November 18, 1957 75 Cents

# AVIATION WEEK

A McGRAW-HILL PUBLICATION

## Exclusive Report On Countermeasures

•

## How Blue Angels Fly Air Shows

Navy's Blue Angels

*THE CONVAIR JET 880 WILL OFFER YOU COMPLETE LUXURY...*

## Two on the Aisle!

Luxurious in every detail, the Convair Jet 880 will offer travelers in the new jet age *first-class two-abreast seating throughout!* In addition to unmatched luxury, the 880, with a cruising speed of 615 miles per hour, will be the *world's fastest* jet passenger plane!

**CONVAIR**

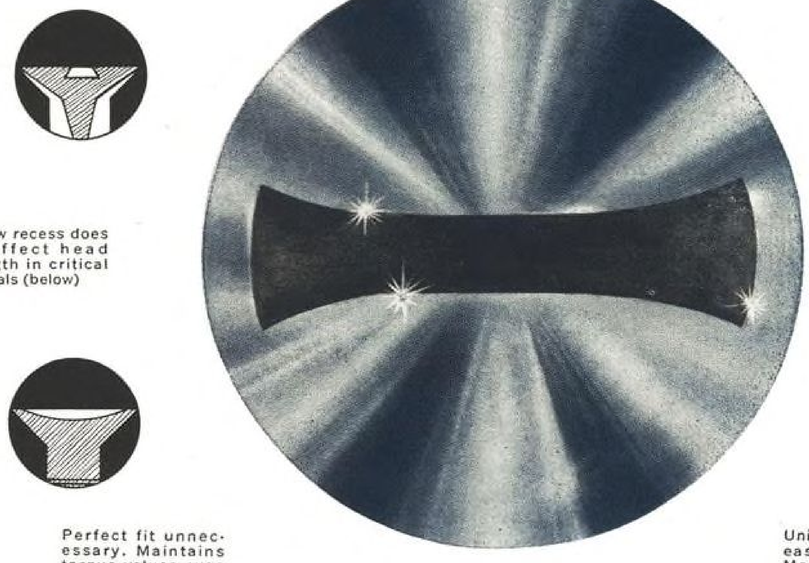
A DIVISION OF GENERAL DYNAMICS CORPORATION

# SYMBOL OF SUPERIORITY

Driver allows 360° of working surface. Rotate to expose new driving surfaces (left)

Undercut locks-in driver blade, does not cam out (below)

Hi-Torque Fasteners give positive inward thrust in driving or removal (above)

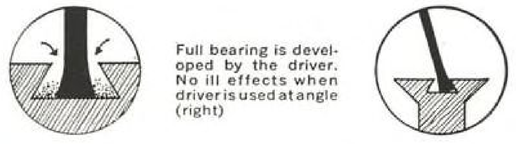


Shallow recess does not affect head strength in critical materials (below)

Undercut recess locks-in aerodynamic sealer when used (above)

Perfect fit unnecessary. Maintains torque values even with dirt or oil in recess (below)

Unique appearance, easily identifiable. May be applied to all turning fasteners (above)



Full bearing is developed by the driver. No ill effects when driver is used at angle (right)

# HI-TORQUE FASTENERS

*The key to Hi-Torque superiority is in the distinctive shape of the recess. It has an arcuate base; diverges outwardly from center; is undercut at sides. This shape insures full bearing thrust; locks driver in recess; gives greater torque values than heretofore possible.*

*Available in all metals including: alloy steels, 431 stainless steel, 17-4 PH, and 17-7 PH, AM 355, A-286, Inconel X, Greek Ascalloy, 4-4 and 6-4 titanium, Vascojet 1000, Thermold J, and Haynes #25.*

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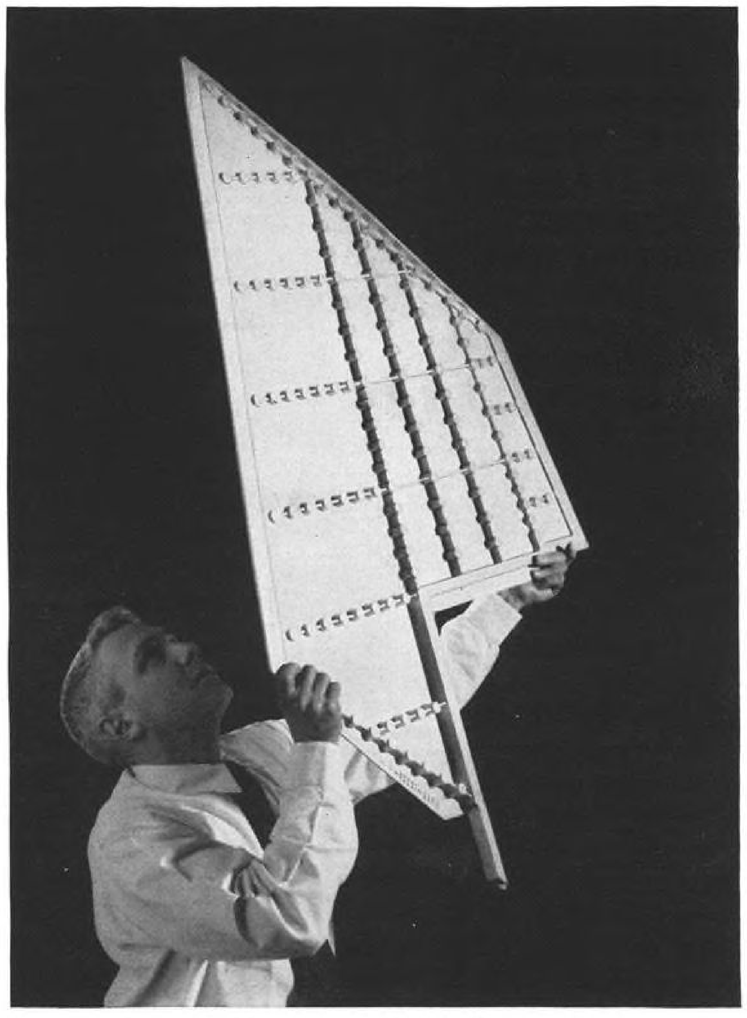

THIN-WALL magnesium casting for the Regulus missile fin produced by Dow.


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YOU NAME THE CASTING. Dow can supply you with ordinary and extraordinary shapes or sizes. Specialized techniques rigidly maintain your standards and specifications. Heavy-wall or thin-wall, room or elevated temperature use, the best—and surest—answer to your problems is Dow magnesium castings! Contact your nearest Dow sales office for additional information. THE DOW CHEMICAL COMPANY, Foundry Sales, Bay City, Michigan.

YOU CAN DEPEND ON DOW




## AVIATION CALENDAR

**Nov. 18-21**—Air Conditioning & Refrigeration Exposition, International Amphitheatre, Chicago, Ill.

**Nov. 18-22**—Third Norelco Electron Microscope School, Instruments Division, Phillips Electronics, Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

**Nov. 18-26**—Advisory Group for Aeronautical Research and Development, Combustion and Propulsion Panel, 12th meeting; **Nov. 26-27**—AGARD Aeronautical Panel, Shoreham Hotel, Washington.

**Nov. 18-29**—Technical Conference, International Air Transport Assn., Miami, Fla.

**Nov. 19**—Basic Research in Our Technological Future, sponsored by Hampton Roads Section, American Helicopter Society, Langley AFB Officers' Club, Va.

**Nov. 20**—Development of Helicopter Instrument Flying, Members of Department of Rotary Wing Training and Army Aviation Board, Ft. Rucker Section, American Helicopter Society, Officers' Open Mess, Ft. Rucker, Ala.

**Nov. 20-22**—30th Meeting, Aviation Distributors and Manufacturers Assn., Sheraton-Cadillac Hotel, Detroit.

**Nov. 21**—Luncheon Meeting, National Security Industrial Assn., Honor Guest, Adm. Jerauld Wright, USN, Palm Terrace, Hotel Roosevelt, N. Y.

**Nov. 25**—Board of Directors Meeting, Air Transport Assn., Statler Hotel, Washington, D. C.

**Nov. 26**—Some Aspects of Refrigeration in Supersonic Aircraft, Library, The Royal Aeronautical Society, London, England.

**Nov. 26**—Annual Membership Meeting, Air Transport Assn., Statler Hotel, Washington, D. C.

**Nov. 28-30**—Annual Snowbird Soaring Contest, Harris Hill, Elmira, N. Y.

**Dec. 1-6**—Annual Meeting, American Society of Mechanical Engineers, Statler-Sheraton McAlpin Hotels, New York.

**Dec. 2-5**—American Rocket Society, annual

(*Continued on page 6*)


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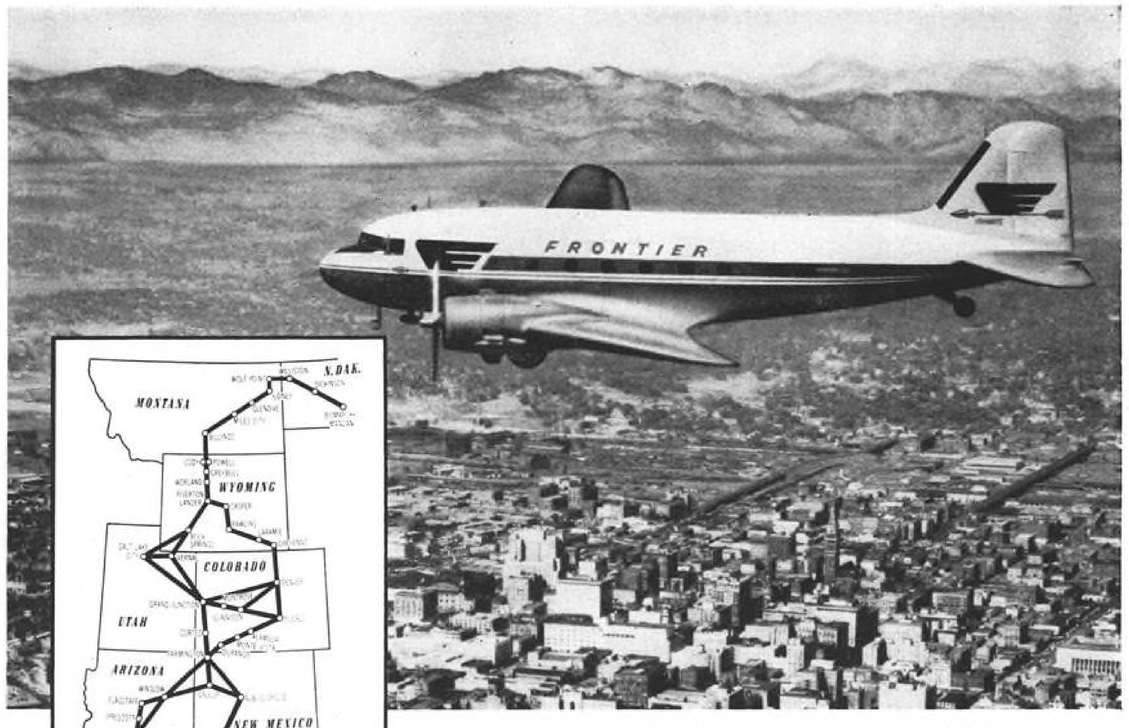


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## AVIATION CALENDAR

(*Continued from page 4*)

meeting, Hotel Statler, New York.

