protect the hydraulic control servos for the jet vanes. These temperature-sensitive servos control the jet vanes which guide the missile during the early part of the first-stage flight. Johns-Manville, producer of flexible Min-K, says that the flexible insulation can be supplied in much less time than custom-molded insulation. This enhances the material's potential for use in prototype vehicles. The material is not erosion-resistant in character which limits its use to areas free from blast effects.

The blanket insulating material is a development of the company's Min-K (minimum conductivity), an asbestos-base material which has been available in molded form for about two years. Since its introduction, the molded Min-K series of material has been produced in clad (Min-Klad) and structurally reinforced (Interlok) versions as well as in various densities. The development of the flexible material represents a further broadening of the product line.

Flexible Min-K may be installed and removed with the ease of conventional fibrous insulation, yet has a "K" (Btu. in./sq. ft. hr. deg. F) better than that of a dead air space.

Flexible Min-K is developed from a high-density version of the material called Min-K 1301. The material is stitched between two glass cloth faces with glass thread. The glass thread stitching tends to destroy the insulating integrity of the flexible material which results in a 12% higher "K" than that of the molded product. This will demand somewhat more mass in the flexible material if comparable performance is to be achieved.

This reduction in efficiency is said to be offset by the versatility of the material in all but the most demanding weight/space specifications. Flexible Min-K may be tailored to fit a cylinder, cone or other geometric shape, or it may be furnished in tape form for spiral wrapping around ducts. The blanket material may be bonded to a plastic or metal backing sheet or fitted with slide fasteners to facilitate installation and removal. The company also plans to make the material available with graphite cloth facing for high temperature applications and with silastic-treated glass cloth for water- or vapor-resistance.

The physical properties of flexible Min-K are equivalent to those of Min-K 1301. It is a low diffusivity, low conductivity material and conductivity decreases with reduction in atmospheric pressure.

The flexible insulation has a maximum service temperature of 1,300F. The K of the material is 0.22 at 300F, 0.23 at 400F, 0.26 at 600F and 0.30 at 1,000F. The density of the insulation is 20 lb. per cu. ft.

Maximum service life of Min-K 1301 is 200 hr. at 1,300F, 1,000 hr. at 1,200F and 5,000 hr. at 1,000F temperatures. At the end of the recommended service life, the conductivity will have increased approximately 15%.

Johns-Manville emphasizes that in missile applications service life—most of which can be measured in seconds—has no bearing on the material's usefulness. This also is true of high temperature limits which may be exceeded for transient periods.

Space Vehicle Log

(As of Jan. 1, 1961)

Satellites in Orbit	Name	Source	Launch	Period Min.	Apogee Stat. Mi.	Perigee Stat. Mi.	Transmission[1] Freq. (mc.)	Est. Lifetime[2]
1958 Alpha	Explorer I	US	1 Feb. 58	107.0	1146	217	108-108.03	7-10 yr.
1958 Beta I	Rocket Body	US	17 Mar. 58	138.4	2687	406		200-1,000 yr.
1958 Beta II	Vanguard I	US	17 Mar. 58	133.9	2449	406	108-108.03[3]	200-1,000 yr.
1959 Alpha I	Vanguard II	US	17 Feb. 59	125.4	2049	348	108-108.03	100-250 yr.
1959 Alpha II	Rocket Body	US	17 Feb. 59	129.5	2273	344		100-250 yr.
1959 Delta	Explorer VI	US	7 Aug. 59	Position Uncertain			108.06-108.09	Uncertain
1959 Epsilon II	Capsule (Discoverer V)	US	13 Aug. 59	93.6	431	123		Uncertain
1959 Eta	Vanguard III	US	18 Sept. 59	129.7	2314	316	108-108.03	50-150 yr.
1959 Iota I	Explorer VII	US	13 Oct. 59	101.1	670	344	108-20-40-60[3]	30-40 yr.
1959 Iota II	Rocket Body	US	13 Oct. 59	101.0	661	343		30-40 yr.
1960 Beta I	Rocket Body	US	1 Apr. 60	99.1	465	429		50-100 yr.
1960 Beta II	Tiros I	US	1 Apr. 60	99.1	467	429	108-108.03-235 (video)[3]	50-100 yr.
1960 Gamma I	Rocket Body	US	13 Apr. 60	93.0	351	179		2 yr.
1960 Gamma II	Transit IB	US	13 Apr. 60	95.2	428	231	54-162-216-324	6 yr.
1960 Epsilon I	Sputnik IV	USSR	15 May 60	93.3	364	175	19.995	2-3 yr.
1960 Epsilon III	Metal Object	USSR	15 May 60	93.7	394	172		3-4 yr.
1960 Epsilon IV	Metal Object	USSR	15 May 60	93.3	367	176		Uncertain
1960 Zeta I	Midas II	US	24 May 60	94.3	313	300	[3]	8-15 yr.
1960 Eta I	Transit IIA	US	22 June 60	101.6	650	389	[3]	50-200 yr.
1960 Eta II	Greb	US	22 June 60	101.7	658	381	108[3]	50-200 yr.
1960 Eta III	Rocket Body	US	22 June 60	101.3	638	383		50-200 yr.
1960 Iota I	Echo I	US	12 Aug. 60	117.2	1316	620	108.06-107.94[3]	2-10 yr.[4]
1960 Iota II	Rocket Body	US	12 Aug. 60	118.0	1031	950		4,000 yr.
1960 Iota III	Metal Object	US	12 Aug. 60	118.2	1050	941		2,500 yr.[4]
1960 Iota IV	Metal Object	US	12 Aug. 60	118.2	1044	950		400 yr.[4]
1960 Iota V	Metal Object	US	12 Aug. 60	118.3	1060	940		2,500 yr.
1960 Nu I	Courier IB	US	4 Oct. 60	106.9	768	586	50 (beacon)[3]	200-500 yr.
1960 Nu II	Rocket Body	US	4 Oct. 60	106.4	736	591		200-500 yr.
1960 Xi I	Explorer VIII	US	3 Nov. 60	112.6	1419	259	108	20-50 yr.
1960 Xi II	Rocket Body	US	3 Nov. 60	112.6	1417	259		20-50 yr.
1960 Omicron	Discoverer XVII	US	12 Nov. 60	92.0	346	114		2 mo. (capsule recovered
1960 Pi I	Tiros II	US	23 Nov. 60	98.1	458	378	108-108.03-235-237.8 (video)[3]	200-500 yr.
1960 Pi II	Rocket Body	US	23 Nov. 60	97.9	445	378		200-500 yr.
1960 Sigma	Discoverer XVIII	US	7 Dec. 60	93.2	391	143		uncertain (capsule recovered)

Lunar and Space Probes	Source	Launch	Status	
Pioneer IV	US	3 Mar. 59	Orbiting Sun	960.05
Lunik I (Mechta)	USSR	2 Jan. 59	Orbiting Sun	19.997-19.995-19,993-183.6
Lunik II	USSR	12 Sept. 59	Hit Moon—13 Sept. 59	183.6-39.986-19.993-20.003
Pioneer V (60 Alpha)	US	11 Mar. 60	Orbiting Sun	378 (and 150 watts)

Decayed Satellites		Source	Launch	Down	
1957 Alpha I	Rocket Body	USSR	4 Oct. 57	1 Dec. 57	
1957 Alpha II	Sputnik I	USSR	4 Oct. 57	Early Jan. 58	20.005-40.002
1957 Beta	Sputnik II	USSR	3 Nov. 57	14 Apr. 58	20.005-40.002
1958 Gamma	Explorer III	US	26 Mar. 58	28 June 58	108-108.03
1958 Delta I	Rocket Body	USSR	15 May 58	3 Dec. 58	
1958 Delta II	Sputnik III	USSR	15 May 58	6 Apr. 60	20.005-40.01
1958 Epsilon	Explorer IV	US	26 July 58	23 Oct. 59	108-108.03
1958 Zeta	Atlas (Score)	US	18 Dec. 58	21 Jan 59	132.435-132.905-107.97-107.94
1959 Beta	Discoverer I	US	28 Feb. 59	5 Mar. 59	
1959 Gamma	Discoverer II	US	13 Apr. 59	26 Apr. 59	
1959 Epsilon I	Discoverer V	US	13 Aug. 59	28 Sept. 59	
1959 Zeta	Discoverer VI	US	19 Aug. 59	20 Oct. 59	
1959 Theta	Lunik III	USSR	4 Oct. 59	20 Apr. 60	133.6-39.986
1959 Kappa	Discoverer VII	US	7 Nov. 59	26 Nov. 59	
1959 Lambda	Discoverer VIII	US	20 Nov. 59	8 Mar. 60	
1960 Delta	Discoverer XI	US	15 Apr. 60	26 Apr. 60	
1960 Epsilon II	Rocket Body	USSR	15 May 60	17 July 60	
1960 Lambda I	Sputnik V	USSR	9 Aug. 60	20 Aug. 60	19.995
1960 Kappa	Discoverer XIV	US	18 Aug. 60	15 Sept. 60	
1960 Lambda II	Rocket Body	USSR	19 Aug. 60	23 Sept. 60	
1960 Epsilon VII	Metal Object	USSR	15 May 60	24 Sept. 60	
1960 Epsilon V	Metal Object	USSR	15 May 60	Sept-Oct. 60	
1960 Epsilon VI	Metal Object	USSR	15 May 60	Sept-Oct. 60	
1960 Epsilon VIII	Metal Object	USSR	15 May 60	Sept-Oct. 60	
1960 Epsilon IX	Metal Object	USSR	15 May 60	Sept-Oct. 60	
1960 Mu	Discoverer XV	US	13 Sept. 60	17 Oct. 60	
1960 Gamma III	Metal Object	US	13 Apr. 60	Early July 60	
1960 Theta	Discoverer XIII	US	10 Aug. 60	14 Nov. 60	
1960 Rho I	Sputnik VI	USSR	1 Dec. 60	2 Dec. 60	19.995
1960 Rho II	Rocket Body	USSR	1 Dec. 60	2 Dec. 60	
1960 Zeta II	Metal Object	US	24 May 60	5 Dec. 60	

Notes: 1) Where transmitting frequencies are not given, they are not available; 2) Lifetime estimates recently were considerably revised from the initial Space Vehicle Log (AW Oct. 17, p. 129) as a result of new computations by the National Space Surveillance Control Center; 3) Still transmitting, no video from Tiros I; 4) Approximations only.

Sources: National Space Surveillance Control Center and National Aeronautics and Space Administration.



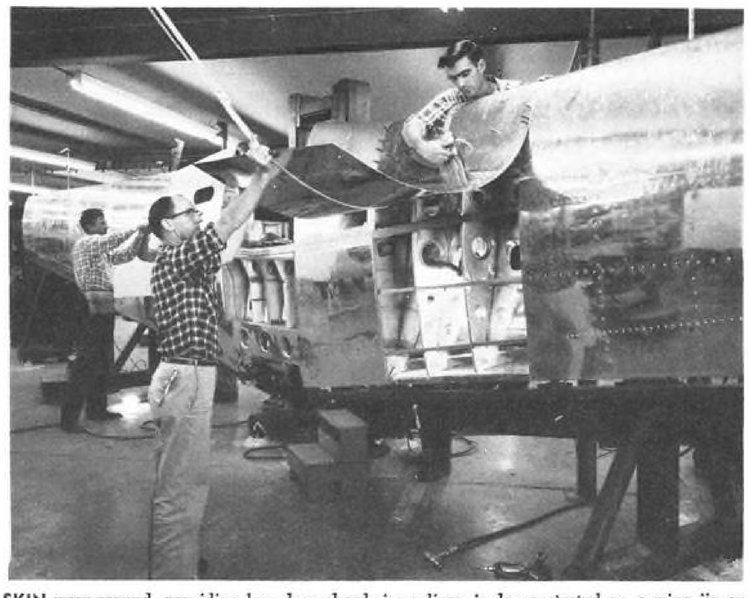
DORSAL fin on the new all-metal Mooney Mark 21 four-place lightplane is most obvious external difference from earlier Mark 20 models. Standard model costs $15,995 flyaway factory. Powerplant is a four-cylinder Lycoming O-360-A1A developing 180 hp.

Mooney Produces All-Metal Mark 21

By Erwin J. Bulban

Kerrville, Tex.—Reorganization of Mooney Aircraft Co.'s engineering and production capabilities here are geared to establishing a rapid growth rate for the business aircraft builder in tune with the business aircraft industry's predicted development over the next decade.

The company provided a tipoff as to its plans during its distributor-dealer meeting at which the new all-metal Mark 21 single-engine, four-place business plane (AW Jan. 9, p. 100) was introduced following months of closely guarded development. "No admittance" signs were posted in its engineering and production line areas to conceal that Mooney had cleared out its wood-working facilities and had switched to 100% metal fabrication.



SKIN wrap-around, providing low drag chordwise splices, is demonstrated on a wing jig on the production line. Wing is the same type as earlier Mark 20s, except for all-metal feature.

Mooney President Hal Rachal said that the changes had brought the company's engineering and production capabilities in line with its sales planning and forecast that in 1961 the Kerrville firm would double its output of aircraft and build up factory personnel by approximately 150 persons this year to bring the total to 300. He said that on the basis of current expectations, employment here will probably increase at the rate of approximately 150 per annum for the foreseeable future.

Rachal said that 330 Mark 21s are being programed for 1961 and predicted that this figure could double in 1962. At the present rate of production and sales volume, he believed that close to 4,000 of the single-engine four-placers will be built in the next five years.

Providing some perspective of what this growth entails for Mooney, the company previously had built approximately 700 of the earlier wood-wing Mark 20s from late 1955 through 1960.

Dollar Volume

For 1961, Rachal expects Mooney dollar volume to increase to $4.5 million in 1961, compared with approximately $2.5 million last year and in 1962 he believes that the company will attain over $7 million. He said that the company is aiming to be high up in the current Big Three (now held by Beech, Cessna and Piper) in the next 20 years.

Rachal explained the switch to all-metal construction by saying that last April management had come to the conclusion that continuing to build the Mark 20 of mixed metal and wood construction would result in a production bottleneck that would seriously limit the company's future growth because of the time-consuming laminating process involved in the airplane's wooden wing and the difficulty in obtaining highly skilled workers in wood.



CERTIFICATION by Federal Aviation Agency for Mark 21 model is presented to Mooney President Hal Rachel, standing at center; at left is Ralph Harmon, vice president and chief engineer. Presentation was made at Mooney's annual distributor-dealer meeting.

Production Flexibility

Greater production flexibility provided by metal construction—where, once necessary tooling was developed, output could be more readily adjusted up and down—and availability of large number of experienced metal workers favored the decision to make the switch.

At a top-level management meeting, Vice President-Chief Engineer Ralph Harmon was asked if the basic Mooney Mark 20 could be built as an all-metal airplane without compromising performance. His decision was "yes" and management embarked on the necessary financing to convert wood-working operations to metal.

Expenditure of some $250,000 was required for engineering, tooling and new machines. The new model, though basically the same design, was redesignated Mark 21 because of the major engineering changes, although technically it carries the designation Mark 20B.

Externally the new Mark 21 at first glance seems to be a direct copy of the previous model, except for the addition of a small dorsal fin. And at first appraisal, substitution of a metal for a wood wing would not appear to be a major development, although pilots who have flown the new airplane remark that it appears to display improved handling characteristics, particularly in stalls, which the engineers find difficult to explain since the physical dimensions and aerodynamic layout of the previous wing were faithfully retained. They attribute improved flight characteristics possibly to the fact that the metal structure provides greater structural stiffness, with the shear-resistant spars retaining skin contours with hardly noticeable wrinkling even at ultimate load.