Dec. 3-4—Human Factors in Systems Engineering, Institute of Radio Engineers & Human Factors Society of America, Penn-Sherwood Hotel, Philadelphia, Pa.

Dec. 4-5—Symposium on high temperature strain gages, Aeronautical Structures Laboratory, Naval Air Materiel Center, Philadelphia 12, Pa.

Dec. 9-13—1957 Eastern Joint Computer Conference and Exhibit, Sheraton Park Hotel, Washington, D. C.

Dec. 16-18—Air Traffic Control Symposium, "The Mission and Methods of the Airways Modernization Board," sponsored by Franklin Institute, Philadelphia, Pa.

Dec. 18—Gas Turbine Development speaker: Rear Adm. S. B. Spangler, USN, Air Development & Materiel Center, at Engineers Club, Philadelphia, Pa.

Jan. 6-8—Fourth National Symposium, Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 14-15—Yankee Instrument Fair & Symposium, sponsored by Instrument Society of America (Boston, Connecticut Valley and Fairfield County Sections), Hotel Bradford, Boston, Mass.

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—International Air Show & Exposition, Master Field, Miami, Fla.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, N. Y. C.

Jan. 30-31—American Society for Engineering Education, 1958 College-Industry Conference, University of Michigan, Ann Arbor, Mich.

Jan. 30-31—Seventh Annual Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor College, Wilmington, Calif.

Feb. 4-6—Thirteenth Conference, Society of Plastics Industry, Edgewater Beach Hotel, Chicago, Ill.

Feb. 19—"Are Flying Saucers Fact or Fancy?", Dr. Hugh Winn, Missile and Ordnance Systems Department, GE, Engineers Club, 1317 Spruce St., Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St., N. Y. C.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, Westminster, London.

Apr. 17-18—RFC-RNAS Reunion, (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York.

Apr. 22-24—1958 Electronic Components Conference; theme: "Reliable Application of Component Parts."




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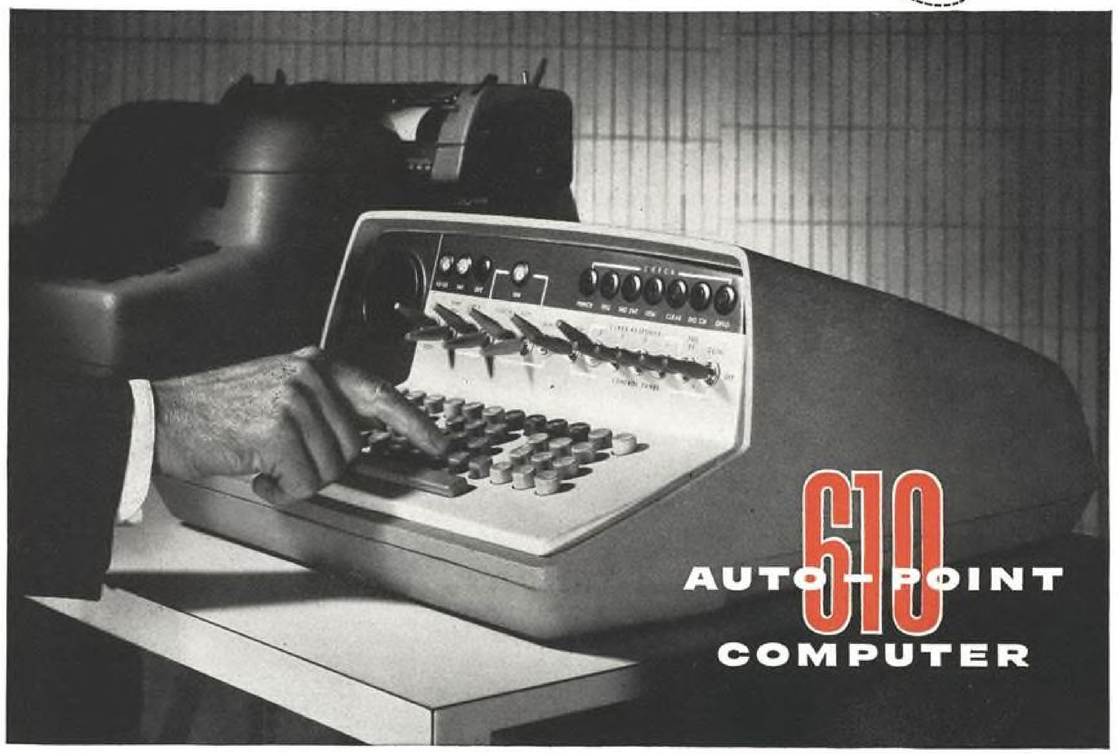


*The only desk-side electronic computer with direct programming and automatic positioning of decimal point*

These exclusive features are just two of the many time- and money-saving advantages of the new IBM 610 Auto-Point Computer—a compact, low-cost, general-purpose electronic computer with many logical and arithmetic facilities to make engineering time more completely creative.

For example, the IBM 610 features single-instruction square root, simultaneous division and multiplication, highly flexible tape units, and requires only a minimum of instruction to learn to operate the machine. The 610 has been designed with reliability as a prime consideration—built-in self-checking provides assurance of accurate results.

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*A few applications of the 610 Auto-Point Computer*

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# After 30,000 hours and 2,000,000 miles, here's what PETROLEUM HELICOPTERS says about Franklin engines:

The above are excerpts from a letter from Leon Boyd of Petroleum Helicopters, Inc.

Franklin

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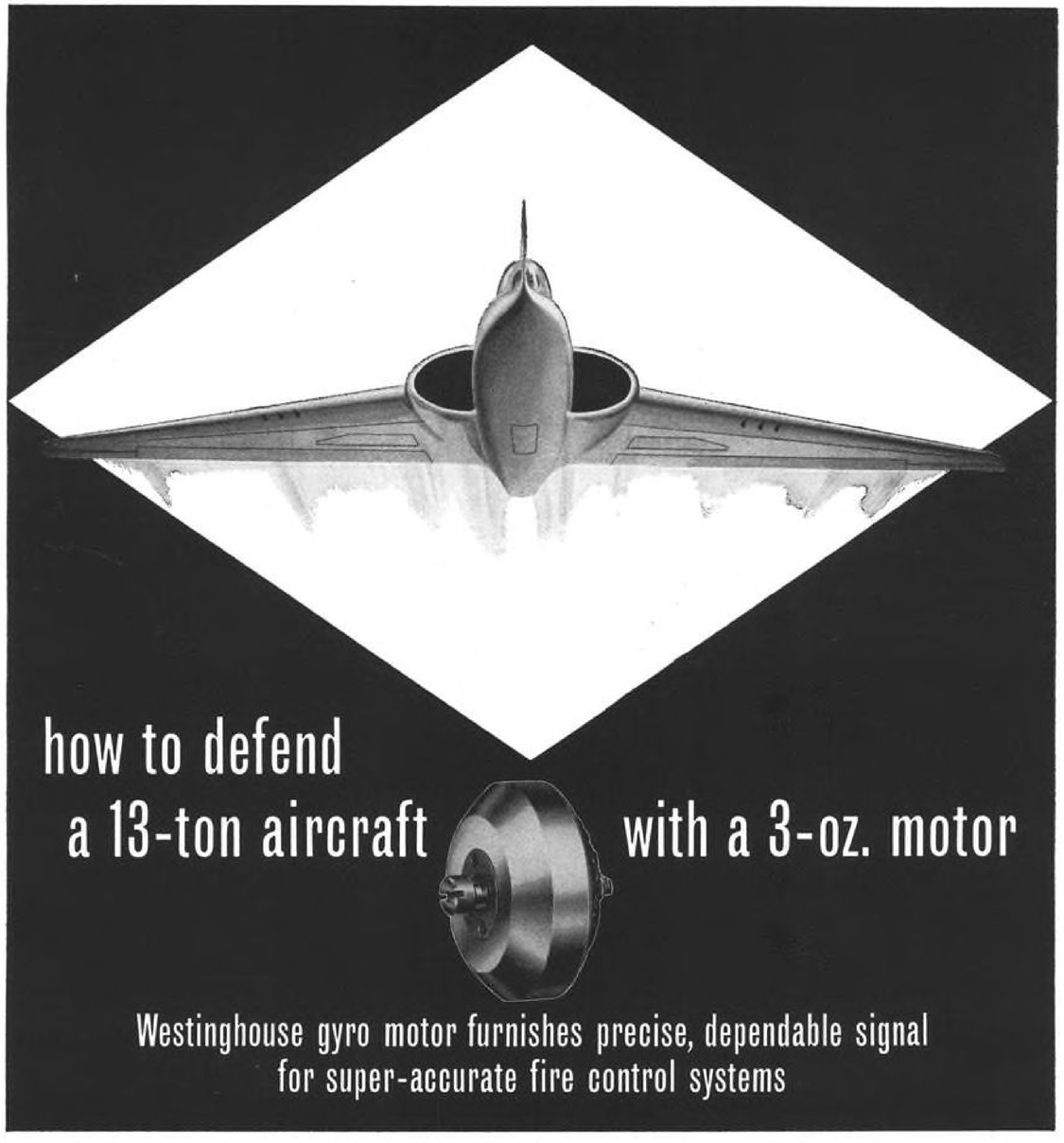


Westinghouse Aircraft Gyro motor is rated 100,000 gram CM² radians/second at 12,000 rpm. Designed for use with 10 volt, A-C, 3-phase, 400-cycle power supply.

Multi-ton sky giants, defensively armed by a 3-ounce motor. That's precision! — and it's made possible by the Westinghouse Gyro Motor.

This "mighty-mite" spin motor is the heart of many super-sensitive aircraft gyroscopes. It's assembled in a temperature- and humidity-controlled room — dynamically balanced — thoroughly tested — and shipped in a hermetically sealed plastic bag and foil envelope.

This extreme care, plus 40 years of Westinghouse aircraft-electrical experience, insures a minimum of 1200 hours maintenance-free service from every motor.

If you would like additional information on the full line of Westinghouse gyro motors, please write Westinghouse Electric Corporation, Aircraft Equipment Department, Lima, Ohio.

**All inquiries and information are kept in strictest confidence, to safeguard both your commercial interests and national security.**

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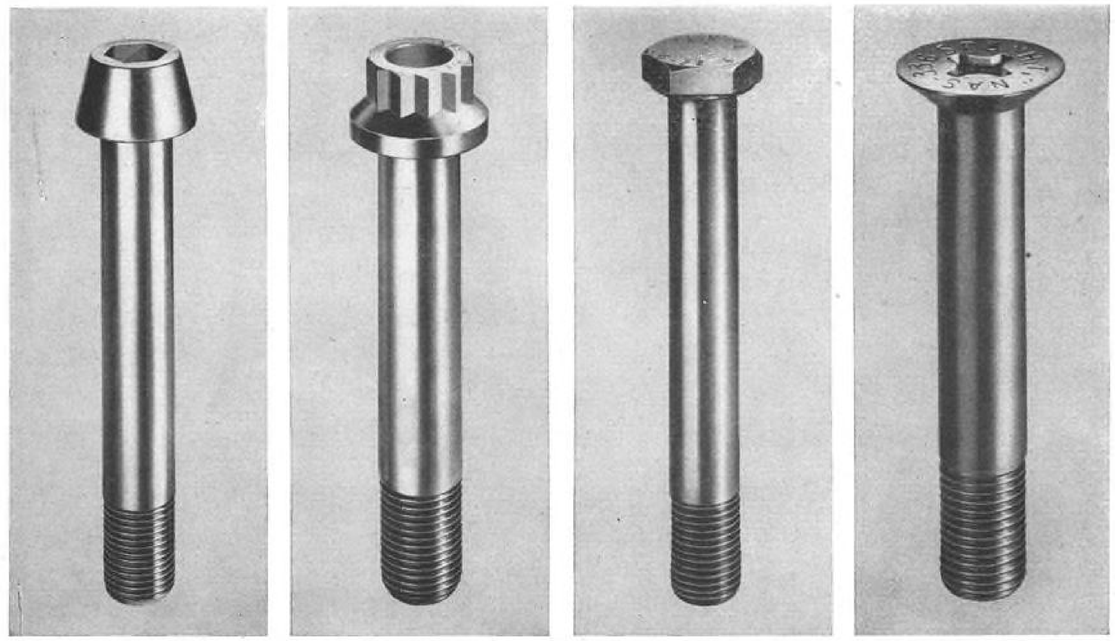
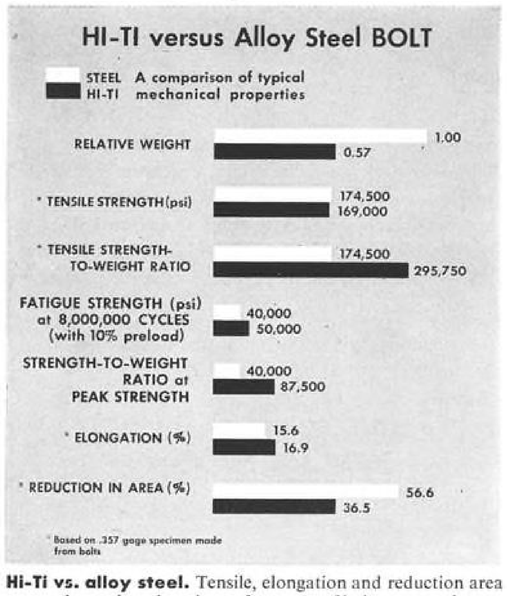
AIRCRAFT EQUIPMENT DEPARTMENT, LIMA, OHIO





**SPS Hi-Ti titanium aircraft bolts** are regularly manufactured in four standard configurations: internal wrenching tension bolts, 12-point external wrenching tension bolts, hexagon head external wrenching shear bolts, and flush head internal wrenching shear bolts. Weighing 43% less than steel bolts of equivalent dimensions, they can save you as much as 1000 lb. per airframe—with no loss in strength.

# SPS Hi-Ti titanium bolts help you build lighter airframes without sacrificing strength




**Hi-Ti vs. alloy steel.** Tensile, elongation and reduction area properties are based on the performance of bolt gage specimens. Endurance limit was determined by subjecting bolts to tension load alternating between maximum and 10% preload for a total of 8,000,000 cycles without inducing failure. Significant comparison is the strength-to-weight ratio at endurance limit.

SPS Hi-Ti titanium bolts help you solve the problem of reducing airframe weight without compromising strength. They weigh 43% less than alloy steel bolts of the same size. One lb. of them can do the work of 1¾ lb. of steel bolts. Yet in tensile-strength-to-weight ratio and fatigue resistance, they outperform steel.

Once considered a laboratory curiosity, titanium bolts have for some time been standard production items at SPS. Hi-Ti bolts are found in many advanced design operational aircraft. This is because SPS—producer of the first successful titanium aircraft bolt—invested over $500,000 and several years of high priority research in learning how to deal with this promising but sensitive metal. Today SPS has the most extensive facilities in the industry for the production and testing of titanium fasteners. As a result, we can give you both the technical assistance and the delivery you need to utilize fully the advantages of titanium bolts in your current airframe projects.

For more information on Hi-Ti titanium aircraft bolts, write Aircraft Products Division, STANDARD PRESSED STEEL Co., Jenkintown 3, Pa.

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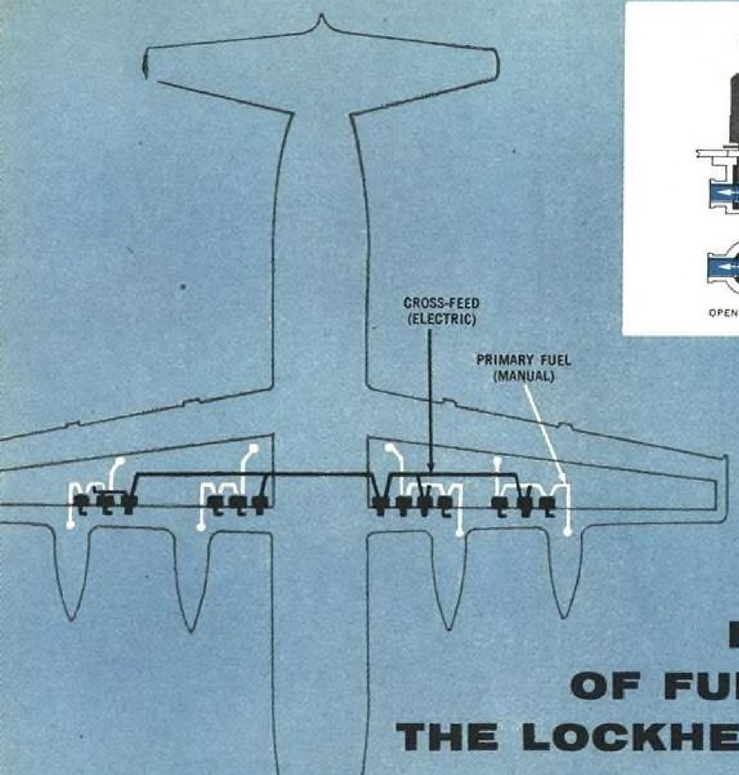


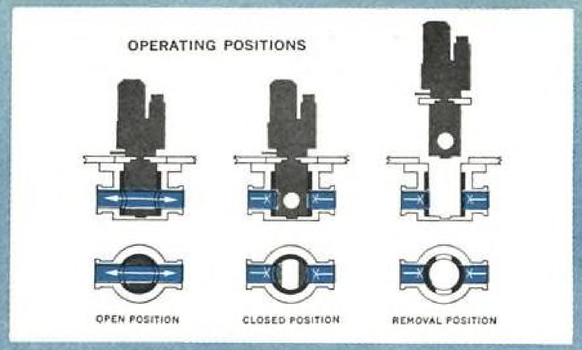

Wing section shows typical mounting position for both manual and motor-operated fuel valves.

# NEW KIND OF FUEL VALVE FOR THE LOCKHEED ELECTRA

**AV-16 motor-operated fuel valve.** "Electra" has 5 to control cross-feed.

**AV-16 manual fuel valve.** "Electra" has 8. Actuators can be removed without draining tanks or breaking fuel lines.

Lockheed issued this challenge: the wing configuration of "Electra" called for an entirely new concept in immersible fuel control valves. In open competition with other valve manufacturers, General Controls met this challenge head-on and was selected because of its volume production reputation and design superiority. The advanced General Controls design best met Lockheed's requirements—in operating characteristics, unique accessibility for simplified maintenance and dependable performance under all operating conditions.

Now all fuel lines are routed *through* the integral wing tanks, saving valuable space for vital engine controls. The valve actuator can be removed for service without disconnecting fuel lines or draining tanks.

It is this ingenuity that causes important aircraft manufacturers like Lockheed to rely on General Controls for automatic and manual valves. If automatic controls figure in your specifications, contact...consult...General Controls.

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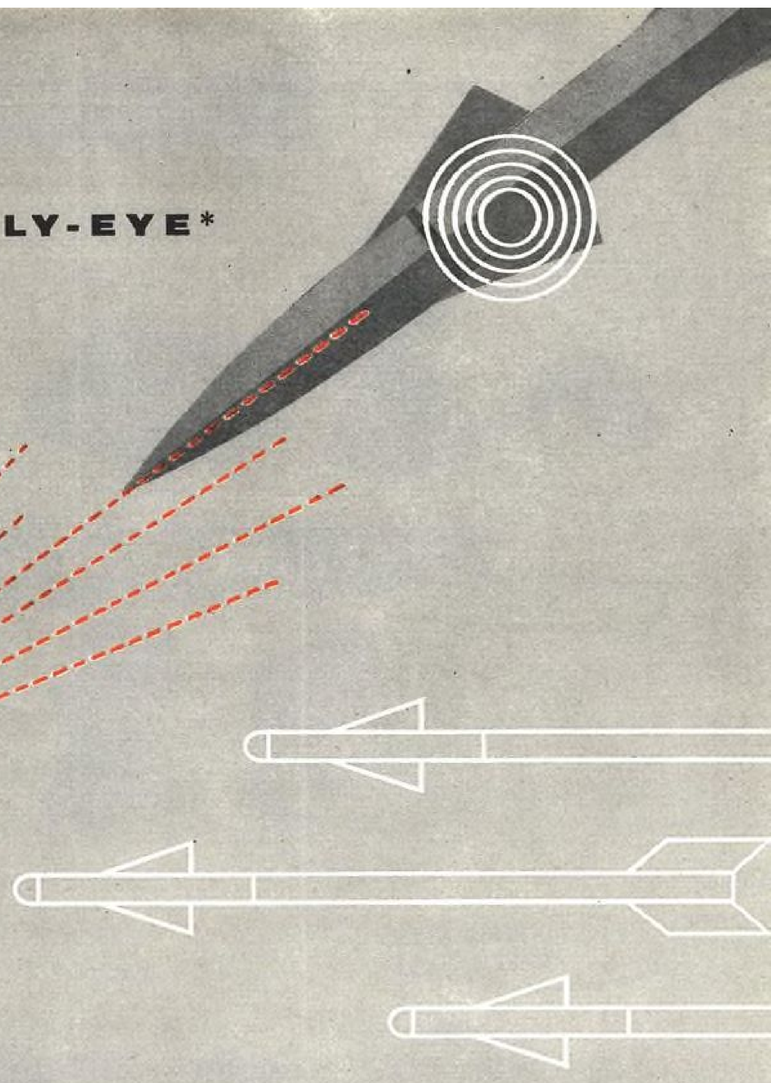

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*Today* . . . Avion's Advanced Development Laboratory is pioneering new, practical, INFRARED techniques — such as **Operation Fly-Eye*** — to meet the ever-increasing need for effective military weapons.