They know that the Mark 21 has better ground handling characteristics, which they say is due to the fact that reduced flex of the metal wing resists tendency of the landing gear to "walk" over the ground and so provides smoother taxiing and less bobbing than was apparent with earlier Mark 20s.

In tackling the conversion to metal, Harmon's design team attempted to

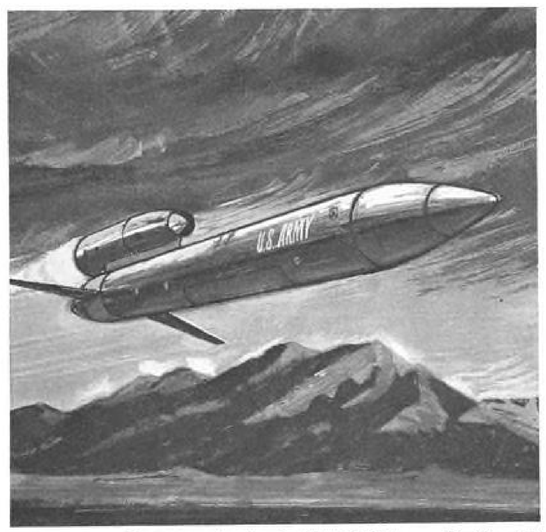


INSTRUMENT panel has all communications equipment centered. Landing gear actuation lever is in center, protruding from the floor; flap handle is immediately to the right.

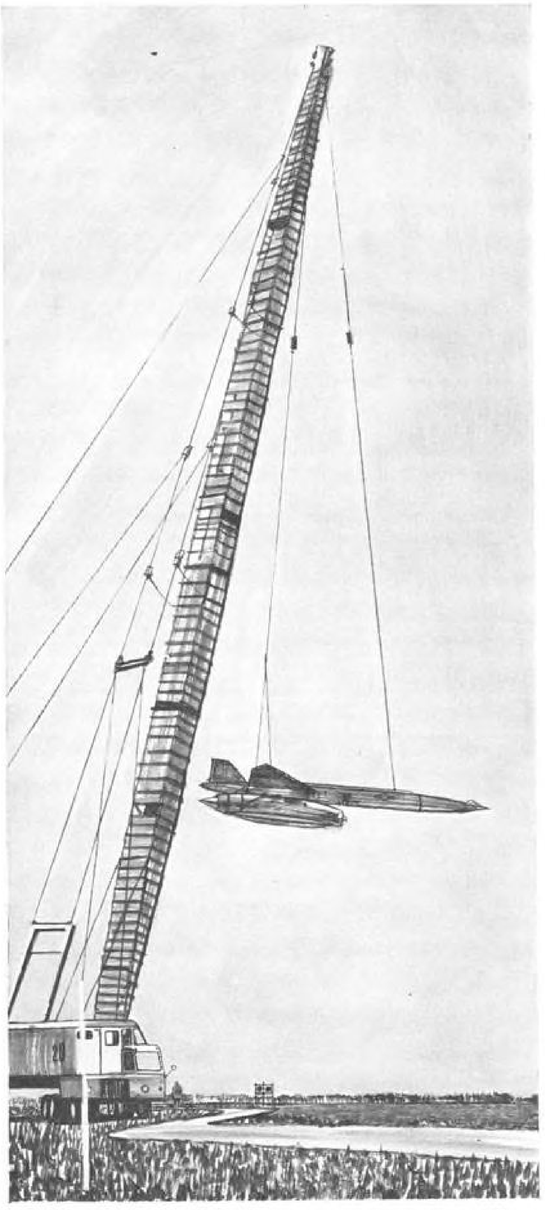
This is systems capability at NAA-Columbus

Many of the significant advances in electromechanics, electronics systems, environment systems, and other areas, were originated and brought to fruition at the Columbus Division of North American Aviation. A complete center of advanced systems technology, the Columbus Division has the minds and facilities to convert original concepts into practical hardware with economy and efficiency. This is true systems capability... this is the Columbus Division.

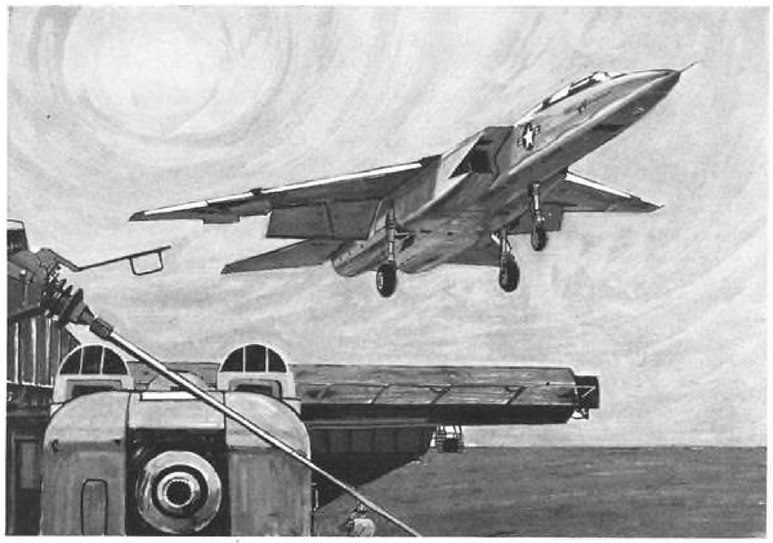
THE COLUMBUS DIVISION OF
NORTH AMERICAN AVIATION, INC.
Columbus, Ohio



TWO IN ONE. New target missile NA-273 (Army Redhead/Roadrunner), designed by Columbus, can fly high or low, at subsonic through Mach 2 speeds. It is launched by solid propellant booster rocket, and ramjet powered.



ELECTRONIC TESTING. Air Force's GAM-77 Hound Dog, on 120-foot crane, undergoes stringent radar reflectivity tests at Columbus as part of research projects in both airborne and ground support electronic systems.



A3J VIGILANTE. World's most versatile Mach 2 airplane, the A3J is small enough to land on a carrier deck, yet potent enough to pack a heavyweight punch. The A3J can perform attack, interception, or reconnaissance missions at deck level or up in the stratosphere. It is being built for the Navy by the Columbus Division.



V/STOL FACILITIES. New six degree of freedom flight simulator is part of facilities set up by Columbus to study requirements of vertical and short takeoff and landing aircraft design and development. Other V/STOL facilities include low-speed to transonic wind tunnel and unique lightweight ejection seat.

1961 Mooney Mark 21
FAA Type Certificate 2A3

Maximum gross weight	2,450 lb.
Empty weight	1,490 lb.
Maximum baggage capacity	120 lb.
Wing loading	14.7 psf.
Power loading	13.6 lb./hp.
Maximum air speed (gross weight)	190 mph.
Maximum cruise speed (75% power @ 2,400 rpm. @ 7,500 ft.)	180 mph.
Optimum cruise speed (67% power @ 2,300 rpm. @ 7,500 ft.)	172 mph.
Economy cruise speed (55% power @ 2,200 rpm. @ 10,000 ft.)	164 mph.
Stall speed (power off, landing gear and flaps down)	57 mph.
Rate of climb (sea level)	1,150 fpm.
Best normal climb speed (indicated)	105 mph.
Service ceiling	20,000 ft.
Normal range (at 9,000 ft., no reserve)	915 mi.

take advantage wherever possible of available state-of-the-art techniques used in jet tactical and transport aircraft, that would also lend themselves to most economical production.

The new wing is built in one piece, with continuous main spar having spar caps extruded from 7075 T-6 aluminum alloy assembled so as to form a Z cross-section 11 in. deep. To maintain maximum airflow integrity, wing skins are stretch-formed and wrapped around the wing, eliminating spanwise skin laps. Only spanwise skin lap is in the fuel tank area where the skins are spliced flush. Riveting is all flush from the leading edge rearward to a point where airflow drag is at a minimum. The structure uses a considerable number of stampings and extrusions to cut costs; extrusions are ordered in custom shapes in long lengths, which can be cut to desired sizes and gang-milled to make desired quantities.

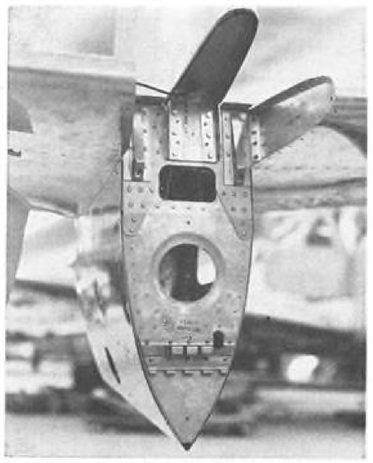
Six Jigs

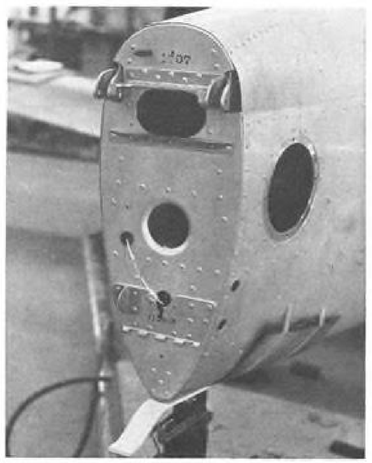
The wing is constructed on six assembly jigs and these pieces are then transferred to a final assembly jig. Jigs are optically leveled and aligned to retain close tolerance fits of parts and to ensure spars will true up when mated.

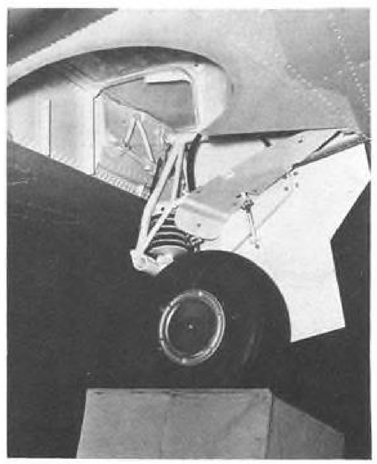
Ailerons and flap hinges are machined from extrusions and incorporate metal seals to maintain close-gap connections and reduce airflow through these sections that could cause drag.

All structural portions of the wing are Turco-treated to resist corrosion, with the main spar being treated with a coating of zinc-chromate primer as an additional protection.

Important feature of wing makeup is







FORWARD face of movable tail cone (left) incorporates multiple load paths to distribute stresses. At center is the fuselage rear, showing heavy attach points for moving tail cone. Main gear tie-in to rear of main spar is detailed in photo at right.

incorporation of integral fuel tanks, providing a so-called "wet wing." Integral fuel system, which has been studied by Beech for possible use on the Bonanza, comprises two tanks on the forward portion of the wings near the roots and have a usable capacity of 49 gal. Sealing compound isolates fuel within the tank area and a check on tank integrity is said to be accomplished simply by coating the joints with soap and applying compressed air to spot leaks. Tank integrity is protected structurally against hard landings by isolating loads from the main landing gear support via a stamping that attaches aft of the wing spar web. Actual landing gear bushings are designed so that the gear will tear loose if shock is severe, rather than permit it to puncture the tank area.

Fuel Feed

Aluminum lines feed fuel from the integral wing tanks to a two-way positive-setting Republic Products selector valve, which uses a Teflon core to resist wear and eliminates the tendency to freeze up as do brass valves, according to Mooney.

Very little change has been made in the fuselage section, except in redesign of some detail parts to speed production and reduce costs. The tail cone has been redesigned for greater strength. This cone, which carries the vertical and horizontal tails, and provides trim by movement of the entire empennage, now embodies a reinforced multiple-bulkhead construction to handle all tail loads. Heavy, machined metal hinges are attached to the tail cone by Huck bolts, Hi-Shear rivets and Hi-Lock fasteners.

Tail cone and attachments are designed to take advantage of dual load paths to lessen stress concentrations and provide fail-safe construction. Even the screw jack assembly, which actuates the tail cone and empennage by means of a torque tube from the pilot's trim wheel, is provided with a dual load path by means of a bolt set inside the screw and the ball bearing box is designed to retain the bearings even if they should fail. A short-coupled piano-type hinge, which attaches the lower tail, absorbs the effects of asymmetrical tail loads caused by gusts and keeps the trim screw-jack unloaded from side loads. There are a total of five heavy hinges connecting the tail. Tail attaching hinges and bolts are reamed to close tolerances to resist end play.

Like the wing, the tail surfaces employ wrap-around skins parallel to the airflow and control surfaces are sealed against air leakage by means of curved metal gap strips butting against the bead

Price List — Mooney Mark 21

Standard airplane (flyaway factory)	$15,995.00*
Price with optional equipment packages:	
Package A (rate of climb indicator, turn-and-bank indicator, Narco VHT-3 Superhomer with nine crystals)	16,785.00
Package B (rate of climb indicator, turn-and-bank indicator, directional gyro, artificial horizon, vacuum system, suction gage, clock, Narco Mark II Omnigator with 29 crystals	17,941.50
Package C (Same as Package B, but less Mark II radio and with King KX-100 and KL-200 omni)	18,534.50
Package D (Same as Package B, less Mark II radio, plus Narco Mark V with omni, Narco ADF-29)	19,235.50
Package E (Same as Package B, less Mark II radio, plus Motorola Nav-Com 100 with omni, Motorola (ADF-T-12)	19,309.50
Miscellaneous equipment available:	
Hunter true airspeed indicator	275.00
Heated pitot	60.00
Grimes G-8400-8-12 rotating beacon	150.00
Grimes G-7080-1-12 rotating beacon	115.00
Curtains	50.00
Sun visors	25.00
Mooney ambulance kit (stretcher and straps)	60.00
Outside air temperature gage	9.50

* Standard Mark 21 equipment includes: Stainless steel engine muffler, 50-amp. generator, tow bar, de luxe reclining seats, tinted glass, dual controls, acrylic paint in choice of four designs, night lights with rheostats, sealed beam landing lights, map reading light, navigation lights, overhead ventilation controls, tachometer, manifold pressure gage, ammeter, fuel pressure gage, fuel quantity gage, oil temperature gage, oil pressure gage, cylinder head temperature gage, mixture control, Bendix magneto and starter switch, electrical master switch, carburetor heat control, electrical fuel boost pump, defrost controls, side map pocket, four ash trays, lighted magnetic compass, airspeed indicator, sensitive altimeter, stall warning horn.



FINAL assembly line at Mooney Aircraft is geared to one-a-day production of Mark 21 all-metal planes, with this schedule forecast to double in a few months. Mooney expects to have a work force of 500 persons this year; 300 Mark 21s are programed.

protruding from the hollowed extrusions that form the leading edges of the rudder and elevators.

Landing gear is similar to the previous Mark 20A, with the exception of heavier retraction tubes, incorporation of grease fittings and installation of new over-center springs that positively force the down-lock mechanism into place when the gear is lowered. Tooling of gear attachment fittings and joints are slightly revised to provide higher degree of precision in making parts, providing smoother operation of the system and ensuring that future spars will mate.

In engineering the new wing, the spar was moved rearward, providing some 4.5 in. additional room in the cabin. Front seats are fitted with tapered reclining seats. Airplane is painted over-all with high-gloss acrylic enamels as standard. Paint schemes and interior were designed by Fred M. Gore, industrial designer of Dallas, Tex.