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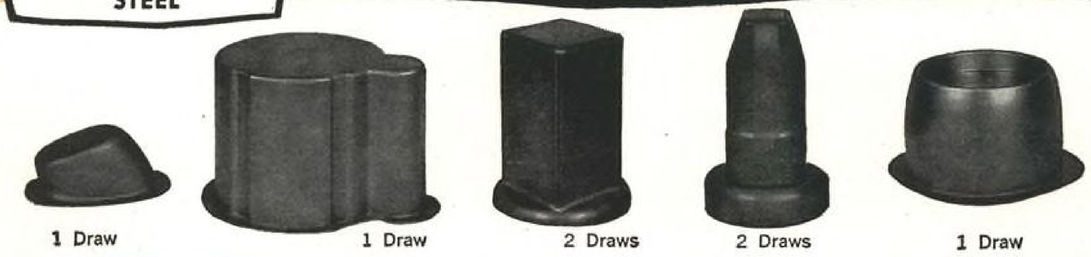

1 Draw | 1 Draw | 2 Draws | 2 Draws | 1 Draw

## of parts of almost any shape

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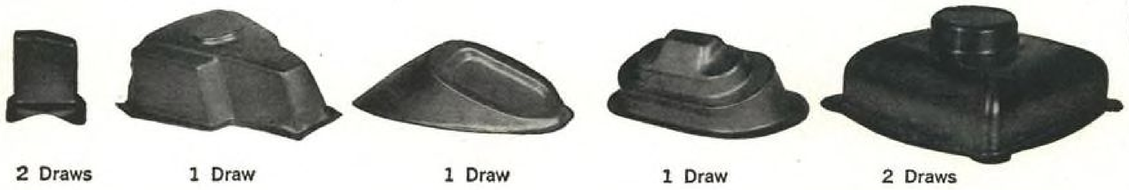

2 Draws | 1 Draw | 1 Draw | 1 Draw | 2 Draws

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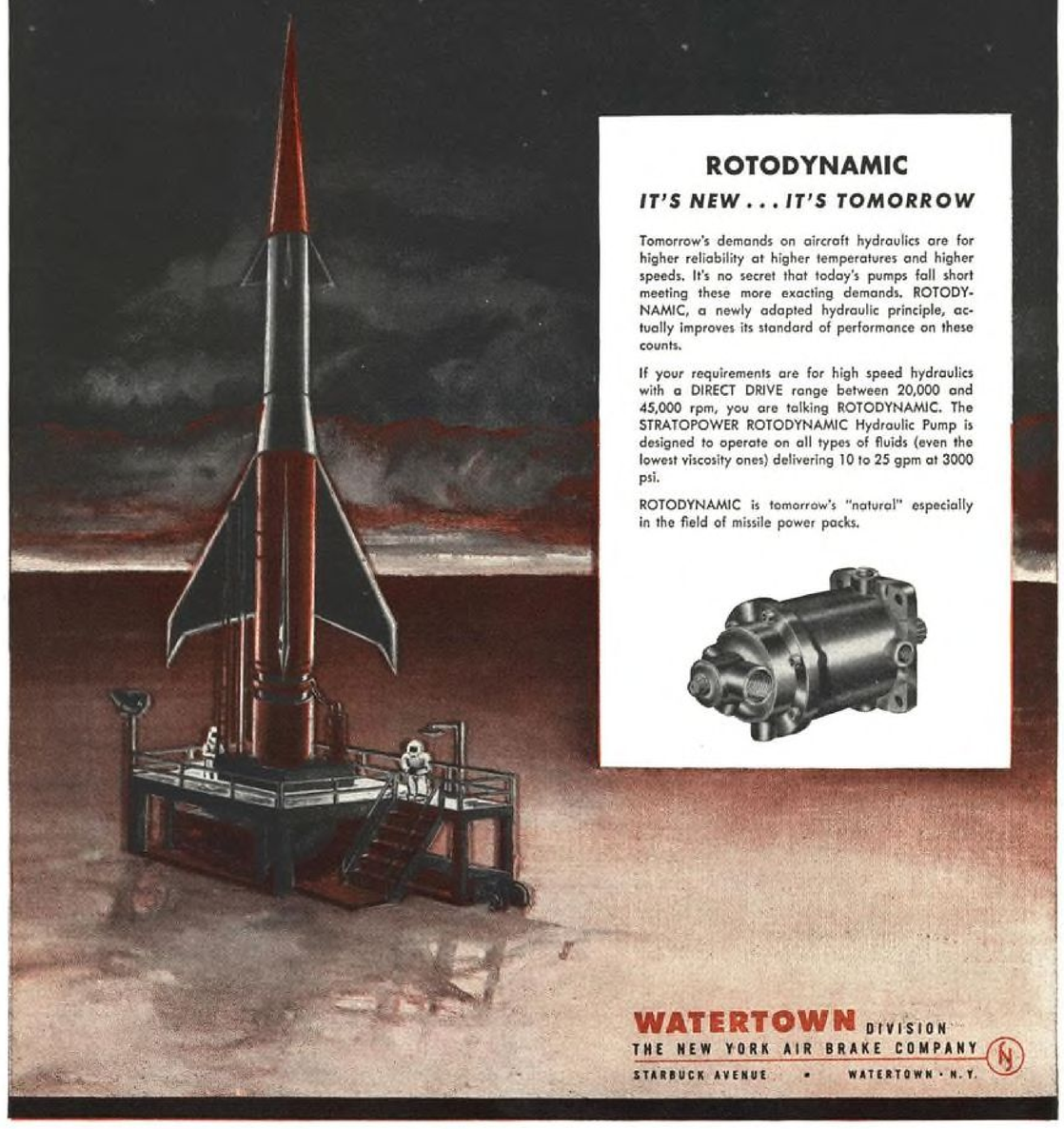

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Tomorrow's demands on aircraft hydraulics are for higher reliability at higher temperatures and higher speeds. It's no secret that today's pumps fall short meeting these more exacting demands. ROTODYNAMIC, a newly adapted hydraulic principle, actually improves its standard of performance on these counts.

If your requirements are for high speed hydraulics with a DIRECT DRIVE range between 20,000 and 45,000 rpm, you are talking ROTODYNAMIC. The STRATOPOWER ROTODYNAMIC Hydraulic Pump is designed to operate on all types of fluids (even the lowest viscosity ones) delivering 10 to 25 gpm at 3000 psi.

ROTODYNAMIC is tomorrow's "natural" especially in the field of missile power packs.



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*. . . and Sinclair helps American spare the horses!*

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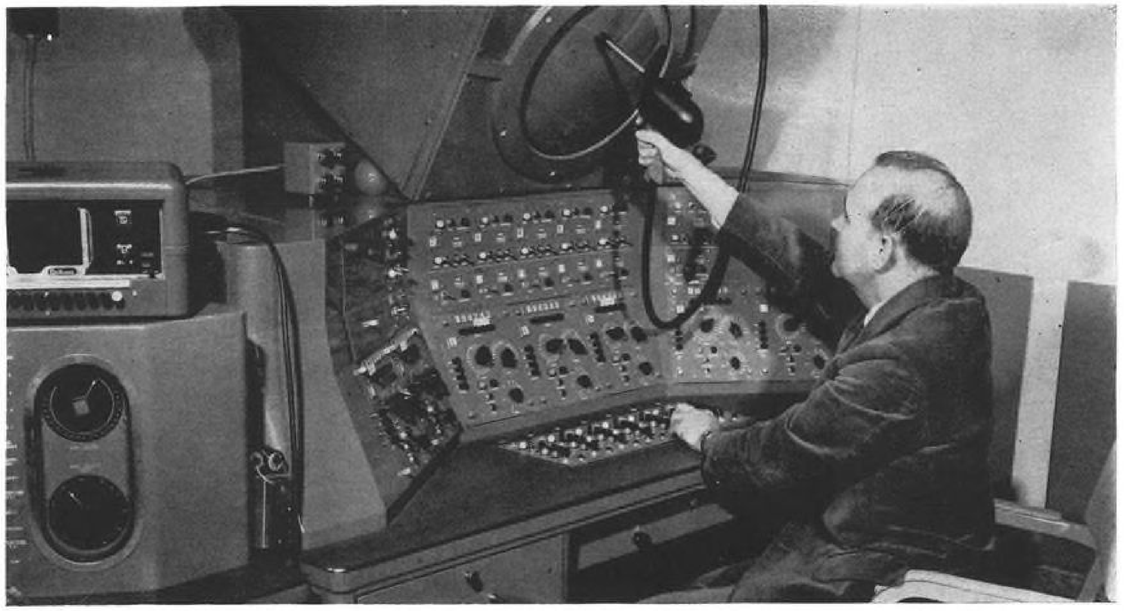

Scientist operates Cambridge-developed light gun used in the VOLSCAN air traffic control system. Use of the gun puts an aircraft "blip" under control of a computer which directs the aircraft to a timed landing under all weather conditions.
*"U. S. Air Force Photo"*

# CAMBRIDGE RESEARCH CENTER DEVELOPS SUPERHUMAN EYES AND EARS FOR AIR FORCE

At the Air Force Cambridge Research Center, in Bedford, Mass., the Air Research and Development Command has a broad program under way in electronics, geophysics and human engineering – and is expanding into many new areas in these fields.

The objective of much of the Center's electronics research is to improve the systems and instruments that serve as visual and auditory senses for the Air Force, making it possible to control and detect the incredibly fast missiles and planes of today and tomorrow. Such work has included development of "super systems," such as the SAGE air defense system, which provides coordinated aerial detection and interception over a vast area. Other projects include mobile, tactical air control systems (TACS); advanced radar for ground, aircraft and missile systems; automatic aerial traffic control systems, such as VOLSCAN; research in computer techniques, as well as creating computers for Cambridge's own use; and extensive work in communications, data processing, magnetics, radiochemistry, weapons control systems, and many other fields.

Cambridge is cooperating closely in the International Geophysical Year – as well as doing its own research into meteorology, auroral physics, storm detection and weather forecasting techniques, the upper atmosphere, meteor physics, jet stream research, and many other areas now becoming of intense interest to practical science.