Powerplant

Powerplant is the latest version of the four-cylinder Lycoming O-360-A1A, developing the same 180 hp. as the previous model on the Mark 20A, but incorporating tapered, chemically hardened cylinder balls, improved piston rings and 180-deg. oil temperature thermostat to provide optimum oil temperatures in all flight regimes and provide better vaporization of fuel-air mixture in the intake manifold. The new Bendix S-200 "shower of sparks" type magneto system is fitted; also standard is a 50-amp. Delco-Remy generator and 12-v. Delco-Remy starter. An Airborne Mechanism Model 113 dry-type vacuum pump has been incorporated to eliminate oil stains on the fuselage.

Initial deliveries of the new Mark 21 begin this month and the company is scheduling production at a one-a-day rate for several months, boosting this to two daily in several months. Company reports that its order backlog on the new model extends into July production schedules.

Mooney plant rework extended beyond building new jigs and tools. For example, the engineering department decided to lift a trick from the "big-plane" builders and provide production with dimensionless drawings from which templates are made using light sensitive emulsions sprayed on metal and transferring the drawings to metal via ultraviolet light exposure. It is expected that this system, minus the usual tolerances marked on standard drawings, provides error-free transfer and ensures that tolerances do not build up to where parts do not fit readily.

Mooney also has set up International Business Machines Model 402 equipment that is used for analyzing shop costs and inventories—every part that leaves the stock room, for example, falls under IBM control, providing key personnel with ready access to analytical data from which corrections can be made in procedures for further cost savings. One idea under consideration is to develop a shop personnel badge which can be coded so that workers can transfer IBM-usable coded information directly to work orders so that it need not be translated later before insertion in the 402 system.

Re-engineering of the Mark 21 was done with future designs in mind—the new structure provides the four-placer with considerably more growth potential than the previous Mark 20 series had. But Ralph Harmon is quick to point out that management is set on staying out of the "horsepower race" and the company's major engineering aim is to constantly seek aerodynamic and power refinements that will enable it to match competitive performance with less power and at a lower price.

Harmon, who was largely responsible for the Beech Bonanza—considered by the industry to have provided the four-place business airplane with a major design breakthrough in the postwar era in performance and efficiencies—says that he will seek to repeat this performance at Mooney in the future. He feels that it can be done, not by radical design or big engines, but by capturing the best possible combination or available-state-of-the-art knowledge distilled out of the costly research and development financed by the services for new military aircraft. These ideas, which though commonplace in the jet aircraft industry, represent well-advanced procedures to the business airplane field and are just waiting for someone to meld them properly he says.

Engine Improvements

Harmon believes that a considerable future is in store for the small piston engine and that improvements can be made here in fuel consumption, weight, installation and performance that can provide good gains at low cost to the manufacturer with important performance increases for the potential customer. Harmon also feels that engineers have to consider that more and more small business plane operations will be operating in the 10,000-12,000-ft. altitude regime in the decade ahead and design accordingly.

It appears that Mooney has decided to put off its earlier plans to enter the light-twin field for several years, and will wait until it can provide a breakthrough that will stand out markedly from the heavy current competition in this field. It has scrapped the Mark 20 twin-engine conversion it had been using as a testbed.





GREAT ENCOURAGEMENT FOR SEAMEN.



ALL GENTLEMEN SEAMEN and able-bodied LANDSMEN who have a Mind to diſtinguiſh themſelves in the GLORIOUS CAUSE of their COUNTRY, and make their Fortunes, an Opportunity now offers on board the Ship RANGER, of Twenty Guns, (for FRANCE) now laying in PORTSMOUTH, in the State of NEW-HAMPSHIRE, commanded by JOHN PAUL JONES Eſq; let them repair to the Ship's Rendezvous in PORTSMOUTH, or at the Sign of Commodore MANLEY, in SALEM, where they will be kindly entertained, and receive the greateſt Encouragement.---The Ship RANGER, in the Opinion of every Perſon who has ſeen her is looked upon to be one of the beſt Cruizers in AMERICA.---She will be always able to Fight her Guns under a moſt excellent Cover; and no Veſſel yet built was ever calculated for ſailing faſter, and making good Weather.

Any GENTLEMEN VOLUNTEERS who have a Mind to take an agreable Voyage in this pleaſant Seaſon of the Year, may, by entering on board the above Ship RANGER, meet with every Civility they can poſſibly expect, and for a further Encouragement depend on the firſt Opportunity being embraced to reward each one agreable to his Merit.

All reaſonable Travelling Expences will be allowed, and the Advance-Money be paid on their Appearance on Board.

IN CONGRESS, MARCH 29, 1777.

RESOLVED,

THAT the MARINE COMMITTEE be authoriſed to advance to every able Seaman, that enters into the CONTINENTAL SERVICE, any Sum not exceeding FORTY DOLLARS, and to every ordinary Seaman or Landſman, any Sum not exceeding TWENTY DOLLARS, to be deducted from their future Prize-Money.

By Order of CONGRESS,

JOHN-HANCOCK, PRESIDENT.

DANVERS: Printed by E. RUSSELL, at the Houſe late the Bell-Tavern.

GREAT REASSURANCE FOR AMERICANS

NAVAL 50th ANNIVERSARY 1911 1961 AVIATION

24 hours a day, 365 days a year—the U.S. Navy stands watch over our precious peace.

It takes men. And lots of them. Such men as sailed the Ship RANGER in 1777. The breed hasn't died out. The free world sees them today serving with U.S. Naval Aviation. They are the watchful eyes along our shores, across the seas and in the sky. They are great reassurance for all Americans.

In this 50th year of Naval Aviation, careers are more varied and more rewarding than ever before. Airmen who qualify will fly some of the world's finest airplanes. Chances are they will have been made by Grumman—a name that has reassured Navy pilots for 30 years.

Peace takes a lot of watching. The men of Navy Aviation are doing just that.

Earliest known recruitment "poster" dated 1777, for service in the U.S. Navy with John Paul Jones

GRUMMAN

AIRCRAFT ENGINEERING CORP.



Radar Transmitter FPS-35

For the security of our nation

The AN/FPS-35 Radar Search Set is an integral part of America's security defense network. This massive sentinel stands in vital areas protecting the nation.

FXR is the designer and developer of the Line Modulator, the key block in the transmitter complex. High level engineering combined with complete precision facilities produced the answers to the unique problems encountered.

Solutions to the most exacting specifications are the foundation of FXR's service in High Power Electronics. The solution to your particular problem is but a phone call away. Just call and ask for an FXR applications engineer to discuss your needs.

FXR, Inc.

Design • Development • Manufacture

25-26 50th STREET • RA. 1-9000
WOODSIDE 77, N. Y. • TWX: NY 43745

*for ultimate reliability**

On Mark JET STARTER COUPLINGS

are now standard on **TWA BOEING 707**'s

— qualified for all commercial jet aircraft



*Warranted for a full 6 months field service.

On Mark COUPLINGS, INC.

4440 York Boulevard, Los Angeles 41, California
Telephone: CLinton 4-2278

REPRESENTATIVES: AIRSUPPLY-AERO ENGINEERING
Division of the Garrett Corporation
Beverly Hills, Calif.; Mineola, Long Island, N.Y.; Indianapolis, Ind.
The Garrett Corporation of Canada, Ltd., Montreal, Canada

WHO'S WHERE

(Continued from page 23)

Changes

Pierre A. Portmann, assistant director, Research and Development Directorate, Page Communications Engineers, Inc., a subsidiary of Northrop Corp., Washington, D. C.

Elby Martin, marketing manager-advanced technologies, Central Staff Marketing, Texas Instruments, Inc., Dallas, Tex., and **W. R. Bailey,** in charge of the newly formed TI Apparatus Division, Special Products Department.

Vernon Weihe, director of the newly formed Advanced Systems Planning Group of General Precision, Inc., with headquarters in Washington, D. C.

Dr. Alva C. Todd, director of applied research for military products, the Hallicrafters Co., Chicago, Ill.

Marsden L. Lytle, assistant to the chief engineer, Space Electronics Corp., Glendale, Calif.

Norman J. Regnier, manager-military relations, International Rectifier Corp., El Segundo, Calif.

Robert D. Calvert, general manager, Electro-Mechanical Division of Lear, Inc., Grand Rapids, Mich.

William P. Maughan, Midwest regional manager (Dayton, Ohio), Systems Marketing Division of Laboratory for Electronics, Inc., Boston, Mass.

Ronald J. Hurley, general manager, Acoustica Division of Acoustica Associates, Inc., Los Angeles, Calif.

George M. Cooley, senior analytical engineer, and **Ronald D. Curtis,** senior project engineer, Fafnir Bearing Co., New Britain, Conn.

D. L. Larson, systems engineering manager, and **W. G. Williamson,** operations research manager, Industrial Engineering Department, United Air Lines.

James R. Miller, production manager, SKF Industries, Inc., Philadelphia, Pa.

Louis J. Bruno, government relations representative, Philco Corp.'s Lansdale (Pa.) Division, with headquarters in Dayton, Ohio.

Dr. George Caryotakis, manager of the newly formed High-Power Laboratory, Eitel-McCullough, Inc., Belmont, Calif.

William P. Murden, Jr., deputy director of OMEGA (Operations Model Evaluation Group Air Force), Technical Operations, Inc., Burlington, Mass.

Kendell Oulie, director of planning, The Garrett Corp., Los Angeles, Calif.

R. L. Bentley, assistant to the vice president-marketing, Avco Corp.'s Research and Advanced Development Division, Wilmington, Mass., and **R. P. Conniff,** manager of re-entry vehicle sales.

George H. Scott, corporate director, Industrial Relations Office of Chance Vought Corp., Dallas, Tex., and **N. B. Molinarro,** corporate labor relations director, and **Wayne F. Comer,** Mr. Scott's staff assistant. Also: **J. B. Andrasko,** industrial relations manager, Industrial Relations Department of Vought Astronautics Division.

Roland T. Volker, assistant sales manager, Precision Parts Division, Ex-Cell-O Corp., Detroit, Mich.

ARDC-Europe Stressing Space Research

By Cecil Brownlow

Brussels—European office of USAF's Air Research and Development Command currently is marshaling European scientific talent to bolster over-all U. S. efforts in the realm of manned space flight.

Concentrating on basic research areas that have been largely overlooked within the continental U. S. and where results can be obtained through a maximum of effort and a minimum of time, EOARDC is placing particular emphasis upon the biosciences and metallurgy within the space field.

As space technology has progressed, explains Col. Robert G. Moll, the center's deputy commander, "we have found tremendous gaps in our (bioscientific) knowledge. We are making equipment to put a man in space, and now we find we may have to build a new man to go with it."

EOARDC hopes to make its contribution toward finding some of the needed answers with such studies as "Response to Pain" under way in Belgium, "Biophysical and Neurophysiological Studies of Nerve" in Sweden, "Study of Spinal Reflex Response During Stress and Fatigue" in Italy, "Research on Drugs on Neural Transmission" in England and "Human Performance as Indicated by Analysis of Nervous Function" in France.

Metallurgy studies include work on fatigue problems, radiation effects, thermal stresses and structural chemistry.

European scientists, one officer here says in explaining the need for such programs, are often more willing to look at the minutiae of an over-all problem than are their American counterparts.

"The Europeans," he says, "have a unique scientific talent as individual investigators and are willing to take a long look at a small part of the big problem —something which we have little time for in the U. S."

"These people," another adds, "are not necessarily production oriented. Their desire is often strictly limited to a scientific search for knowledge."

EOARDC's interests, however, are by no means confined to space research. Basic research proposals in almost every area of interest to the Air Force are sought and welcomed.

The office is monitoring 415 active contracts in 12 fields for several Air Force research agencies at a total cost of slightly more than $11 million. Another 96 proposals have been approved but not yet contracted, and 78 others are under evaluation. Biggest customer is the Air Force Office of Scientific Research in Washington with 180 contracts—68 of them in bioscience—valued at approximately $3.6 million, followed closely by the Cambridge Research Laboratories with 121 valued at $3.5 million.

Average cost of contracts awarded through EOARDC is about $12,000, ranging from lows of $1,200 to highs of about $80,000. Officials here estimate that a contract let within Europe can be completed at approximately one-third the cost of a similar project inside the United States.

Well over 90% of the contracts are with universities, or individual scientists within the universities, and, although latitude in approach and subject matter is often allowed, none is let unless it is approved and funded by Air Force research centers within the United States and falls within the confines of a specific research goal under study.

Primary search is for areas where knowledge is needed but where there is little or no specific work under way in the United States. If, for example, the European office should forward a proposal to the United States and find that a similar one had been made by an American university, the former would be immediately withdrawn.

"The ideas we accept for study don't always have to be something we aren't

Summary of Active EOARDC Contracts

(and sponsoring agencies)

FIELD	AFCRL		AFOSR		RADC		WADD		ARL		OTHER	
	No.	$ Value	No.	$ Value	No.	$ Value	No.	$ Value	No.	$ Value	No.	$ Value
Bioscience			68	1,407,235			6	61,084			4	45,108
Chemistry			22	439,814			8	101,650	15	329,318		
Electronics	37	1,233,537			14	1,632,244	3	35,691			1	68,500
Geophysics	78	2,162,540			1	24,933						
Materials			1	12,208			19	453,863	2	38,000	1	80,000
Mathematics			15	144,390					1	42,794		
Mechanics			29	435,610			6	186,195	4	43,735	1	47,700
Metallurgy			6	170,778			3	52,120	4	195,913		
Physics	5	85,904	25	564,638			1	23,000	17	536,302	1	5,185
Propulsion			3	104,646					1	15,000		
Solid State Sciences			11	327,854								
Special Projects	1	5,000			1	35,250						
TOTAL	121	3,486,981	180	3,607,173	16	1,692,427	46	913,603	44	1,201,062	8	246,493



A REVIEW AND PREVIEW OF WORLD-WIDE AEROSPACE DEVELOPMENTS

Aerospace industry developments have captured the imagination and thinking of scientific-military, government and industry planners everywhere . . . commercial space applications . . . weather, navigation and recoverable satellites . . . supersonic transports . . . molecular electronic circuitry . . . nuclear powered aircraft and missiles . . . jet powered business aircraft.

These dynamic leaps in technology affect the progress of thousands of U.S. companies in practically every phase of U.S. industrial activity. Interpreting these developments is vital to our industry's economic welfare and demands specialized analysis.

Once a year . . . for 27 years . . . industry decision-makers turn to the industry's top technical reporting team and the "Inventory of Aerospace Power" for the answers. The "Inventory Issue" has won unmatched respect and reputation as the authoritative review and preview of national and international aerospace developments.

CONTENTS OF THE INVENTORY ISSUE

Charts, graphs, tables, specifications will cover in detail, budgets, missiles, avionics, manufacturing, engineering and many more areas of military and civil aerospace activities. AVIATION WEEK's 37 man editorial staff of graduate engineers and aerospace specialists will collect, sift, analyze and interpret the significance of hundreds of technical and market developments.

ADVERTISER BENEFITS

Intense reader interest generated by past issues and vital editorial content make the "Inventory Issue" an ideal advertising opportunity. As in the past, reader service cards will be included to enable subscribers to easily contact advertisers for additional information. Reader service cards in the 1960 issue generated over 8,500 inquiries in seven months demonstrating long-life of "Inventory Issue" advertisements.