This Center is also responsible for a broad program in "human engineering." It is concerned with research on hearing, speech intelligibility, and information processing by the human operator. Other studies involve the human limitations and capabilities of members of complex communications and control networks.

Cambridge, located at L. G. Hanscom Field, makes use of the talents of hundreds of government scientists and engineers – and also draws upon the brain power of a great many universities and colleges, as well as industrial organizations – helping to keep the United States technically second to none.


This is one of a series of ads on the technical activities of the Department of Defense.

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November 18, 1957

# AVIATION WEEK

Vol. 67, No. 20

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**COVER:** In tight diamond formation, U. S. Navy Blue Angels flight demonstration team starts a roll to the left in new area-ruled afterburner-equipped Grumman F11F-1 Tiger fighters over practice area south of Pensacola Beach, Fla. Colored water streams from their wingtips to define their flight pattern. Practice flights are run twice daily to maintain team proficiency for heavy annual show schedule. For details of Blue Angeles crowd-catching demonstration routine see story beginning p. 70.

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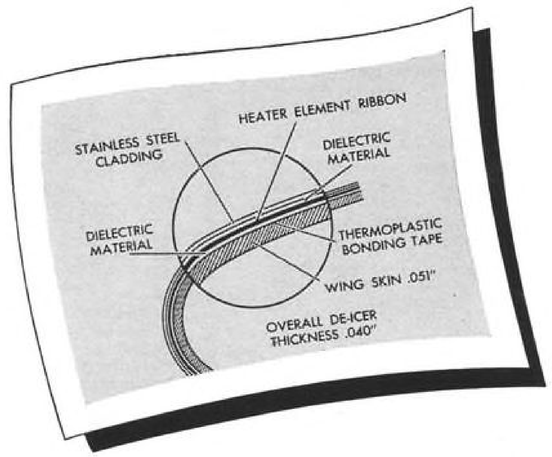


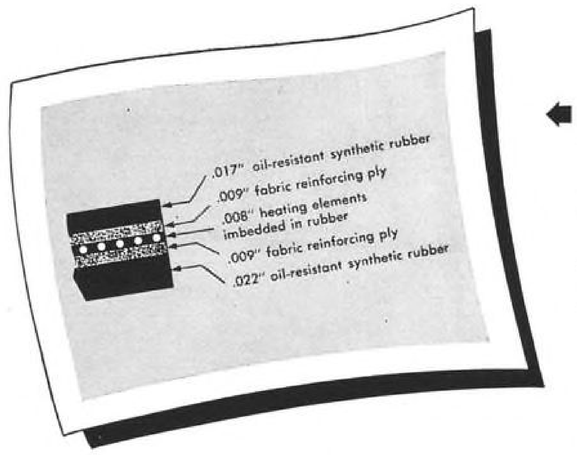


**2. HEATED RUBBER**—B.F.Goodrich electrically heated rubber is a lightweight method of supplying heat for ice control in localized areas such as air intakes, cowls, propeller blades and spinners. Typical applications—Lockheed's Constellations and C-130. Heating elements arranged for proper heat pattern are sandwiched between thin, flexible sheets of rubber to fit complex curves or flat surfaces. Power density can be as high as 40 watts psi—overall thickness as small as .030".

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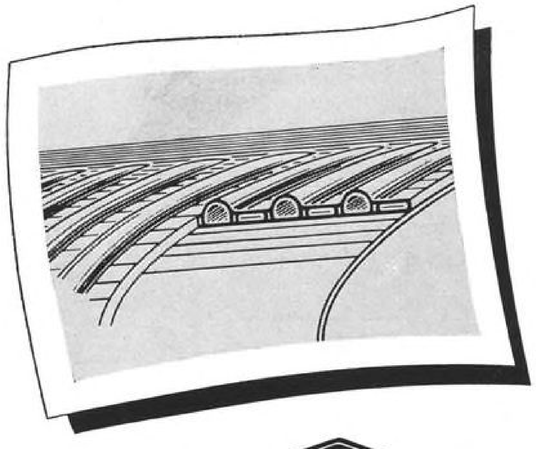

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# EDITORIAL

## Mr. McElroy Goes to Bat

During his first months in the Pentagon as Secretary of Defense Mr. Neil McElroy, the Cincinnati soap magnate, has made a vigorous start on reversing the most dangerous policies of his predecessor, the Detroit automobile engineer Mr. Charles E. Wilson. Last August (AW Aug. 19, p. 21) we warned that Mr. McElroy was inheriting a "can of worms" in the Pentagon not of his own making that would make it extremely difficult for him to make the proper progress before he untangled this mess.

In his first few months in office Mr. McElroy has made his position crystal clear on four basic issues that reverse prior Pentagon policy.

They are:

• **Quick affirmation** of his belief in basic research as a foundation for military technology. This was one of the major issues in the Pentagon during Mr. Wilson's regime. He never lost an opportunity to wisecrack derisively at basic research and the impractical "eggheads" who wanted to find out why the grass is green, or to build an atomic powered airplane or explore space.

### Right Side

The fact that Mr. McElroy put himself quickly and unequivocally on the record on the right side of this vital issue should do much to heal the breach between the scientific community and the Pentagon opened by Mr. Wilson's open contempt for basic research.

• **Quick restoration** of the $170 million cut in research and development funds below the level appropriated by Congress. This cut was one of Mr. Wilson's last official acts in the Pentagon and its restoration was one of Mr. McElroy's first decisions as his successor. It reinforced Mr. McElroy's early affirmation of his understanding of the role of science in military technology.

• **Prompt action** to restore $400 million in procurement funds being withheld by the Defense Department in an effort to keep under the $38 billion expenditure ceiling imposed by the White House for Fiscal 1958. The tremendous financial dislocation of the aircraft industry threatened by this action has been reported in detail during the past months by our military editor, Claude Witze. The fact that this action meant that the United States government would in effect be "welching" on its legally contracted debts and would force a tremendous slow-down in the production of new military weapons was quickly grasped by Mr. McElroy. He was equally prompt in taking action to restore these funds and move toward a workable solution of the problem.

### Industry's Own Funds

We predict that the aircraft industry will be more than willing to assume a larger share of financial responsibility for its operations in the climate created by Mr. McElroy's understanding of the issues at stake.

• **Decision** to permit the Army to make a satellite launching attempt with its Jupiter C three stage research missile. The basic decision to separate the satellite program from existing military technology and hardware spotlighted more than anything else the basic misconception of the role of science in military technology that had dominated government thinking in the past. Mr. McElroy's decision to permit the Army to use its off-the-shelf hardware for a satellite program is a reversal of this unsound policy and a positive step in the right direction.

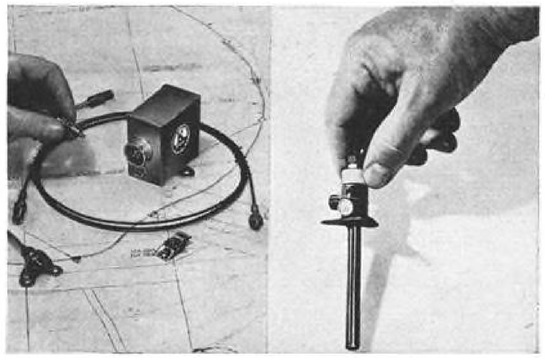
In view of this action it appears possible that Mr. McElroy will also erase the stigma placed on space research by his predecessor and soon lay the groundwork for a sound program in this area, steering carefully between the enthusiastic promoters who want to establish colonies on Venus and the ultra-conservatives who still can't see the military implications of satellite and manned space stations.

### Burdensome Legacy

Mr. McElroy's task in running the Pentagon at one of the most critical moments in our history as a nation is enormously complicated by the legacy left by his predecessor. He will have to wrestle with these problems as well as the new ones created by the galloping technology of our times.

Mr. McElroy is off to a good start with a series of steps that should rally to his support all of the military, scientific and political elements that give the genuine welfare of their country top priority and are willing to work vigorously and unselfishly to preserve its future.

—Robert Hotz



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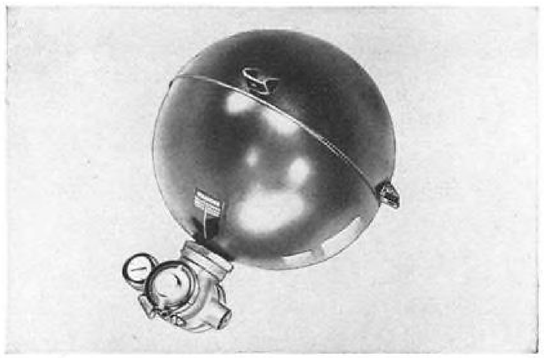

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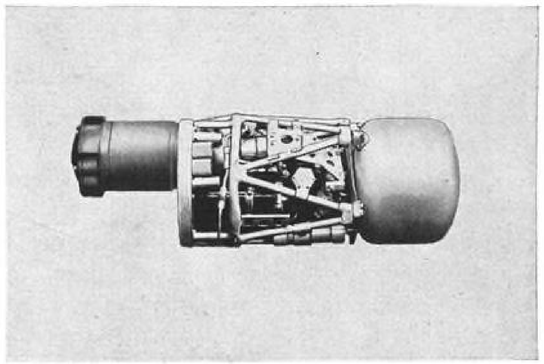

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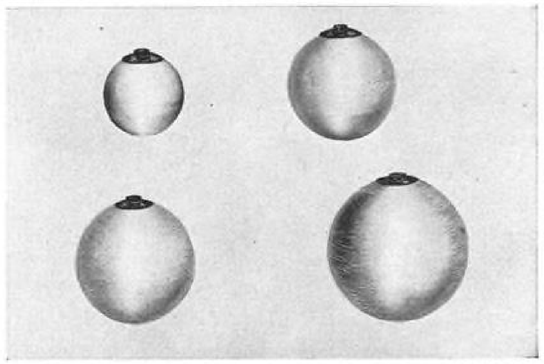

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**William H. Garbade**, a director, Hycon Mfg. Company, Pasadena, Calif.

**Raymond W. Searle**, president and treasurer, Technology Instrument Corp., Acton, Mass.

**William L. Wearly**, president, Joy Manufacturing Co., Pittsburgh, Pa. **A. B. Drastrup** succeeds Mr. Wearly as executive vice president.

**H. B. Sallada**, senior vice president-Programs Management Dept., Chance Vought Aircraft, Inc., Dallas, Tex. Also: **J. R. Silverman**, program management director, and **Forbes Mann**, long range planning director.

**Leonard M. Clark**, vice president, and **George F. Hagger**, vice president-engineering, Snap-Tite, Inc., Union City, Pa.

**Clifford C. VanderWall**, vice president-manufacturing, Ansul Chemical Co., Marinette, Wisc.

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**Frederick H. Guterman**, a vice president, Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

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**Walter H. Powell**, vice president, International Resistance Co., Philadelphia, Pa.