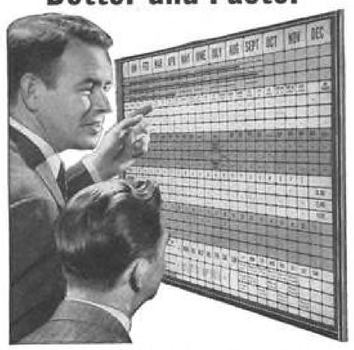
To reach over 82,000 key engineering-management men, write, wire or phone collect your AVIATION WEEK District Manager for more complete information. Regular advertising space rates apply.

Aviation Week
and ***Space Technology***

A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y.

PUBLISHING DATE: MARCH 13, 1961

How To Get Things Done Better and Faster



BOARDMASTER VISUAL CONTROL

- ☆ Gives Graphic Picture—Saves Time, Saves Money, Prevents Errors
- ☆ Simple to operate—Type or Write on Cards, Snap in Grooves
- ☆ Ideal for Production, Traffic, Inventory Scheduling, Sales, Etc.
- ☆ Made of Metal. Compact and Attractive. Over 500,000 in Use

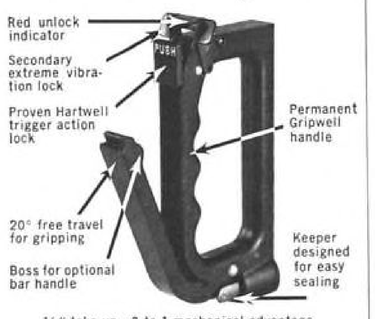
Full price $49.50 with cards

FREE 24-PAGE BOOKLET NO. GK-10 Without Obligation

Write for Your Copy Today

GRAPHIC SYSTEMS
YANCEYVILLE, NORTH CAROLINA

WHEN QUALITY IS YOUR TARGET
THE GRIPWELL ELECTRONIC CHASSIS LATCH HELPS YOU HIT THE BULLSEYE



½" take-up • 8 to 1 mechanical advantage

GRIPWELL® ELECTRONIC CHASSIS LATCH

A handsome, strong and durable handle latch to fasten "plug-in" type electronic chassis, providing for positive ejection and injection of the chassis and allowing an eight to one mechanical advantage, with a total one-half inch take up.

Write today for complete information

THE HARTWELL CORPORATION
9035 VENICE BOULEVARD, LOS ANGELES 34, CALIF.
Offices:
Chicago • Ft. Worth • Hackensack • Seattle • Wichita

looking into at all in the States, but it certainly should be a fresh approach," one officer says.

"Our biggest payoff here," he says, "has been to give us [the Air Force] something of a global picture of what's going on in basic research as opposed to the bird's eye view we get at home."

Generally, the contracting officers are seeking proposals or research projects already under way that readily adapt themselves to Air Force needs rather than generating requirements to fit these needs and then seeking out capable scientists to carry them out. Col. Paul F. Nay, EOARDC commander, says:

Relative Freedom

"What we are trying to do here is to let the scientist do what he wants to do provided the Air Force wants or needs the results. We normally don't try to tell a man what to do or how to do it."

Such leeway can be provided with little apprehension for two basic reasons: it is required for effective work in the basic research field, and the scientists with which the Brussels office deals are among the best in Europe and are capable of completing their programs with little or no monitoring from above.

End product of roughly 99% of the contracts is a final report, although on occasion—particularly in electronics—a piece of hardware emerges, and in these cases the dollar flow can sometimes be reversed as a result of new production for U. S. industry. Under terms of the EOARDC contracts, the Air Force receives a royalty-free license for production of any hardware that might evolve, and, if it is put into production, it normally would be manufactured in the United States. There have been instances, however, where fully-developed pieces of equipment produced in prototype form in Europe have been turned over to U. S. firms who have found that they could not adequately reproduce the equipment.

The impact of EOARDC's contribution since its founding in 1952 is almost impossible to evaluate in terms of any specific reference or achievements to date because of the nature of basic research where visible fruits may be long in appearing.

Data obtained here becomes part of a broader, integrated program.

Funding Uncertain

The importance of basic research per se is hard to define and difficult to explain to a layman or a production-oriented official, and it invariably suffers a proportionately large slash whenever military funding becomes tight. In the dollar-short days of late 1957, the Air Force Office of Scientific Research was threatened for a time with extinction (AW Sept. 16, 1957, p. 27).

Add to this the fact that EOARDC, a basic research agency, is operating in Europe at a time when U. S. political leaders are saying that all possible dollars must be spent at home, and the peril to its continuance becomes clear.

Referring to the dollar shortage, one planning official says that, for the moment, "we have no idea where this business is going to go over here. We conceivably could be cut off tomorrow."

He and his colleagues are convinced, however, of the importance of the work being conducted here—and the research void it fills—and believe the office's effort should at least be allowed to level off at a pace approximating that of Fiscal 1960 when 303 contractual actions were completed at a cost of about $4.8 million.

One possible method foreseen, or hoped for, by some officers to continue the pace here at the current level without biting deeply into dollar stocks would be to make available U. S. "counterpart funds" stored in the various nations involved as a means of paying the office's contractual expenditures.

These funds have been built up over the years through the purchase of surplus U. S. equipment or other items with the local currency of the nations concerned. Under law, these funds—and in some countries they are substantial—cannot be used by agencies such as EOARDC, which pays its bills in local currency, or by the respective embassies and consulates. They can be used for certain purchases of property and by touring congressmen, who can draw upon the funds at will.

Any broadening of the use of these "counterpart funds" would require the approval of Congress.

Organized in 1952

Established in 1952 at a time when the climate was admittedly somewhat different from that found in the robust Western Europe of today, EOARDC began functioning on a significant basis in Fiscal 1955 after its needs had been made known, proposals submitted and evaluated.

In Fiscal 1955, 47 contracts were awarded through the office with a total value of $450,000. By Fiscal 1957, the figures had climbed to 141 and $1.4 million respectively. Then the Soviets startled the United States with Sputnik I and, in Fiscal 1958, EOARDC activity spurted to 243 contracts with a value of $3.1 million. Since this time, it has inched in progressive steps to its present level.

To avoid obvious security pitfalls, all contracts are let on an unclassified basis, and full reports of the work are made available to the governments of the respective countries in which the work has been conducted. The scientists also are encouraged to submit their findings to various scientific journals for possible publication.

This entails some risk of aiding the Soviets in their work along parallel fields, but EOARDC officers believe such help is minimal at best. In the first place, it is difficult if not impossible to envelop basic research activities in secrecy as you might endeavor to do with a weapon system. In the second place, as Col. Nay explains:

"Since we are sponsoring the research, we know specifically what we want out of it and what we want to do with it. The Russians may see the reports in technical journals, but they may not know what to do with it. We're still trying to figure out applications for some of the German research material we captured in World War II."

Geographically, the programs range from Norway to Italy to Africa—(one contract) to Turkey. Nations with the most representation in the program are France with 38 contracts valued at $2.5 million, the United Kingdom with 101 at $1.9 million, Germany with 61 at $1.7 million, Sweden with 54 at $1.6 million and Italy with 48 contracts valued at approximately $1 million.

Types and areas of research are as varied. A sampling of current projects includes:

- **Infrared** and far infrared spectrum of the sun—University of Liege, Belgium.
- **Torsion and plate problems**—University College, Cork, Ireland.
- **Polar radio communication** blackout phenomenon—Norwegian Defense Establishment, Oslo.
- **Research on ferro-resonant computer** and control devices—Ciudad University, Madrid.
- **Arctic geomagnetic research**—Danish Meteorological Institute.
- **Self demodulation of radio waves** in the ionosphere—Physics Institute, Naples, Italy.
- **Heat vibration** in solids by means of X-rays—University of Athens, Greece.
- **Excited states** of light atomic nuclei—University of Strasbourg, France.
- **Gravitational waves** emitted by a material system—Technion Research & Development Foundation, Haifa, Israel.
- **Thermodynamics of irreversible processes**—University of Leiden, The Netherlands.
- **Fatigue strength** of riveted joints at elevated temperatures—Technical University of Istanbul, Turkey.
- **Sky and sun ultraviolet radiation**—Physik-Meteorological Observatory, Davos, Switzerland.
- **Electron scattering** and oscillations in plasma—Queen's University of Belfast, Northern Ireland.
- **Aerodynamic heating** and thermal stresses in aircraft structures—Technische Hochschule, Vienna, Austria.
- **Research for structural chemistry** of silicates and related substances—Univer-

This announcement is neither an offer to sell nor a solicitation of an offer to buy any of these securities. The offering is made only by the Prospectus.

NEW ISSUE

January 5, 1961

60,000 Shares

National Aeronautical Corporation

narco

Common Stock
(Par Value One Dollar Per Share)

Price $26 per Share

Copies of the Prospectus may be obtained in any State only from such of the several underwriters, including the undersigned, as may lawfully offer the securities in such State.

White, Weld & Co. Incorporated — Yarnall, Biddle & Co. — Stroud & Company Incorporated

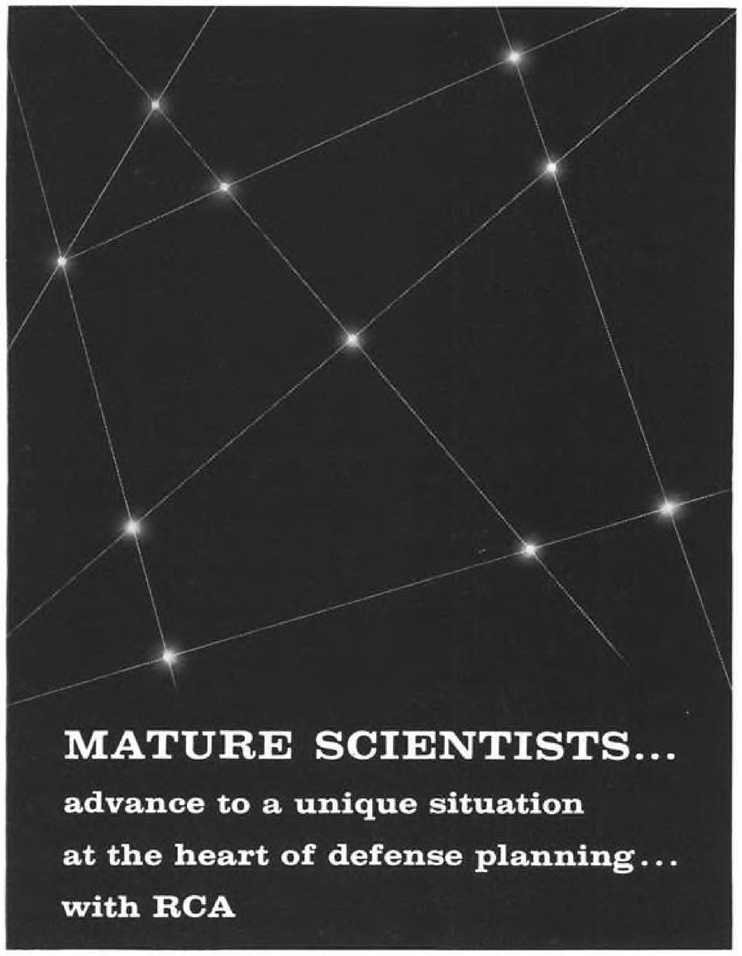
Harriman Ripley & Co. Incorporated — Hallgarten & Co. — Hemphill, Noyes & Co.



INERTIAL SYSTEM INTEGRATION

Can you measure a movement several thousand times slower than the hour hand of your watch? With the skills of an expert organization behind you, could you design and develop your own test methods, equipments, and procedures? These would be for the evaluation of servo, gyro, and accelerometer performance and early prototype inertial systems, and would include precision voltage analog measurements. Write Mr. Donald Krause.

LITTON SYSTEMS, INC. Guidance & Control Systems Div.
Beverly Hills, California



MATURE SCIENTISTS...
advance to a unique situation at the heart of defense planning... with RCA

Scientists accustomed to an atmosphere of intensive thinking and high-level accomplishment will find RCA's Advanced Systems Staff most stimulating. Removed from the importunities of administrative detail, they will concentrate their full capacities upon determining concepts for very advanced military systems and techniques, and upon directing programs to implement their conclusions. Space satellites and missiles will receive particular emphasis.

Current fields of study include counter-measures, advanced communications, high resolution radar, systems support, USW, information handling.

Present opportunities are for electrical engineers, physicists and mathematicians with a minimum of 5 years' experience, and an advanced degree.

The location is in the Greater Philadelphia area, offering many civic, cultural and educational advantages.

Are you the unusually imaginative man for one of these unusually stimulating positions? We would appreciate your writing:

Dr. A. H. Benner, Dept.AW-11
Radio Corporation of America
Bldg. 10-1
Camden 2, New Jersey

EQUAL JOB OPPORTUNITY

RCA
The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

sity of Aberdeen, Scotland.

• **Development of statistical methods** for designing aircraft with respect to fatigue—Aeronautical Research Institute of Sweden, Ulvsunda, Sweden.

• **Research for growth of turbulent** fluctuations in free shear flow—Hermann Foettinger Institute, Berlin.

• **Luminescence of lunar surface** materials—University of Manchester, England.

In a number of instances, EOARDC has been able to get more for its money by "buying into" research programs already under way with the limited financing available to the universities involved. The Air Force, by providing funds to accelerate the project, receives in turn all the available findings.

For example, EOARDC money is underwriting approximately 15% of the cost of a study of the correlation between cosmic ray activity and the earth's geomagnetic field being conducted by Sweden's University of Uppsala. In return, the Air Force receives 100% of the findings.

A number of scientists who can afford to make the gesture also donate their talents without charge and pass the funds available under EOARDC contracts down the line to graduate student helpers. This not only provides more manpower for the project but also contributes toward the education of future scientists.

Col. Nay says, "This is one of the intangibles of our work over here. You never know what the fallout of this sort of thing is. We think it helps a lot, however, in good will alone."

Another intangible as to future results and contributions is the stimulation EOARDC funding has given to space technology research within Western Europe, particularly in the bioscience field, and the capability it has provided some of the smaller nations which they probably never would have developed on their own.

Such knowledge has, in turn, spurred space interest in Europe as a whole and given the smaller nations a logical place as contributors to the integrated 11-nation space program now being organized on a cooperative basis (AW Dec. 12, p. 29).

Final purpose and eventual application of research knowledge gained here is often abstruse, and it is understandable why Air Force officials are confident that publication of the findings in most instances will be of little immediate use to the Soviets.

A study now under way on the transformation of water vapor from gas to a liquid state, for instance, can have a wide range of applications. Its findings could be used to aid in influencing precipitation rates over a localized area or in determining means of "boring holes" in airport cloud

BUT, OUR PENDULUMS AREN'T SIMPLE, SIGNOR GALILEO!

Since your time, Schuler has shown that a simple pendulum can be used for navigation here on Earth if it has a period of 84.4 minutes. By your formula, Signor, the pendulum would be 3,959 miles long! We couldn't keep it simple; we had to mechanize an artificial pendulum with Schuler's long period to inertially guide the Mace missile. If you, as an engineer, would like to join us in compounding such new approaches from traditional science, and if you have a BS, MS or PhD in Physics, ME, EE, or Math, please contact Mr. E. A. Allen, Director of Scientific and Professional Employment, 7929 S. Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS



V/STOL

- Aerodynamicist
- Engineer with interest in dynamics, vibrations and aeroelasticity
- Performance Engineer for evaluation of V/STOL systems

These positions offer both challenge and reward to men interested in analytical and experimental *research studies* on helicopters and other V/STOL aircraft. Work will be extremely varied and will include preliminary evaluations of novel configurations, as well as long-range research studies on the mechanics of flight at low speeds.