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**P. F. Bauer, E. J. Mercer** and **William M. Wallace**, vice presidents, Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.

**Dr. Walter R. Dornberger**, technical assistant to the president, Bell Aircraft Corp., Buffalo, N. Y.

## Honors and Elections

**Adm. Arthur W. Radford** (USN, ret.) has been named to receive the 1957 Forrestal Memorial Award by the National Security Industrial Association. The award is given annually to "a distinguished American whose leadership has promoted significant understanding between industry and government in the interest of national security."

## Changes

**Fred Thearle**, chief engineer, Transland Co., Torrance, Calif.

The project systems branch of Lockheed's Missile Systems Division, Sunnyvale, Calif., has appointed the following staff managers: **E. R. Proctor**, schedules and coordination; **Karl J. Wein**, support systems; **Harry Windsor**, logistics.

**Cameron N. Lusty**, weapons system consultant, Avien, Inc., Woodside, N. Y.

**Dr. Clement J. Savant, Jr.**, director of engineering, American Electronics, Inc., Los Angeles, Calif.

# INDUSTRY OBSERVER

► Rocketdyne Division of North American Aviation is developing a rocket engine of under 10,000 lb. thrust with a firing time of up to 10 min. for aircraft applications. Engine, being built under Navy contract, would give existing aircraft additional zoom capability plus some maneuvering ability at higher than normal altitudes, or greater horizontal speed capability.

► **Approximately four Fairchild Goose missiles have been flown in development program to date. Except for structure surrounding turbojet engine, design is an almost all-plastic configuration about 40 ft. long with triangular wing.**

► Air Force has spent approximately $12 billion thus far in support of development programs for titanium and its alloys. Industry is now working closely with metal developers to achieve alloys best suited to normal production processes.

► **Piasecki Aircraft Co. is developing under Navy sponsorship a four-rotor drone helicopter for over-the-horizon anti-submarine work using sonar, other gear. Machine is omnidirectional due to square configuration, can carry depth charges.**

► Tests of Lockheed F-104 equipped with MB-1 Genie atomic air-to-air missile are scheduled to begin within the near future.

► **Cincinnati Milling Machine Co., in experiments to investigate metal cutting at extremely high speeds, has achieved metal removal on one type of steel at 16,000 surface ft. per min. Studies are aimed at helping overcome production difficulties during next decade.**

► First aircraft produced under North American Aviation's WS-202A long-range interceptor project will be designated the YF-108.

► **Work on solid propellant powerplant for Navy's Polaris fleet ballistic missile has been curtailed by recent accidents at Aerojet's Sacramento solid propellants plant in which some key personnel were injured and facilities severely damaged by several explosions.**

► Prototype Boeing 707 jet transport is having a Pratt & Whitney J75 turbojet engine installed in the number two position inboard on the left wing for tests. Necessary modifications are scheduled to be completed by the end of the month.

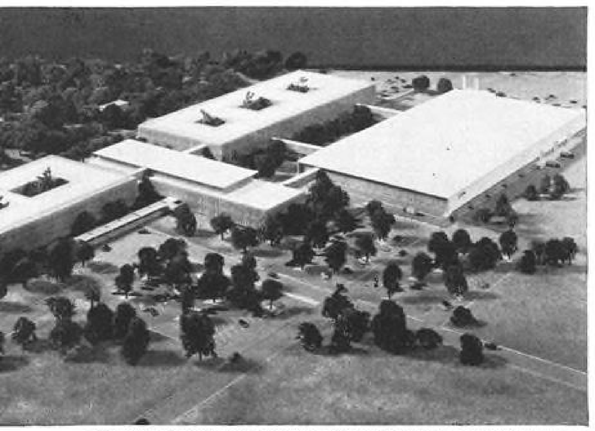
► **Refinement testing is being continued at Naval Ordnance Test Station, China Lake, Calif., on Aerojet-General's solid propellant booster for Boeing Bomarc interceptor missile.**

► Army, in its drive to cut helicopter operating costs further, says one important factor is the flow of engineering changes. Army holds some of these are made without proper consideration of the amount of inventory rendered obsolete by retrofit orders. Army policy now is to avoid retrofit with improved components unless there is good economic justification in order to limit drain on current expenditure rate.

► **USAF's new combined functions range to be operated over Gulf of Mexico by Air Force Armament Center, Eglin AFB, eventually is expected to serve as test area for all major USAF missiles except intermediate range and intercontinental ballistic missiles. Ballistic missiles, including Navy's Polaris fleet ballistic missiles, will demand all time and facilities at USAF Missile Test Center, Cape Canaveral, Patrick AFB, Fla. Firings of Boeing Bomarc interceptor missile probably will move to Eglin, and range also will be used for some bomb, rocket and gun testing.**

► Lear Inc. is working on improved weapons guidance instrument systems for USAF. Recent contract by Air Materiel Command for continuance of the work totaled $5.4 million.

Dr. Arne Wikstrom



Pictured above is our new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion in early 1958, this ultramodern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

# A SCIENTIST-ENGINEER SPEAKS ABOUT AVCO

MORE AND MORE it is being appreciated that no sharp borderline between science and engineering should exist. These two fields must strongly overlap to bring into being the fullest creativity of both.

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Industrial research must rest on the foundation provided by the creative basic scientist. Yet its end product—new commercial items, new defense systems and new techniques—comes into being only through the insight and skill of the creative engineer.

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A. Wikstrom

Dr. Arne Wikstrom
Special Technical Assistant to the President

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*Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.*

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# Washington Roundup

## Why New R & D Ruling

Discount reports that the Defense Department's revision and expansion of its "Policy on Basic Research" issued last week points the way to a 100% increase in the research and development budget. More money will be spent in this area but a doubling of the program is not likely. Real reason for the new policy directive—to restore badly damaged morale among scientific workers in the Defense Department, universities, government laboratories and industry. Redefinition and new pledge to support basic research was a pre-Sputnik idea, launched not long after Frank Newbury had his major row with the Defense Science Board last spring (AW April 15, p. 26). Departure of Newbury from the post as Assistant Secretary for Research and Engineering and of Charles E. Wilson as Secretary of Defense made it timely to release the new policy.

## Non-Partisan Blame

The many protestations of non-partisanship in the forthcoming Senate Preparedness Subcommittee's investigation of the missile-satellite programs are being accepted with tongue in cheek in congressional circles (AW Nov. 11, p. 31).

Latest declaration was by Edwin L. Weisl, newly appointed counsel of the subcommittee which is headed by Sen. Lyndon Johnson (D.-Tex.), Senate majority leader. Weisl, 60-year-old New York corporation attorney, announced on taking over direction of the inquiry:

"Sen. Johnson is not interested in fixing the blame. He is interested in finding out what is right, not who is right, and what is wrong, not who is wrong. He wants this study to be beyond reproach. He wants to uncover all the facts to make this country secure and safe."

In public speeches and testimony, however, Democrats pin the start of the missile program lag with the inauguration of the Eisenhower Administration in 1953; Republicans with the 1945-52 Truman era.

Preparedness Subcommittee hearings are scheduled to start Nov. 25. The plan is to have some open and some closed-door sessions.

## Position Available

President Eisenhower's report that Secretary of State John Foster Dulles will add a science adviser to his staff was uttered with more confidence than the State Department can justify. The search has been on for a year and none of the top flight men who have been approached will accept the job. There are two reasons. One, to which the State Department will admit, is budgetary. The other, not mentioned, is the security check to which an agreeable candidate would be subjected. Any scientist worth his salt can get just as good a job outside the government without facing the horror of a rundown from the Dulles sleuths.

## Holaday's Role?

One of the major mysteries resulting from President Eisenhower's first "confidence-building" speech concerns the status of William M. Holaday, Special Assistant to the Secretary of Defense for Guided Missiles. The White House said steps have been ordered to make sure Holaday "is clothed with all the authority that the Secretary himself possesses in this field."

When the job was created in March, 1956, Charles E. Wilson, then Secretary of Defense, said Eger V. Murphree had been given authority to get the missiles program "really under way." The directive establishing the office says Murphree and Holaday, his successor, "will be responsible for the direction and coordination of all activities in the Department of Defense connected with the research, development engineering and production of guided missiles, except those types already adopted for service use."

When Holaday entered the picture last May, the job was expanded, and the Vanguard satellite program included in Holaday's bailiwick. Wilson's opinion was that the satellite "is a scientific curiosity, but it's not of any great interest on the part of the military."

Eisenhower's remarks probably were made to torpedo the Wilson philosophy once and for all, giving Neil H. McElroy, new Defense Secretary, full encouragement to work on scientific curiosities.

## Missile Expenditures

Defense Department expenditures for missile programs for the four fiscal years 1955 through 1958 will amount to over $6.5 billion, according to Dr. Paul D. Foote, Assistant Secretary of Defense for Research and Engineering. The breakdown: 1955, $718 million; 1956, $1,168 million; 1957, $2,102 million; 1958, $2,541 million. The Fiscal 1958 figure does not reflect any acceleration which might be ordered for the program.

## West Coast Requests

U. S. attitude toward granting additional routes for foreign air carriers to the West Coast appears to be stiffening, perhaps because of the large number of requests. Almost every foreign airline not now authorized to fly to the West Coast would like to extend its routes across the U. S. or be permitted to fly the Polar Route direct from Europe. State Department and Civil Aeronautics Board officials and industry representatives have been discussing civil aviation matters with various countries including Spain, Switzerland and France.

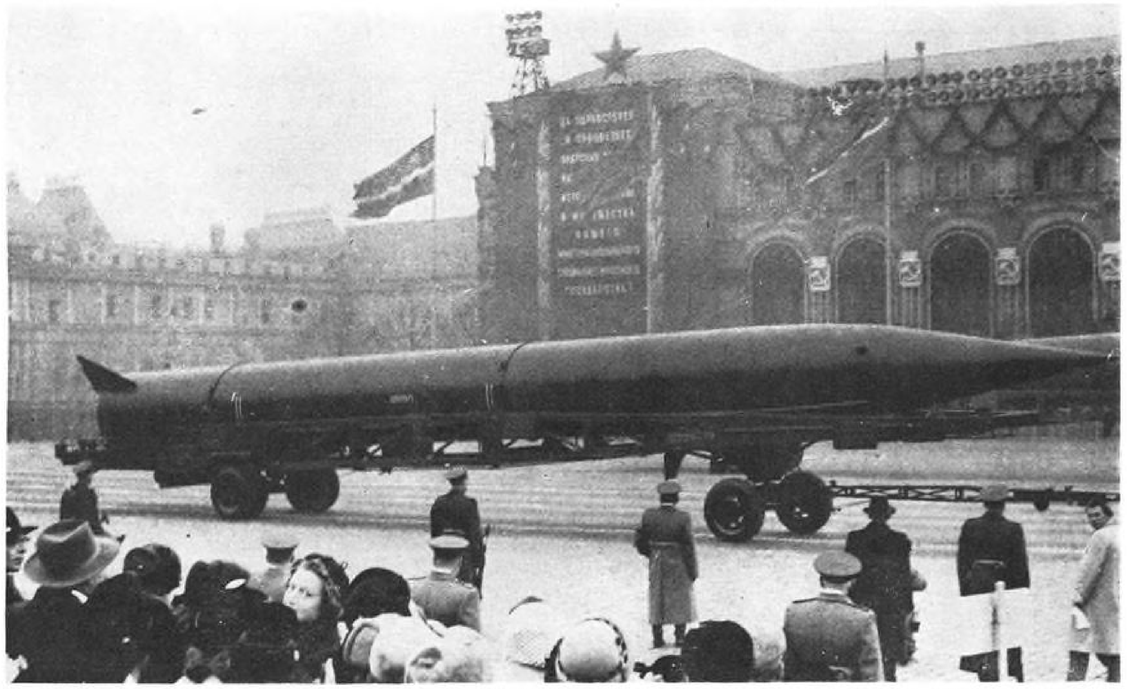
## Progress Payment Cut

Cost-plus-fixed-fee contractors no longer are eligible to benefit from government financing of all costs for inventories, work-in-progress and services. New Defense Department Directive (No. 7800.6, Nov. 1, 1957) cuts these progress payments to a maximum of 80% as predicted by USAF more than two weeks ago. (AW Nov. 4, p. 26). Directive says specifically that the extent of the contractor's capital investment will be considered when the fee or profit is fixed. An exception can be made in the case of a small business, where the rule would invoke a hardship.

## MATS Investigations

Staff of a special Senate Commerce Subcommittee headed by Sen. Warren Magnusen (D.-Wash.) moved forward last week with an investigation of the operations of Military Air Transport Service, submitting a detailed questionnaire to Defense Department. Hearings are expected to begin after the convening of Congress in January.

—Washington staff



**SOVIET T-2** intermediate range ballistic missile rolls into Red Square on highway transporter during 40th anniversary celebration of Bolshevik revolution. T-2 has a range of about 1,000 miles and uses liquid oxygen and kerosene propellants. Design shows many basic influences of German V-2 techniques including control system. Missile is about 70 ft. long and has been in production nearly a year.

# Man in Space Needed to Recapture Lead

## U. S. scientists warn that satellites are not enough to overtake Soviet's technical-propaganda lead.

By Evert Clark

**Washington**—Increasing number of scientists are warning that the U. S. will not regain technological-propaganda lead over Russia unless it puts a man into space first. This would take at least four years by the most optimistic estimate.

Regardless of who wins this important lap in the race for space, many scientists believe this country will live in the shadow of superior Soviet achievements in this field for the next several years.

U. S. last week dropped its pose that it is not in competition with Russia by assigning a top priority rating to the Vanguard satellite program. This has been reserved for ballistic missile programs until now.

It also departed from policy by ordering Army to begin launching satellites with its Jupiter C ballistic test vehicle. Until now, the satellite program has been described as a purely scientific effort, deliberately kept apart from weapons programs.

But a growing number of scientific and technical advisers, many of them within the government, believe the Russian military-technological-propaganda threat demands much bolder programs than anything now being given serious consideration at top government levels.

Some even suggest skipping such steps in the logical development sequence as the hypersonic bomber and trying to put a permanent space station into orbit within five to seven years.

### Soviet Missiles

Russia already has missiles capable of carrying 5,000 lb. warheads—with several megatons explosive power—over ranges of 5,000 mi., according to some estimates. Launching of satellites and successful firing of at least two intercontinental missiles tends to confirm this.

Scores of firings of intermediate range ballistic missiles also leave little doubt that Russia is well on the way to solving re-entry and guidance problems for missiles of this type.

If Soviet T-2 IRBMs (see box) also are used as later stages of the T-3 intercontinental ballistic missile, as most observers believe, then accuracy of the IRBMs launched so far may mean the guidance solution for the ICBM also is near at hand.

Sputnik I and Sputnik II launchings—using the T-3A vehicle, modified from the ICBM—obviously are first steps in an extensive, carefully-planned Soviet space program. In addition to the 228,000 lb. thrust engine used in the ICBM and Sputnik launchers, Russians may soon have an engine rated between 800,000 lb. and 1,000,000 lb. thrust for use in hypersonic bombers or for space exploration.

T-4 hypersonic bomber test vehicle and T-4A hypersonic bomber, for attack at Mach 12-15, already are at least in the planning stages.

Most U. S. observers do not believe either Sputnik launching gives an indication of Russian missile guidance capability. They say error indicated if Russians were aiming for circular instead of elliptical orbit is so great that it is unsafe to assume it is an error. High accuracy of IRBM firings also casts doubt on the circular orbit theory.

Although chemical propellants are capable of having achieved the Sputnik satellite launchings and probably will continue to be used for all U. S. military rockets, space exploration will require advances in this area as well as others.

Russians continue to boast of their apparent lead in rocketry and space techniques but admit they have not solved all their problems, either.

Academician Leonid I. Sedov, writing in Pravda on his trip to Barcelona, as chief of the Soviet delegation to the International Astronautical Congress (AW Oct. 14, p. 29), credited his country's lead to "timely understanding of the correct technical paths and correct concentration of effort and means on the most important tasks."

"The reports presented by foreign scientists permit one to conclude that in solving the problems of cosmic flight, the USSR has moved ahead not alone by the fact of launching an artificial earth satellite," Sedov said.

"Soviet science also can boast important achievements in the field of pure theoretical investigation."

Sedov said acceptance of Russian as an official language at the Congress was a significant demonstration of the esteem in which Soviet research is held.

Near-term problems "still to be solved," he said, include return of satellites to the earth, launching of manned satellites and flight to or around the moon with return to the earth.

Moscow Radio also said last week that "at present it is not the aim" to recover satellites. The broadcaster noted that animals had been saved from rocket flights even though "the rocket burned itself out," and said "something similar can be rigged up for a Sputnik. The task for the moment is still very complicated, but realizable."

Sputnik II's radio transmitter died several days after launching, lending strength to Russian statements that the experiment was intended to last only that long, and that the dog was dead.

Sputnik I's transmitter lasted three weeks.

Pravda last week confirmed that Sputnik II is the final stage of a multistage rocket (AW Nov. 11, p. 29) and said it shed a small protective nose cone when it went into its orbit. Cosmic, ultra-violet and X-radiation were measured with instruments mounted on a circular table farthest forward. Behind this was a spherical container similar to the first satellite. It contained two transmitters, electric batteries, a heat regulator and sensing elements to measure temperature, etc.

Back of this was a hermetically sealed sphere, protruding from the rocket's body and containing Laika, her food supply and instruments for recording her respiration, heartbeat and blood pressure.

Astronomer F. Y. Zigel wrote in the trade union paper Trud that hundreds of rockets eventually will go to 3,000 mi. and eject giant satellites called "cosmic institutes" and carrying not only scientific instruments but fuel for interplanetary ships.

U. S. efforts to regain lost prestige resulting from Sputniks led to assignment of DX priority ratings to contracts and purchase orders for research and development, production and construction materials for Project Vanguard. Vanguard has been designated as Brick-Bat .03 on Defense Department's Master Urgency List.

Army's satellite launching schedule had not been announced late last week. But observers who have followed the Army proposals doubt that anything larger than 500 lb. can be launched before the end of 1958 by Army or Navy—leaving the U. S. approximately a year behind Russia's present position.

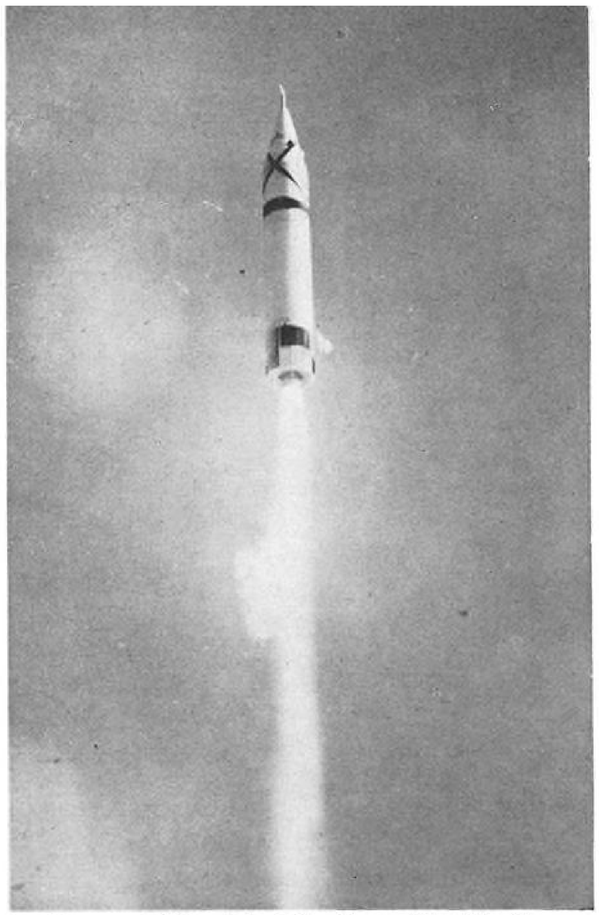
The five U. S. ballistic missile programs, meanwhile, are averaging a 43-44 hour work week. The average is raised considerably by testing programs, which are the most active. Average shortly before Defense Secretary Neil McElroy took office was 41 hours.

### Soviet Missiles

**Washington—Soviet missile and hypersonic bomber program includes these models now in production, testing or developmental stages:**

- **T-1 (M-101)—Motor of 77,000 lb. thrust, improved from the German V-2 engine. Forerunner and test vehicle for intermediate range ballistic missile (IRBM).**
- **T-2 (M-103)—IRBM, with 228,000 lb. thrust motor. Motor had been tested as early as 1950 or 1951.**
- **T-3 (M-104)—Intercontinental ballistic missile (ICBM), probably using two 228,000 lb. T-2 motors plus a T-1.**
- **T-3A—Sputnik launcher, modified from the ICBM.**
- **T-4—Hypersonic bomber test vehicle.**
- **T-4A—Hypersonic bomber with attack capability at Mach 12-15. Rocket engine of 800,000 to 1,000,000 lb. of thrust for this vehicle and for space research may be in development now.**

**USAF THOR** intermediate range ballistic missile is roughly the same length as the Soviet T-2 on the opposite page. Nose cone shapes are radically different. Russians had extremely pointed nose on their parade missiles while Thor blunt nose cone is good example of U. S. re-entry technique. Thor uses gimballed rocket for control while T-2 uses vanes to deflect rocket exhaust in V-2 fashion.