Corporate-sponsored and with strong management backing, this program offers both personal security and advancement opportunities to outstanding men with M.S. degrees. Facilities include a complex of modern wind tunnels, a variety of rotor and propeller test equipment, and the nation's largest industrial computational laboratory. Publication of papers is encouraged.

Since expansion in this program requires that we fill these positions immediately, *write today* to Mr. W. D. Walsh, Personnel Dept.:

RESEARCH LABORATORIES
UNITED AIRCRAFT CORPORATION
400 Main Street, East Hartford 8, Conn.



BENDIX-PACIFIC

in Southern California

needs ENGINEERS *with*

DOCTORS'- MASTERS'- BACHELORS'

DEGREES

for electrical and systems work in fields of
Missile Guidance—Instrumentation—Telemetry
Anti-Submarine Detection Systems/Operations Research
Military Navigation

Advanced positions are open in our "Eagle" Missile Program in Electrical Engineering for the design of transistor circuits, servomechanisms, microwave electronics and data links.

Please send resume to W. C. WALKER
ENGINEERING EMPLOYMENT MANAGER

Bendix-Pacific Division
11600 SHERMAN WAY
NORTH HOLLYWOOD, CALIF.

Other High-Level Electronic Engineering Positions Available

covers. On a broader scale, it also might eventually contribute to methods of influencing the climate, for good or bad, over strategic areas in time of war.

The geophysics spectrum, as a whole, is another area in which EOARDC plays a valuable part in expanding the scope of Air Force studies to large areas of the earth's surface. All but one of such contracts in force in Europe are sponsored and funded by Cambridge's Geophysics Research Directorate—the other is under the aegis of Rome Air Development Center, Griffiss AFB, N. Y.

Of the approximately 650 contracts currently being sponsored by the Geophysics Research Directorate, 78, or slightly more than 10%, are handled through EOARDC.

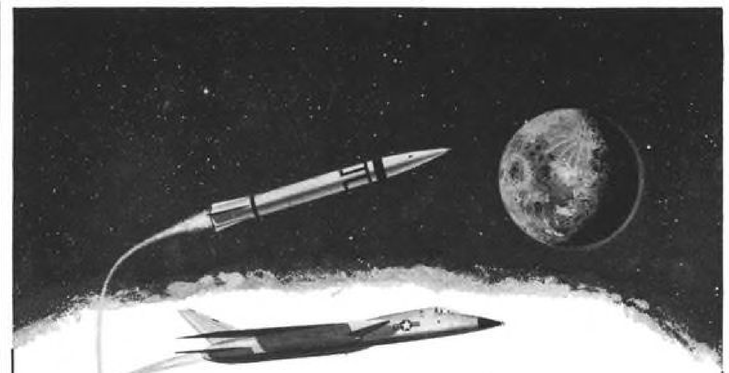
Lt. Col. William L. Jones, head of EOARDC's Physics Division, which monitors the geophysics contracts, says that in addition to providing wider areas for observation, particularly in Scandinavia, Europe has scientists "who have been in the lead in certain fields for a long time, including meteorology, weather forecasts and predictions. We're primarily interested in tying in with areas where they have a high percentage of top-flight scientists and long experience."

Current studies include a project planned to provide methods of more accurately measuring distances between two distinct points on the earth—a must in accurate missile targeting—and several contracts designed to provide inputs for the Air Force's 433L weather system under which it is hoped to make automatic the entire process of weather forecasting from observation—with automatic sensing devices—to analysis and prediction through the use of computers.

The weather contracts include studies by Dr. K. Hinkelmann, of the West German Weather Service, and by the University of Stockholm on better methods for numerical weather analysis and forecasting. At present, Col. Jones says, "we aren't able to feed some variables—effects of incoming radiation, for example—into our equations for weather prediction, so we have to act more or less as though there isn't any radiation. These people are trying to find ways of taking such things into consideration."

In their efforts, the two groups have adopted different approaches in tackling the problem.

In another area within the responsibility of Col. Jones' office, scientists of the Max-Planck Institute in Munich are investigating the percentage of tritium—a gas produced by artificial radio activity or by natural cosmic radiation—within the atmospheric gases as a whole. Such research should give an indication of how long radioactive



DYNAMICS

SUPERVISORS • SPECIALISTS

The Dynamics Section of The Columbus Division of NAA currently has both Supervisory and high level Technical Specialist openings in its Dynamics Development Group.

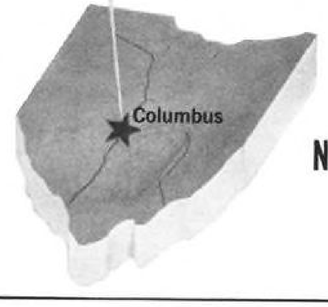
This group is responsible for methods development and support of all advanced engineering programs in the fields of aeroelasticity (static and dynamic), deflection analyses, dynamic and static loads including establishment of load spectra criteria, environmental vibration, and acoustics. This group is also responsible for obtaining and conducting sponsored research from many government agencies in these technical fields. High level technical and supervisory personnel are required with interests in all of the above fields, but particularly with training and experience in the following specialties:

Unsteady Aerodynamics
Acoustic and Vibration Environmental Predictions
Sonic Fatigue Research
Aeroelasticity

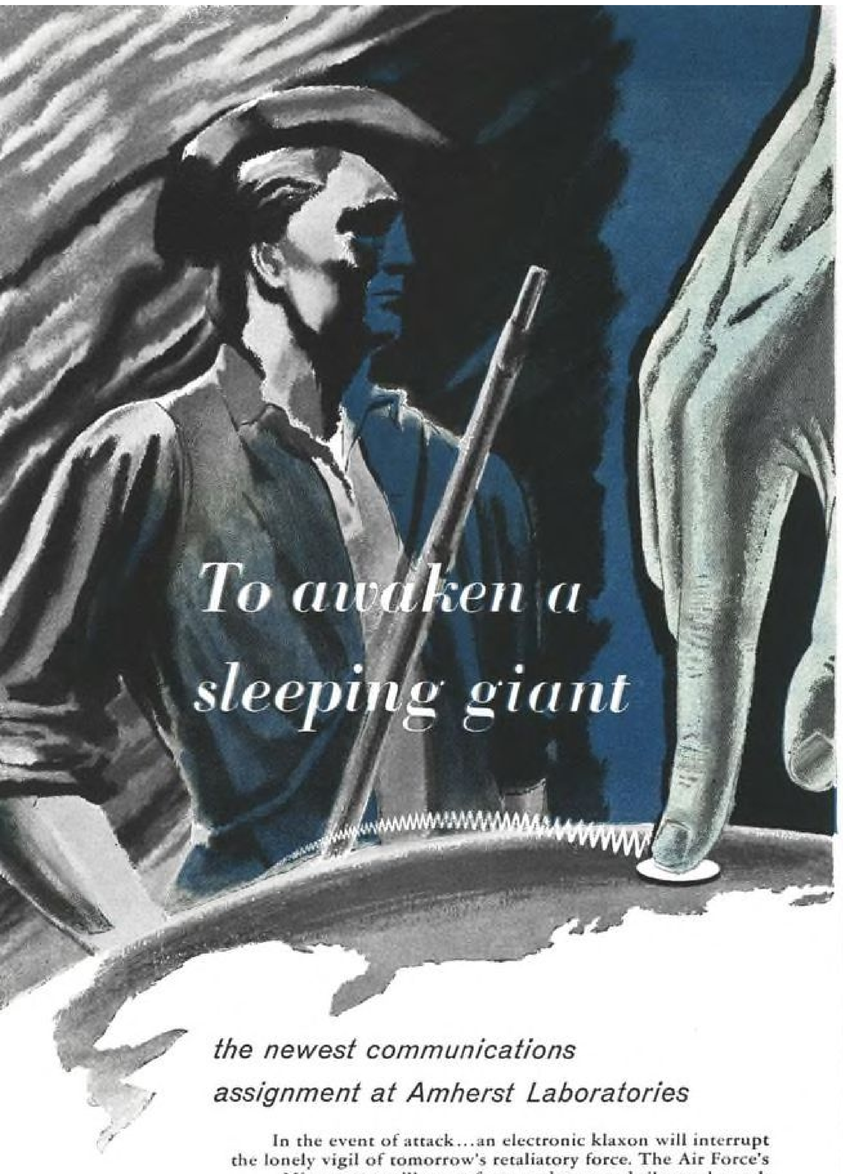
You will be supported in your theoretical research by a well-staffed and equipped Dynamics and Acoustics Laboratory covering an area of approximately 10,000 square feet and under direct Dynamics Section management. Consultation is available in many of these fields from established consultants currently retained on an annual basis by the Dynamics Section.

To arrange for a personal discussion of these opportunities, please call or wire collect:

Mr. V. Beals
Engineering Chief, Dynamics
North American Aviation, Inc.
Columbus 16, Ohio
BElmont 1-1851, Extension 1687



COLUMBUS DIVISION
NORTH AMERICAN AVIATION



the newest communications assignment at Amherst Laboratories

In the event of attack...an electronic klaxon will interrupt the lonely vigil of tomorrow's retaliatory force. The Air Force's Minuteman will erupt from underground silos and streak toward enemy targets...at a moment's notice. The fire command will originate from a remotely located control-launch center and be carried by a jam-resistant signal.

New techniques in Electronic Communications must be developed and converted to practicality. This is just one of the many advanced Ground, Air and Space Communications assignments at Amherst Laboratories.

PROFESSIONAL STAFF AND MANAGEMENT OPPORTUNITIES
are unlimited for Physicists, Mathematicians and Electronics Engineers with advanced degrees and creative desire.

You are invited to direct inquiries in confidence to Mr. Daine C. Maxwell, Amherst Laboratories...or call NF 3-8315 for information. All inquiries will be acknowledged promptly.

SYLVANIA ELECTRONIC SYSTEMS
A Division of SYLVANIA
Subsidiary of GENERAL TELEPHONE & ELECTRONICS
1180 Wehrle Drive, Williamsville, New York

AMHERST LABORATORIES

Shrinking the Universe... through Communications

particles remain in the atmosphere and, from the Air Force point of view, how it can be retained or dispersed.

Maj. Frani Voltaggio, Jr., electronics project officer within Jones' division, is currently directing his efforts into four major areas, although he says that "what we support in Europe is more a reflection of what's available than what our over-all interest is." The four areas are:

- **Tubes and antennas.**
- **Research on the physical processes** of the ionosphere.
- **Basic microwave propagation** and the electromagnetic wave theory.
- **Speech analysis** and simulation.

In the tube and antenna field, EOARDC funds have helped toward a number of interesting developments, straying here from the university level, where equipment is inadequate, to the realm of established firms, particularly Compagnie Generale de Telegraphie Sans Fil (CSF) in Paris.

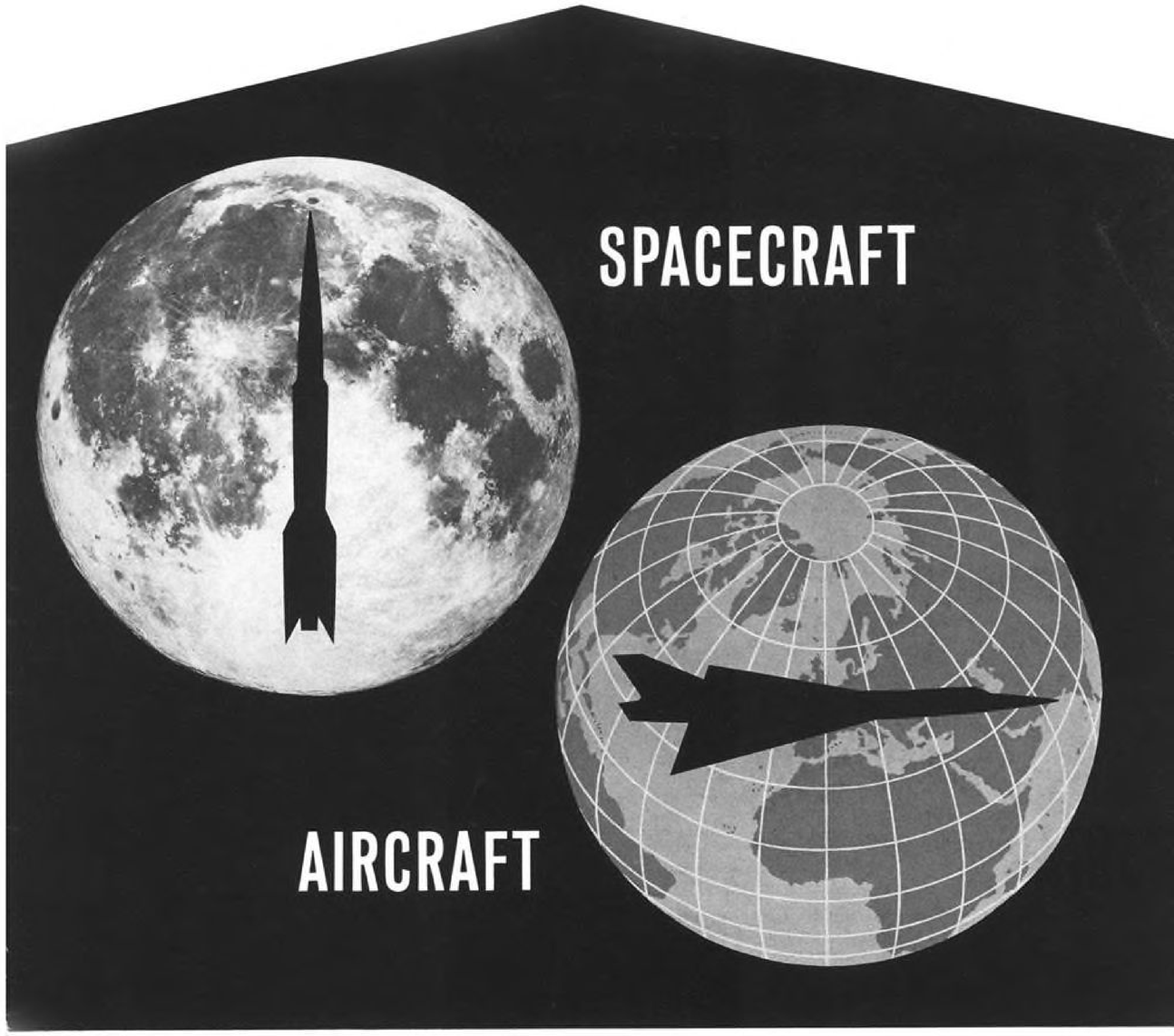
Voltaggio's office has supported CSF in pushing development of its microwave Carcinotron tube, including a millimeter Carcinotron in the four-millimeter band. In antennas, CSF's Department of Applied Physics has developed a unit which Voltaggio describes as "the most highly directive antenna pattern to aperture size of anything developed thus far."

Work by CSF has led to the design of two super-directive antenna arrays—one with five, the other with 11 sources isolated by ferrite unilines—which produce an exceptionally narrow beamwidth. The five-element array, for example, is three-quarters of a wavelength long and produces a beamwidth of 18 deg. as compared with 60 to 70 deg. for a conventional horn aperture of the same size. The development was conducted at the X frequency band, but a contract now in force calls for the design of similar units in the lower frequency spectrum.

Ionosphere Research

In ionosphere research, one of the principal programs is a study of polar communication blackouts in an effort to determine fully the physical process and how to overcome it. General sequence of such blackouts and the reason behind them—solar disturbances—already have been established through a global observation effort, including Arctic stations in Scandinavia.

Research by Prof. Giorgio Bazzilai of the University of Rome on electromagnetic wave propagation provides an example of low-cost effort available in Europe that could produce significant advances. Voltaggio describes Bazzilai's work—a completely theoretical investigation of the behavior of wave guides—as a "very simple research endeavor that doesn't require anything but



NOW UNDER ONE ROOF AT LOCKHEED / BURBANK

Lockheed California Division has expanded its already great resources at Burbank. For it now encompasses, under one roof, the two vast worlds of Spacecraft and Aircraft.

This typifies Lockheed policy to steadily advance the state of the art through basic research in related and scientific fields.

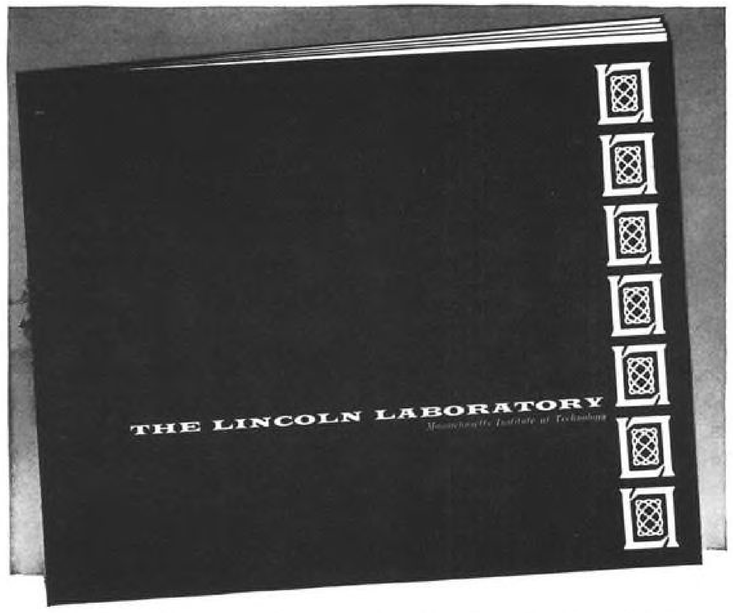
Result? Now—more than ever—Lockheed offers Scientists and Engineers uncommon opportunities; equips them with every modern facility; gives them freedom to explore and express new ideas; makes possible greater individual recognition.

Now being designed and developed in Spacecraft and Aircraft are: Hypersonic interceptors; V/STOL; supersonic interceptors; limocopters; missiles; manned spacecraft; and satellites.

Scientists and Engineers of outstanding talent are now invited to participate in this new, dual enterprise. Immediate openings are available to: Aerodynamics engineers; thermodynamics engineers; dynamicists; electric research engineers; servosystem engineers; electronic systems engineers; biophysicists; infrared physicists; hydrodynamicists; ocean systems scientists; physio-psychological research specialists; mammalian culture research specialists; and radiation hazards specialists.

Write today to Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1101, 2406 N. Hollywood Way, Burbank, California.

LOCKHEED
CALIFORNIA DIVISION



The Lincoln Laboratory, Massachusetts Institute of Technology, announces a major expansion in its program. We urgently request the participation of senior members of the scientific community in our programs in:

RADIO PHYSICS and ASTRONOMY
SYSTEMS:
- **Space Surveillance**
- **Strategic Communications**
- **Integrated Data Networks**

NEW RADAR TECHNIQUES
SYSTEM ANALYSIS
COMMUNICATIONS:
- **Techniques**
- **Psychology**
- **Theory**

INFORMATION PROCESSING
SOLID STATE Physics, Chemistry, and Metallurgy

• **A more complete description of the Laboratory's work will be sent to you upon request.**

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
BOX 29
LEXINGTON 73, MASSACHUSETTS

a man's brains and time and a certain amount of assistance from an electronic computer."

Bazzilai is undertaking the first known complete modular analysis of wave guides filled, or partially filled, with ferrite materials. From this he hopes to theoretically determine the behavior of wave guides under these conditions. If they indicate better efficiencies, less attenuation, the next step may be physical experiments with various ferrites.

It could, Voltaggio says, "give us a basis to build on, and I don't know of anyone else who has come up with an idea to do such work."

In another area, Prof. E. H. Meyer of the University of Goettingen, Germany, is studying the application of acoustic techniques to microwave behavior which he hopes will lead to new methods of measurement. Primary concern is with the absorption, transmission and reflection of electromagnetic waves by different materials.

Speech analysis and simulation research in Europe covers a wide range. One EOARDC contractor, looking toward the day when voice communications with space crews may become a necessity, is trying to determine how a normal spoken message can be condensed into code to reduce bandwidths and permit more messages to be sent on the communication links.

One possibility is transmitting a tightly compact, possibly unintelligible, transmission that would be automatically converted to its normal context at the receiving end.

The search for worthwhile ideas and projects within Europe is an unending one for all four of EOARDC's major divisions—physics, bioscience, aeromechanics and material—which operate under the Directorate of Technical Operations headed by Lt. Col. Edward H. Nowack. In the early days it was literally a university-to-university tramp with the approval of the respective governments involved. Now, however, the work of the office, and its general areas of interest, are known to the European scientific community, and proposals flow in on a fairly steady basis.

Maj. Voltaggio recently noted that an Israeli professor had been elected to a vice presidency of the Institute of Radio Engineers and "just on that input decided it would be a good idea to see him. I thought that, to be elected a vice president of IRE from such a remote country, he must be fairly prominent in his field."

On his next trip to Israel, Voltaggio did just that, and "this chap turned out to be one of the giants in electronic research but not too well known in the States because he publishes in German only."

The professor, Voltaggio says, "proceeded to give us four or five excellent practical ideas. We're now looking at them to see how, and if, they tie into Air Force needs."

When a proposal is favorably accepted by the Brussels office, it is forwarded to the United States to the Air Force research center most directly concerned. The center, in turn, either accepts and provides funds for the contract or rejects the proposal.

In the past, all agreements have been drawn up as negotiated contracts, but EOARDC recently received permission to issue grants in certain cases. Once a grant is made, there is little or no recourse left to EOARDC in the event the program does not come off successfully, but a grant has its advantages. A major one is the elimination of much of the red tape involved, and a contract can be trimmed from its normal 16 pages to approximately two.

With all the work it oversees, EOARDC has managed to remain relatively trim. Its staff comprises 25 officers, 11 airmen and 22 civilians, mostly clerical.

Of the officers, 13 are qualified in physics, bioscience, aeromechanics or materials, and eight are pilots. For a variety of reasons, ARDC prefers to leave the technical reins in the hands of military personnel.

"How else," Col. Nay asks, "could you get a Ph.D. in guidance and control on a captain's pay?"

Europeans Agree On Joint Traffic Control

Paris—Six West European nations have agreed to set up an international agency to devise a more efficient traffic control system for flights over Europe.

Called Eurocontrol (AW Sept. 5, p. 42), agency is being created by West Germany, Belgium, Holland, France, Luxembourg and Great Britain. Other nations, notably Italy, are expected to join shortly. Idea behind the agency is that jet traffic over Europe's relatively crowded air space is generating traffic control problems not formerly encountered with piston aircraft.

Present air traffic control system throughout Western Europe is based on zones, with some countries being divided into as many as three zones. Control does not extend beyond 25,000 ft. Thus, high-speed jets, often crossing Europe well above 25,000 ft., are not surveyed under the present system.

Complete details of the Eurocontrol system have not as yet been completed. In general, it is planned to divide the whole of Western Europe, including the United Kingdom, into two large zones. Southern traffic control center would be located at Rome, the northern center at Luxembourg.

4 Vital, Rewarding Positions

For Creative Engineers with Project BMEWS

RCA offers electronics engineers truly creative assignments on the most complex and challenging radar/data processing system ever undertaken—BMEWS. Engineers capable of meeting the challenge of this prime defense effort will find these opportunities both stimulating and rewarding.

FIELD-STRENGTH MEASUREMENT ENGINEER—Implement a complete monitoring and measuring program for BMEWS forward sites. A minimum of three years' experience in microwave and X-ray measurement techniques, and ability to analyze and write technical reports are required. BSEE, plus some supervisory background preferred. Frequent travel to forward sites.

QUALITY CONTROL ENGINEER Develop quality control program on the component and assembly level, in support of an operating BMEWS system. Minimum of 3 years' quality control engineering; familiarity with quality control inspection techniques, statistical sampling, and evaluation. Ability to provide self direction and leadership to a quality control operation. Location: Rome, N.Y.

DIGITAL ENGINEERS—Liaison and project level responsibility for site engineering activities on missile impact prediction computer, radar data take-off, and switching systems. Experience in digital logic design and transistor techniques on computer and on-line data handling equipment, plus degree is required. Locations: Riverton, N. J. with periodic trips to site; Van Nuys, Calif., with subsequent extended assignment to Thule, Greenland.

DETECTION AND TRACKING RADAR SYSTEMS ENGINEERS Supervise installation, checkout and integration of detection and tracking radar equipment. Intensive formal or on-the-job training on equipment, systems acceptance, and performance evaluation. Three to ten years' experience on long range radar (transmitters, receivers, and data processing systems) is required. Location: Riverton, N. J., with 3 months site rotation; or extended site assignments.

There is special site compensation for positions requiring extended site assignment.

To arrange a confidential interview, send your résumé to:

Mr. J. P. Thatcher, Employment Mgr.
RCA Service Company, Dept. BM-18A1
1908 Bannard Street
Riverton, New Jersey

EQUAL JOB OPPORTUNITY

RCA® The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED RATE:

The advertising rate is $31.00 per inch for all advertising appearing on other than on contract basis. Contract rates on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

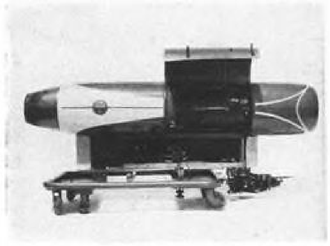
UNDISPLAYED RATE:

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

Send NEW Ads or Inquiries to Classified Adv. Div. of Aviation Week, P. O. Box 12, N. Y. 36, N. Y.



Need Jet powerplants? How much thrust?

Write, wire or telephone:

STEWARD-DAVIS

Gardena, Calif./Cable: STEDAV
Phone: FAculty 1-3414/FAA Approved Agency 4044

Reciprocating engines:

R-1820, R-1830, R-2000, R-2600, R-2800-C, CA, CB engines and overhaul services. Unusual test, overhaul, service, and propulsion development problems welcomed.

C-82, C-119, JET-PACKET Transports

Inventories of aircraft, parts, engines, and engineering. Transports bulky loads which cannot be loaded into other aircraft. Ideal flight research aircraft.

Turbojet engines:

Westinghouse J-30 (1600 lbs thrust), J-34 (3400 lbs.), Continental J-69 (1000 lbs.). Also auxiliary JET-PAK's for installation on underpowered aircraft.

CONVAIRS
Airline and Executive
Several of Both Available

Convair Trade-In
DOUGLAS DC-3
200 M.P.H. A12 Autopilot
Trades Accepted

DOUGLAS DC-6
DC-6A DC-6B
Finance or Lease

Also Grumman Twin Beech and Lockheeds in Stock

Contact:
Frederick B. Ayer & Associates, Inc.
250 Park Avenue, New York 17, New York

FOR SALE

GENE AUTRY'S
PERSONAL BEECH D 18-S

This airplane has been maintained to highest standards and is in excellent condition. Have purchased larger equipment.

CONTACT HERB GREEN
10000 Riverside Drive
North Hollywood, California
Phone: HO. 2-7373

WHERE TO BUY

Featuring additional products, specialties & services for the aviation field

---

FOR SALE
LEASE OR LEASE PURCHASE
Boeing Model 377
STRATO CRUISER
14 AIRCRAFT
FROM
$75,000.00
Flyaway

U. S. Certificated 112 seat configuration, full overseas equipped. Long range. 20 NTSO engines. Large Inventory of Supporting Aircraft and Engine Spare Parts.

WILLIAM STEINER
Phone: TOpaz 2-9355 or GArfield 6-4481
13010 Ardis Ave. Downey, California

HIGH TEMPERATURE FASTENERS
Engineering Catalog Number 286 on request
Manufacturers AN—N.A.S.—M.S. 6 Digit Hardware
SPECIALS TO YOUR SPECIFICATIONS
Mercury air parts co., inc.
9310 West Jefferson Blvd., Culver City, Calif.
Telephone—UPton 0-5923—Teletype—CVR CY 4138
TOUGH SPECIALS 10 DAY DELIVERY
MANUFACTURERS OF PRECISION HARDWARE

Excellent Corporate Lodestar Autopilot latest modifications. Will trade down to well equipped late model Aero-Commander or Twin Bonanza.

LINDEN FLIGHT SERVICE INC.
Linden Airport, Linden, New Jersey
Hunter 6-8800 Digby 9-3140 (NYC)

FOR SALE AIRCRAFT

Aero Commander 560, Series #177, Mfg. August, 1954. Bendix AOF, ARC 150-OMNI, LTRA-6, OMNI, L.F., 3 lite Mrkr. Pioneer remote compass, L2-Auto pilot w/altitude control Collins 51 X/L transceiver, fliteronics audio Amp. 150 hrs. R/E —zero time, L/E new interior-fresh license. Price $40,000.

RADIATION, INC.
Melbourne, Florida. Contact: L. P. Clark, Jr. Director Public Relations.

SEARCHLIGHT Equipment Locating Service

NO CHARGE 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 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 to locate the following used equipment:

.....

.....

NAME .....

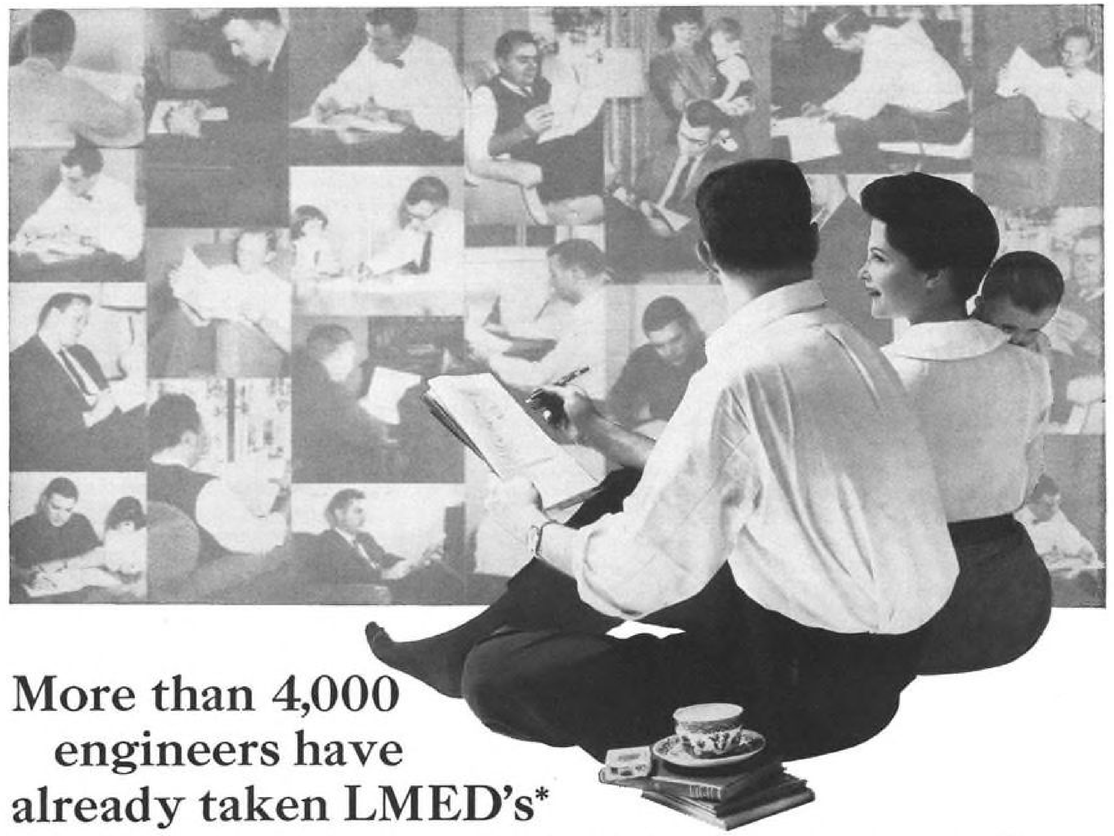
TITLE .....

COMPANY .....

STREET .....

CITY .....ZONE....

STATE 1/16/61



More than 4,000 engineers have already taken LMED's* self-appraising technical tests! *Have you?*

Whether you're thinking about a change, or simply interested in finding out how you stack up against other engineers in your field, LMED's Technical Tests will give you a sound means for appraising your abilities—right in your own home.

Carefully designed and pre-tested by LMED engineers, these technical quizzes are meant to be taken and scored for your self-appraisal only. The results need never be divulged to anyone—including Light Military.

Individual tests are available for the fields of Radar, Microwave, Communications, Electronic Packaging (ME), and Engineering Administration (a self-scoring psychological questionnaire).

Just check your fields of interest below, and we'll send you the corresponding tests, answer sheets and evaluation guides. They'll give you an objective basis for determining the probabilities of your success at Light Military—*before you even consider making application.*

MAIL THIS COUPON FOR YOUR TESTS

Current Areas of Activity At The Light Military Department

Space Communications & Telemetry • Missile & Satellite Computers • Space Vehicle Guidance • Undersea Warfare Systems • Thermoplastic Data Storage • Space Detection & Surveillance • Command Guidance & Instrumentation • Infrared Missile Applications.

LMED

* LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

FRENCH ROAD, UTICA, NEW YORK

Mr. R. Bach 64-WC
Light Military Electronics Dept.
General Electric Company, French Road, Utica, New York

Please send me tests (limited to 2 subjects per individual) answer and self-evaluation sheets covering the areas checked:

☐ RADAR ☐ MICROWAVE
☐ ELECTRONIC PACKAGING (ME)
☐ COMMUNICATIONS ☐ ADMINISTRATIVE ENGINEERING

Name_____
Home Address_____
City_____ Zone____ State_____
Home Phone_____
Degree(s)_____ Year(s) Received_____

Propulsion System and Power Cycle Analysts

Select Opportunities for outstanding . . .
- PHYSICAL CHEMISTS
- MECHANICAL ENGINEERS
- CHEMICAL ENGINEERS

Several select positions are now available in an analytical group engaged in performance analysis of systems that will represent significant advancements in the state of the art — advanced hypersonic air-breathing propulsion systems, nuclear power-cycle concepts for auxiliary space power-units, air-transportable power-packages and central power-station equipment. Studies require objective imagination and a wide range of scientific and technical skills.

Programs are of the long-range sustained type and have excellent management support. Readily available are superior analog and digital computer services and contributing efforts by experienced specialists with complementary skills.

These are attractive opportunities at a level that will interest outstanding technical men. Minimum qualifications include an advanced degree plus related experience.

Write in confidence to
MR. W. D. WALSH

RESEARCH LABORATORIES
UNITED AIRCRAFT CORPORATION
400 Main Street, East Hartford 8, Connecticut

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITION VACANT

Challenging positions are open for engineers with experience in Helicopter performance, dynamic and structural analyses. Contact Alb C. Ballauer, R. J. Enstrom Corp., Menominee, Michigan.

POSITIONS WANTED

Employed Scheduled Airline Captain age 42 desires executive flying coupled with sales or other work. 16,000 accident free hours. Foreign employment acceptable. World wide experience. Resume on request. Avail. 1st Feb. PW-5910, Aviation Week.

Responsible pilot. Airline Transport Rating —Single, Multi. Instructor. 6000 hrs. through Twin Beechs. Instrument experienced. Age 40. Married. Presently employed midwest. PW-5915, Aviation Week.

FOR SALE

Cabin Pressure Regulators at $25 each just like new. Benjamin Sales Co., 3235 Fenkell, Detroit 38, Michigan.

Collins 51R-3 Type Omni Receiver $800 Bendix MN85 type Omni receiver $350. Sperry auto pilot A-12D Main Amplifier 673613-6 $750. MN97 type Omni mags $125. Kollsman Synchroscope Tachometer overhauled $125 Schwein 24V B&T $35. Parts like new & certified. N. J. Aviation, 110 Liberty St., Ridgewood, New Jersey GI 4-1345.

FOR SALE

Helicopters—Assurance and Helicopters . . . We sell both. Reconditioned . . . Bells, Hillers, Sikorskys and parts—Domestic and Worldwide . . . Helicopter Sales Inc., 125-12 84 Road, Kew Gardens 15, New York.

NEED ENGINEERS?

An employment advertisement in the EMPLOYMENT OPPORTUNITIES SECTION will help you find the engineers you need. It's an inexpensive, time-saving method of contacting competent personnel for every engineering job in the Aviation industry. The all paid circulation of AVIATION WEEK offers you an opportunity to choose the best qualified men available.

For rates and information write:

Classified Advertising Division

AVIATION WEEK
P. O. Box 12 New York 36, N. Y.

Bausch & Lomb

A firmly established giant in the optical industry, this upstate New York corporation is rapidly expanding in electronic-mechanical systems work. Emphasis lies in commercial analytical and scientific instrumentation with a healthy balance of research and development contracts for military programs. Look into these professional opportunities with Bausch & Lomb Incorporated:

- **PHYSICISTS**
  Ph.D. or M.S. with experience and/or interest in the following areas: vacuum, solid state optics, infra-red, analytical instruments—to perform research in advance development.
  B.S. or M.S. with experience in a standards laboratory or in the development of measuring instruments or methods.
- **CONTRACT ADMINISTRATOR**
  B.S. with 3 or more years in government contract administration & liaison.
- **PROCESS ENGINEERS**
  B.S. in M.E., E.E. or I.E. with several years experience in process engineering in the areas of instrumentation, optics or consumer products.
- **ELECTRICAL ENGINEERS**
  B.S. with M.S. desirable. Three or more years experience in circuit design. Instrument experience valuable but not required. Must be capable of working without direct supervision.
- **INSTRUMENT ENGINEERS**
  Physicist with 2 or more years experience in optics and electronic instrument research and design.
  Mechanical engineer to design ophthalmic machinery, optical or analytical instruments.
- **OPTICAL ENGINEERS**
  B.S. in Optics, M.E. or Physics and 2 or more years experience in optical engineering. Will provide the optical engineering design of a broad line of products.
  B.S. with a major or minor in physiological optics and an interest in ophthalmic instruments.
- **MECHANICAL ENGINEERS**
  B.S. with M.S. desirable. Must have a strong background in machine design, small mechanisms and instruments. Must be capable of original product design and project responsibility.
  B.S. with M.S. desirable and a heavy background in physics and with design experience in the field of analytical or optical instruments.
- **PRODUCTION ENGINEERS**
  Quality control engineer with B.S. degree and 2 or more years experience.
  Inspection—B.S. in engineering with supervisory experience in inspection procedures.
- **TECHNICAL WRITER**
  B.S. with 3 or more years in technical and proposal writing with administrative ability.
- **LIVE IN ROCHESTER**
  Rochester is located in the heart of the upstate New York vacation country and is noted for its beautiful homes and gardens, fine schools and University, outstanding cultural advantages and high ratio of professional residents.
- **YOU ARE INVITED**
  to forward your resume to H. A. Frye, Professional Employment.

Bausch & Lomb
12 Bausch Street
Rochester 2, New York

ENGINEERS—SCIENTISTS

From pioneer nose cone development to the new APOLLO study and ADVENT programs, the Missile & Space Vehicle Department of General Electric is involved in the progress of nearly every area of space technology. The engineer and scientist seeking professional growth in this diverse and expanding field of vital national importance, is invited to review MSVD's 5-year roster of accomplishments, its long term expanding programs, and many openings.

Opportunities to move ahead in every aspect of Aerospace Science & Engineering

- Aerodynamics-Flight Mechanics
- Thermodynamics-Heat Transfer
- Structures Engineering
- Navigation & Control Systems
- Space Propulsion; Space Power
- Communication Systems
- Guidance — Inertial, Radar
- Life Support Systems
- Materials Studies
- Re-Entry Physics
- Flight Test Analysis
- Space Mechanics
- Applied Mathematics
- Optics
- Advanced Systems
- Advanced Manufacturing
- Transistor Circuit Design
- Reliability
- Project Engineering
- Digital Circuitry & Logic
- Measurements & Standards
- Instrumentation
- Ground & Space Support
- Electronic Packaging

Highly competent people, at various levels of experience, are desired to work closely with MSVD engineers and scientists, many of whom have made notable individual contributions to space technology.

Apply by sending a brief summary of your background to D. G. Curley, Dept. 64WC

MISSILE & SPACE VEHICLE DEPARTMENT
GENERAL ELECTRIC
3198 Chestnut St., Philadelphia 4, Pennsylvania

Write for MSVD Position Index containing detailed description of current openings.

Look at the Record of Achievements

- The **FIRST** recovery of an orbiting satellite vehicle. (Discoverer Satellite Recovery Capsule)
- The **FIRST** flight demonstration of effective space vehicle stabilization control and navigation.
- The **FIRST** measurements in space of earth's magnetic field and infrared radiation.
- The **FIRST** operational re-entry vehicles for both IRBM and ICBM missiles.
- **SUCCESSFUL** measurement of space radiation to an altitude of 1200 miles. (NERV Space Probe)

Look at Current Projects In Progress

- Re-entry vehicles for the TITAN, ATLAS, SKYBOLT & THOR missile programs. (Operational and Development Stage)
- NERV-Nuclear Emulsion Recovery Vehicle (Flight Test Stage)
- ADVENT Communications Satellite (Early Development Stage)
- Discoverer Satellite Recovery Capsule (Flight Test Stage)
- APOLLO Manned Space Vehicle (Also, five other Manned Space Vehicle Study Contracts)
- ADVANCED Studies in Space Probes



Some Current Areas of Need

- POWERPLANT TEST AND ANALYSIS
- INSTRUMENTATION AND CONTROL DESIGN
- POWERPLANT EQUIPMENT DESIGN
- REACTOR NUCLEAR ANALYSIS
- THEORETICAL PHYSICS (PhD)
- EXPERIMENTAL PHYSICS
- ENGINEERING STATISTICS (PhD)
- REACTOR MECHANICAL DESIGN
- HYDRO-THERMAL ENGINEERING COMPUTATIONS
- COOLANT TECHNOLOGY
- NUMERICAL ANALYSIS
- REACTOR EQUIPMENT DESIGN

Building on a succession of achievements in reactor applications and nuclear development, The Knolls Atomic Power Laboratory is currently expanding its program scope in a number of new directions—both exploratory and developmental.

Security restrictions prevent the identification of projects, or a detailed disclosure of the unique professional opportunities now open at KAPL. However, within these limitations we would be pleased to discuss the unclassified portions of our programs and describe the Laboratory's specialized experimental, computational and test facilities to nuclear scientists and engineers interested in reactor power plant development.

NEW OPENINGS ANNOUNCED

FOR NUCLEAR ENGINEERS AND SCIENTISTS

Qualified candidates, with experience in one or more of the fields listed at the left are invited to inquire about positions now available.

Address your inquiry in strict professional confidence to Mr. A. J. Scipione, Dept. 64-WC. U. S. Citizenship and appropriate engineering or scientific degree required.

Knolls Atomic Power Laboratory
OPERATED FOR A.E.C. BY
GENERAL ELECTRIC
Schenectady, New York

FOR INFORMATION

About Classified Advertising,

Contact The McGraw-Hill Office Nearest You.

ATLANTA, 9
1375 Peachtree St. N.E.
TRinity 5-0523
R. POWELL

BOSTON, 16
Copley Square
COngress 2-1160

CHICAGO, 11
520 No. Michigan Ave.
MOhawk 4-5800
W. J. HIGGENS

CLEVELAND, 13
1164 Illuminating Bldg.
SUperior 1-7000
W. B. SULLIVAN

DALLAS, 2
1712 Commerce St.
Vaughn Bldg.
RIverside 7-5117
J. GRANT

DENVER, 2
1700 Broadway—Tower Bldg.
ALpine 5-2981
J. PATTEN

DETROIT, 26
856 Penobscot Bldg.
WOodward 2-1793
P. HAMMOND

HOUSTON, 25
Prudential Bldg.,
Holcombe Blvd., Rm. W-724
JAckson 6-1281
GENE HOLLAND

LOS ANGELES, 17
1125 W. 6th St.
HUntley 2-5450
W. C. GRIES

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

PITTSBURGH, 22
4 Gateway Center
EXpress 1-1314
P. PIERCE

ST. LOUIS, 8
3615 Olive St.
JEfferson 5-4867

SAN FRANCISCO, 4
68 Post St.
DOuglas 2-4600
D. GARDNER

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, JANUARY 16, 1961

A. C. THE ELECTRONICS DIVISION, GENERAL MOTORS CORP. 123
AERONUTRONIC, A DIVISION OF FORD MOTOR COMPANY 80-81
AEROQUIP CORPORATION 79
AEROTEC INDUSTRIES, INC., AIRCRAFT EQUIPMENT DIV. 86
AIRCRAFT FITTING COMPANY, THE 96
ALPHA CORPORATION, A SUBSIDIARY OF COLLINS RADIO COMPANY 72-73
AMCEL PROPULSION, INC., A SUBSIDIARY OF CELANESE CORP. OF AMERICA 60-61
AMERICAN BRAKE SHOE COMPANY, KELLOGG DIV. 82
AVIATION WEEK AND SPACE TECHNOLOGY 118-119

BALL BROTHERS RESEARCH CORPORATION 98
BECKMAN INSTRUMENTS, INC. 94
BEECH AIRCRAFT CORPORATION 8
BELL AEROSYSTEMS COMPANY ..... 3rd Cover
BENDIX PACIFIC DIVISION, THE BENDIX CORPORATION 124
BENDIX SYSTEMS DIVISION, THE BENDIX CORPORATION 87
BETHLEHEM STEEL COMPANY 10
BRUSH INSTRUMENTS DIVISION OF CLEVITE CORP. 67

CANNON ELECTRIC COMPANY 64
CARLSON, INC., G. O. 59
CHICAGO AERIAL INDUSTRIES, INC. 22
COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC. 110-111, 125
CONVAIR, A DIVISION OF GENERAL DYNAMICS CORP. ..... 4th Cover

DEUTSCH COMPANY, THE 100
DOUGLAS AIRCRAFT COMPANY, INC. 46
DOW CORNING CORPORATION, SILICONES 4

ELECTRONIC COMMUNICATIONS, INC. 55
ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA 54
EX-CELL-O CORPORATION, AIRCRAFT & MISSILES DIV. 3

FXR, INC. 116

GARRETT CORPORATION, THE 105
GRAPHIC SYSTEMS 120
GRUMMAN AIRCRAFT ENGINEERING CORPORATION 114-115

HADLEY, INC., B. H. DIVISION OF CENTRAL HADLEY CORP. 62
HALLICRAFTERS COMPANY, THE 9
HARTWELL CORPORATION, THE 120
HITEMP WIRES COMPANY DIVISION OF SIMPLEX WIRE & CABLE COMPANY, INC. 69

INTERNATIONAL TELEPHONE & TELEGRAPH COMPANY 5

LINCOLN LABORATORY, THE 128
LISLE CORPORATION 65
LITTON INDUSTRIES, INC. 96
LITTON INDUSTRIES, INC. ELECTRONIC EQUIPMENT DIV. 121
LOCKHEED AIRCRAFT CORPORATION 127
LOS ANGELES DIVISION OF NORTH AMERICAN AVIATION, INC. 68, 130

MAGNAFLUX CORPORATION 14
MAGNETIC CONTROLS COMPANY 6
MICRODOT INC. 51

NATIONAL AERONAUTICAL CORPORATION 121
NEW DEPARTURE, DIVISION OF GENERAL MOTORS CORP. 84
NICHOLS COMPANY, W. H. 78
NORTHROP CORPORATION 56-57

ON MARK COUPLINGS, INC. 116

PESCO PRODUCTS DIV. BORG-WARNER CORP 15
PHILCO CORP., GOVERNMENT & INDUSTRIAL DIV. 76
PHELPS DODGE COPPER PRODUCTS COMPANY 92-93

RADIATION, INC. 104
R.C.A. AIRBORNE SYSTEMS DIVISION 122
R.C.A. ELECTRON TUBE DIVISION 11
R.C.A. SERVICE COMPANY 129
REEVES INSTRUMENT CORPORATION 7
RESEARCH LABORATORIES DIVISION UNITED AIRCRAFT CORP. 124
ROHR AIRCRAFT CORPORATION 17
RYAN AERONAUTICAL COMPANY 70-71

SIEGLER CORPORATION 44
SIKORSKY AIRCRAFT DIVISION, UNITED AIRCRAFT CORP. 16
SILICONES DIVISION, UNION CARBIDE CORPORATION 24
SPACE TECHNOLOGY LABORATORIES, INC., A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC. 20
SPERRY GYROSCOPE COMPANY OF SURFACE ARMAMENT DIVISION ..... --
SYLVANIA ELECTRIC PDTS., INC., ELECTRON TUBE DIV. 90
SYLVANIA ELECTRONIC SYSTEM, AMHERST LABORATORIES DIV. 126
SYSTEM DEVELOPMENT CORPORATION 18

TEKTRONIX, INC. 99
TEXACO INC. 42
TUNG-SOL ELECTRIC, INC. 13

VICKERS-ARMSTRONGS LTD., A COMPANY OF BRITISH AIRCRAFT CORPORATION 48-49
VOI-SHAN MANUFACTURING COMPANY ..... 2nd Cover

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

WHERE TO BUY
Mercury Air Parts Inc. 130
EMPLOYMENT OPPORTUNITIES 131-134
EQUIPMENT
(Used or Surplus New)
For Sale 130

ADVERTISERS INDEX

Ayer & Associates Inc. Frederick B. 130
Bausch & Lomb Inc. 132
General Electric Co. 131, 133, 134
Green, Herb 130
Linden Flight Service Inc. 130
Radiation Inc. 130
Research Laboratories 132
Steiner & Co. William 130
Steward Davis Inc. 130

work in the fields of the future at NAA



OPERATIONS ANALYSIS

Opportunities for operations research analysis covering the spectrum of weapon systems. Application of analytical techniques to determination of weapon systems performance and effectiveness involving tactical analysis, statistics, game theory, and nuclear physics.

Facilities for research include new IBM 7090, analog computer laboratory, and tactical game room.

M.S. or Ph.D. in Engineering, Math or Physics preferred. B.S. or B.A. with exceptional experience or recent graduates desiring this field are also encouraged to apply.

For more information please write to: Mr. A. A. Bowman, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California

LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION

LETTERS

For the Records

I have been a subscriber to your magazine for several years and I have always been impressed by its complete and accurate coverage of news items concerned with aviation and space technology. However, in your recent Dec. 26 issue I was surprised to find the rather gross error made on p. 11 ("Laurels for 1960").

I am referring particularly to your statements about Navy Cmdr. John N. Davis and his two records. I would like to point out to you that Cmdr. Davis only flew one record, the 100 km. closed course speed record. I flew the 500 km. closed course speed record on 5 Sept. 1960, 20 days prior to Cmdr. Davis' record flight. If you will check your Sept. 12 issue, p. 39, you will find your own magazine's account of this event.

My purpose in calling your attention to this error is most certainly not intended to detract from Cmdr. John F. Davis' (note proper middle initial) superb performance, as he is a very close personal friend, nor am I seeking a place in your "Laurels for 1960." The main purpose is to set the record straight for any of your future issues or any historical recordings.

T. H. Miller
Lt. Col. USMC
Arlington, Va.

(Aviation Week thanks Col. Miller for correcting the record on records, and belatedly and deservedly includes him in our "Laurels for 1960" listing.—Ed.)

Critic Standards

Concerning qualifications for judging the men in the area (e.g., Mr. Powers), [Roman general] Lucius Paulus (many years B.C.), after listening to the advice of the stay-at-home military experts, said:

"Commanders should be counseled chiefly by persons of known talent, by those who have made the art of war their particular study, and whose knowledge is derived from experience; by those who are present at the scene of action, who see the enemy, who see the advantages that occasions offer, and who, like people embarked in the same ship, are sharers of the danger."

Comments on the incident by U-2 pilots should be carefully considered. Others may qualify by logging a few thousand miles over the USSR in an unarmed glider.

L. J. Wine, Dayton, Ohio
J. F. Kilbane, Fairborn, Ohio

Language Aloft

I would like to know what dwarf-brain coined the word "overflight," and whom he was trying to impress.

In 40 years of airplane watching, it has been apparent that, on occasion, they fly over mountains, around the airport or the Eiffel Tower, from Point A to Point B, between two trees, up in the air, under the Golden Gate bridge, and even into buildings. However, never had anyone thought it necessary to describe these as respectively, overflight, aroundflights, fromflights, toflights, betweenflights, upflights, underflights or intoflights. But now the door has been opened. Since the U-2 incident the concept of an overflight has become very fascinating, despite the fact that every flight is an over-something flight. Why do letter writers, reporters and others insist on referring to the U-2 overflights? Could they not merely say "the flights over Russia," or in referring to a particular one "the flight?"

This matter may seem trivial, and I have tried to inject some humor, but it seems to be typical of an increasing tendency to try to confuse or impress people with fuzzy language, when we should be trying to get our messages across simply and clearly, using two short words where possible instead of three or four long ones. The first life insurance salesman who wanted to make an analyzation of my life insurance position, when a simple analysis would have done, has not been invited back.

The frightening thing is that this kind of promotional talk does impress some people who conclude that the speaker is real sharp and knows much more than they do. However, when the listener or reader develops any of the sophistication which should come with maturity, he will learn to be suspicious of this verbal approach, and he will be less easily influenced. Faith and trust become lost, and communication and cooperation—two of our most precious human powers—deteriorate.

Waldo M. Claflin, II
Huntington, N. Y.

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.

Standardize for Safety

The CAB Accident Investigation Report, "Fuel Starvation Causes C-54 to Crash," in the Oct. 31 issue of Aviation Week (p. 100) deals with an accident apparently caused by pilot error. But much more important and even more inexcusable was the design error committed. A pilot is dependent upon and at the mercy of acquired responses. All toggle switches in all aircraft of all types should be off when in the same position; all clock type instruments should read in the same direction, always, no matter where encountered; similarly, all instrument panels and consoles should be standardized. These are but a few examples of the standardization that is necessary for safety in flight and in all other operations involving human monitoring and operation.

This is a plea for FAA and Department of Commerce action voiced by a potential victim of his and others' reflexes in a complex machine world.

William L. Snodgrass
La Jolla, Calif.

Cornell's Antenna

In your Dec. 19 issue (p. 79) you carried a photograph of Cornell Aeronautical Laboratory's 50-megawatt peak power microwave radar antenna. The caption credited FXR, Inc., with construction of that antenna, whereas credit should actually have gone to G B Electronics Corp., a subsidiary of General Bronze Corp. FXR designed and built the transmitter for the new installation.

Edward B. Chester
Publications Branch
Cornell Aeronautical Laboratory, Inc.
Buffalo, N. Y.

Space Roles

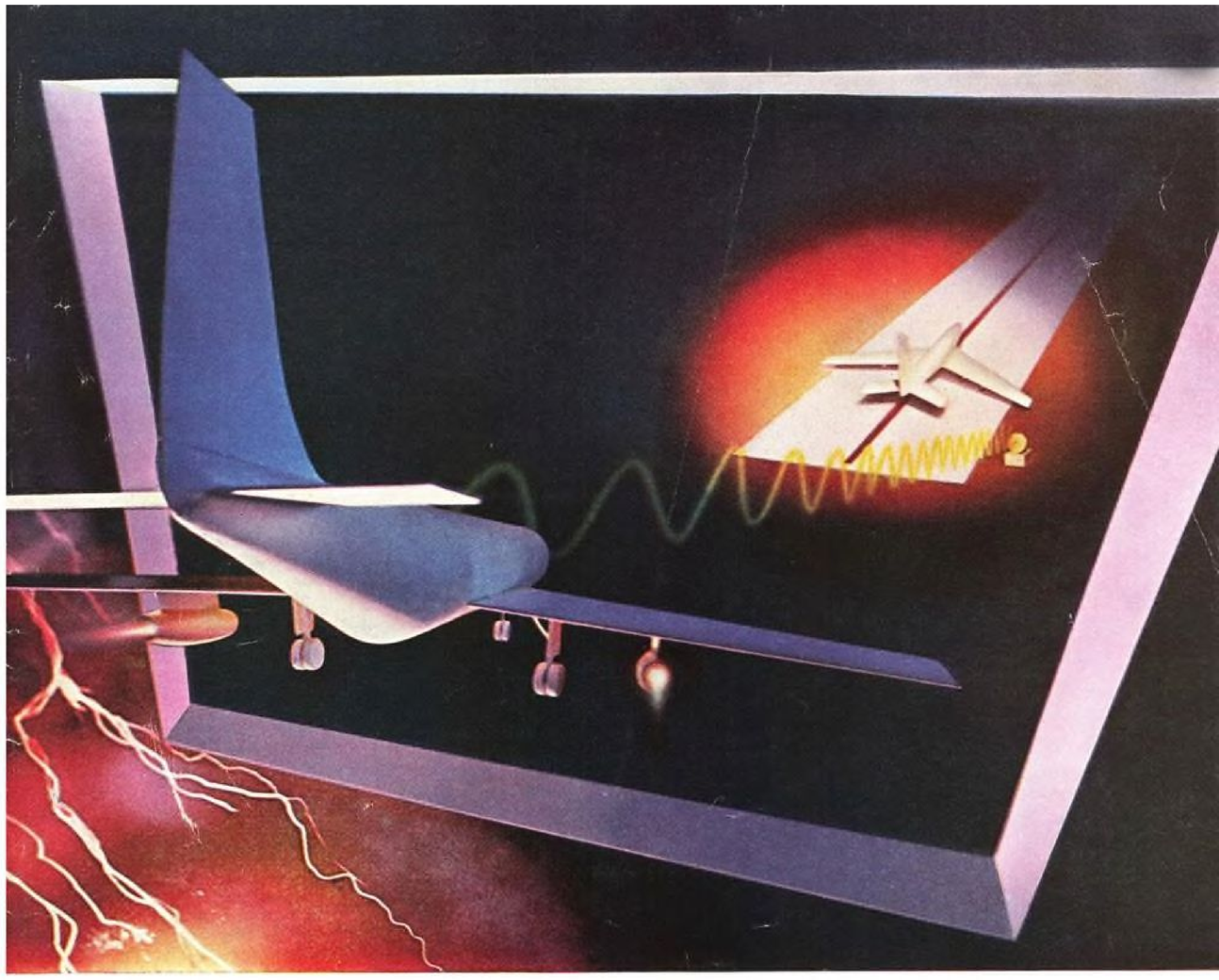
I am somewhat appalled to note that your uncomplimentary comments over NASA's role in space have assumed the proportion of an obvious "campaign" to discredit that organization. Unfortunately, most of your lay readers, such as myself, will not be aware of the fact that yours is just one of the many media being pressured into this by certain defense industries and the U. S. Air Force, to satisfy their own selfish purposes.

Your article "Air Force Outlines Broad Space Plans" in the Dec. 5 issue of Aviation Week (p. 26) is an outstanding example of bias reporting. Shouldn't it have occurred to you that such propagandizing is an act of direct contravention of the laws of the land and the expressed policy of the President of the United States that "space shall be used for peaceful purposes?" Or are you playing the role of naive dupes of the U. S. Air Force by aiding their grand strategy which is aimed at total and single military control of the armed forces—and ultimately the nation's economy—in order to implement their pre-emptive war strategy?

Specifically, ". . . it intends to enter the communications satellite development area, now monitored by the Army" is certainly indicative of the organization which is the prime igniter of "bickering" and "duplication." Another example, ". . . the submarine-launched Polaris missile. Briefers claim it will be ineffective after 1964." You surely know the Joint Chiefs of Staff, the Secretary of Defense, the President of the United States, and our Congress, after weighing all the pros and cons, have decided that Polaris is at least the equal of any weapon system proposed (and at the moment, has 95% of the nation's operational missiles) and have authorized a few billion dollars for its continued procurement through 1964. Either the persons cited above or the U. S. Air Force are wrong, and the one in error is a traitor to this country.

I, for one, would like to read the facts or, at the very least, if you choose to enter and perpetuate the arena of service competition, give us all sides of the story.

Paul H. Lindgren
Lindgren, Lupton and Associates
Arlington, Va.



Bell's All-weather Automatic Landing System—symbolized.

CLEARED TO LAND, WEATHER OR NOT

Today's increasing air traffic demands faster and safer all-weather operation at every airport.

Bell brings this goal one important step closer with its All-Weather Automatic Landing System (ALS) which can fly two airplanes to touchdown every minute, even when visibility is absolutely zero.

The Bell ALS takes over when the pilot brings his plane through the electronic "window in the sky" and guides it to a safe and sure landing.

The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

BELL AEROSYSTEMS COMPANY
BUFFALO 5, N. Y.
DIVISION OF BELL AEROSPACE CORPORATION
A TEXTRON COMPANY

CON

Now in service!

Convair Convair 880, the world's fastest jet passenger plane, enjoy vel enjoy more than speed alone—you'll find a whole new world of personal comfort! A product of "years ahead" engineering, the 880's Comfort Index provides you with roomier seats, wider aisles, and lower noise levels because the 880 is air-crafted for quiet. In the most personal terms, your 880 flight is incredibly smooth, wonderfully serene. Indeed, the only travel sensation aboard the 880 is the changing pattern of the landscape far below. Notably the finest as well as the world's fastest, the Convair 880 is *now in service* with Delta Air Lines.

Among other leading airlines soon to offer Convair 880 or 600 service will be

TWA, AMERICAN, SWISSAIR, S.A.S., REAL AEROVIAS (Brazil), C.A.T. (Formosa), AVENSA (Venezuela), JAL (Japan).



CONVAIR
DIVISION OF GENERAL DYNAMICS