**UNUSUALLY** clear, detailed photographs show launchings of Jupiter intermediate range ballistic missiles at Cape Canaveral launching site.

# Killian Advocates Basic R&D Changes

By Claude Witze

**Washington**—Dr. James Rhyne Killian, Jr., new Special Assistant to the President for Science and Technology, believes the U. S. must make two basic changes in its approach to research and development:

- **It must strengthen coordination** of scientific activities at the policymaking level. More skill in coordination and planning at the top, Killian contends, will improve the effectiveness of the research and development effort "all down the line." Competent advice by scientists and engineers is essential to policymaking.
- **It must invent** new ways of budgeting for research and development. The necessary compromise between economy and requirements must include allowances for "maximum freedom, a willingness to fail and a long view."

### Sputnik Benefit

Dr. Killian's approach and his recommendations are nothing new to Washington observers of U. S. effort over the past few years to keep Soviet Russia from surpassing this country in the field of technological achievement.

Some circles feel that one of the greatest benefits of the Russian satellite achievements will be that the long-standing advice of the president of the Massachusetts Institute of Technology will probably be utilized.

Dr. Killian has given this advice before such tribunals as the House Committee on Government Operations, where he testified at length in 1954 before a Subcommittee on Military Operations headed by Rep. R. Walter Riehlman (R.-N. Y.). It was expanded last year for the airpower investigation of the Senate headed by former USAF Secretary Stuart Symington (D.-Mo.).

In addition, there was a "Killian Report" on the status of our scientific effort that remains a classified document. This study actually was made for the White House by a subcommittee of the President's Scientific Advisory Committee of which Dr. Killian was a member.

It is significant that the results were laid before the President himself and then sent to the National Security Council. They were disturbing, and at the same time conservative, contending that the Russians might take the technological lead away from the U. S. in the period 1960-1965. They reported Red progress in guided missile development, massive production of long-range bombers and fast fighters and other advances.

### Turkish Radar Reports

The report was made in early 1955, and, at that time, Dr. Killian had the advantage of early sightings of Red missile activity from the then brand new radar observation post near Samsun, Turkey, which was disclosed by AVIATION WEEK on Oct. 21 (p. 26). In fact, it is believed that the Killian study and the establishment of the radar post both resulted from intelligence reports on Red missile activity going back to 1953.

Newspaper accounts of what was in the Killian report, emphasizing the possibility that Russian missiles soon would be a threat to the U. S., were flatly denied at the time by the White House. The spokesman who said the press reports were inaccurate was Murray Snyder, then acting press secretary to the President and now Assistant Secretary of Defense for Public Affairs.

### Killian Testimony

Dr. Killian told the Symington Committee last year that he had no responsibility for seeing to it that the recommendations of the Killian report were carried out. The 1955 study, he said, was made by a group of consultants "who made a report and then withdrew."

However, he already had recommended that the job to do this be given to some capable man. Before the Riehlman Committee two years earlier, he declared there was an analogy between private industry and the government in this area.

A progressive industry, he said, needed a vice president in charge of research and development to participate directly in administrative decisions. He added:

"We are approaching this kind of organizational coupling in the National Defense Department. We should develop it further and we also should apply it in each of the three military services."

At the time he spoke, the office of an Assistant Secretary of Defense for Research and Development was 10 months old. The post was filled by Donald Quarles, now Deputy Secretary of Defense. The Air Force is the only branch of the military with an Assistant Secretary for R & D.

### Importance of Management

It was before the Riehlman Committee that Dr. Killian put early emphasis on the importance of management. He found evidence that the top military leaders were poorly informed about technological developments and there was poor use of scientific counseling in the formulation of military plans. He said Quarles should have a closer relationship with the Joint Chiefs of Staff, and that the military bosses were guilty of not wanting this counsel. Dr. Killian told the committee on June 17, 1954:

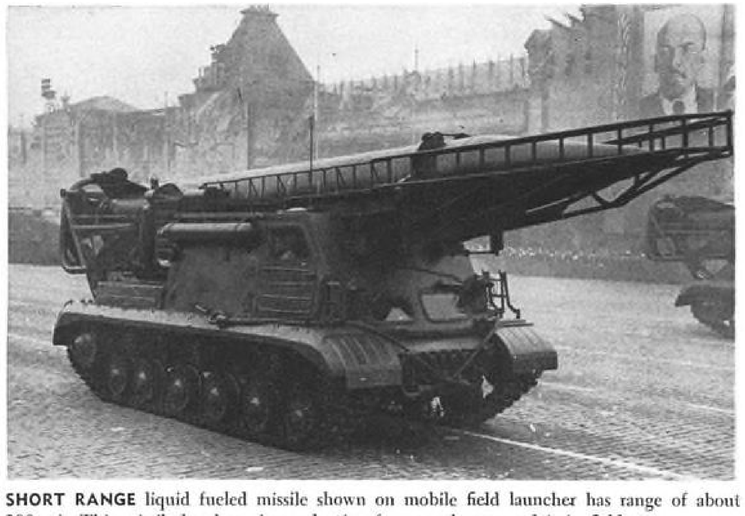
"At the present time, important new technological advances, in my judgment, are piling up and are only partially used because our normal planning and decision-making processes cannot respond and make use of them as fast as they become available.

"We need more of what the engineers call systems thinking about many of these problems that can be tied together to form a whole greater than the sum of its parts.

Dr. Killian was speaking less than

**T-2 IRBM** shown on transporter with caterpillar prime mover carrying launching and servicing crew armed with sub-machine guns. Note pointed nose.

**REAR VIEWS** of T-2 IRBM show large diameter nozzle exit and control vanes submerged in rocket exhaust. Fins appear to be fixed for stability rather than movable for control.



**SHORT RANGE** liquid fueled missile shown on mobile field launcher has range of about 200 mi. This missile has been in production for several years and is in field use.

**DISPLAY** of Soviet missile arsenal in Red Square shows eight Honest John type solid propellant short range missiles (about 25 miles) mounted on mobile field launchers at extreme right. They are followed by eight larger type solid propellant rockets also mounted on caterpillar launchers with heated covers to attain temperatures required by propellant for most efficient performance. Two 200 mi. range liquid fueled rockets are next in line with the two T-2 IRBMs bringing up the rear.

a year after the Defense Department had created a new post of Assistant Secretary for Engineering and filled it with Frank Newbury, a 79-year-old retired official of the Westinghouse Corp. Newbury's job was to screen research project results and decide which ones were practical for development and investment for future procurement. Here is what Dr. Killian thought of this procedure:

"I think in general it is very unfortunate and a great handicap if procurement is mixed up with research . . . we have had many examples . . . of where the philosophy of procurement, when it tended to dominate research, has proven a great handicap."

### University vs. Industry

Dr. Killian's appointment as White House adviser brings to the top a man whose past affiliation with government research has been as a university contractor. He does not believe, however, that universities can or should replace industry as a development agency. In fact, he believes industry should get more research and development contracts. He believes M. I. T. should do government work only more or less as a last resort and in times of emergency. The reason:

"I think in the long run it is not good for educational institutions to undertake work that is secret because it undertakes to contravene the free exchange of information, but I think there is no choice now but to do this kind of thing."

Dr. Killian was instrumental in the establishment of the Institute for Defense Analysis, a university-operated agency designed to operate and improve the effectiveness of the Weapons Systems Evaluation Group. Dr. Killian was quoted at the time as saying something had to be done to improve capabilities of the group. The methods, utilizing university talents, he recommended "reluctantly."

Before last year's Symington Committee hearings, Dr. Killian called for a program to maintain technological supremacy. He urged a new study similar to the 1948 report of the President's Air Policy Commission. The new study, Dr. Killian said, should look for the effects of technological change on management and organization.

He recommended an appraisal of these factors:

- **Utilization of scientific** and engineering manpower. As in Russia, the best men must go to work on the toughest and most important problems.
- **New attention** to those research areas that promise to help in the fields of airpower and defense.
- **Shortening of the cycle** from basic science to production. Direct action and fast decision give the Russians a one-to-three year advantage over the U. S. in this field.
- **Study of the strength** and weaknesses of our system of research, development and production as compared with the Soviets.
- **Study of the impact** of weapon systems on the military organization.

On the subject of fiscal management —the battle of the budget—Dr. Killian's key recommendation is for more flexibility. He favors a firm policy of favoring important projects and cutting back or dropping those without priority. He complains that a rigid and centralized budget makes this kind of adjustment difficult.

**DR. JAMES R. KILLIAN**

Too often, he emphasizes, it is the budget boss who dictates what will be done when the decision should be based on sound scientific judgment.

Another important factor stressed by Dr. Killian in his discussion on fiscal matters is the apprehension of budget officers in the face of possible scientific failure.

"In research," he says, "it is dangerous to be made afraid to fail. . . . There is a natural tendency . . . for fiscal controls and philosophy to encroach gradually upon the essential freedom of action of research personnel, and this is a process that must be constantly watched and resisted."

In all of his appearances in Washington, Dr. Killian has emphasized that he is not a practicing scientist or engineer. He is an administrator and always dodges questions on technical matters, referring them to the admitted experts.

The only graduate of M. I. T. ever to become president of the university, he took his degree 30 years ago as a bachelor of science in business and engineering administration. Fifty-two years old, and a native of Blacksburg, S. C., he has 16 honorary degrees, the President's Certificate of Merit, the Freedoms Foundation Award and a Certificate of Appreciation from the Army.

He has been chairman of the Army's Science Advisory Panel, chairman of the President's Board of Consultants on Foreign Intelligence Activities and is a member of the Science Advisory Committee of the Office of Defense Mobilization.

## Killianisms

- "So far there are all too few men who have the capacity to visualize and direct the integration of complicated technological systems."
- "I cannot escape the feeling that events of the technological age are moving faster than our perception of their meaning, either in industry or government, and that we need more carefully to tune in our receivers to pick up the changes which lie ahead."
- "I stress the importance of the imponderables in comparing our own present strength and future potential with that of Russia. . . . We must recognize the possibility of an intellectual surge in Russia arising out of deep motivations of a non-military sort."
- "It is the yet unanticipated, unconceived discoveries which may determine our military strength tomorrow, and we must provide the environment from which these discoveries are most likely to come."
- "Recent studies have shown that we have come perilously close to becoming a nation of mathematical illiterates in a period when mathematics is an essential ingredient of airpower."
- "Progress will be retarded unless both the top civilian and military officers . . . enunciate and follow policies which give research and development proper emphasis and urgency. I think this is fundamental."
- "We need to create in the minds of the people who work in military research and development more of a sense of urgency than I think has been created in the country at the present time. I think we are too relaxed . . ."
- ". . . Maintaining our leadership is far more important than sitting on our secrets . . . sitting on our secrets will not be the way to maintain that leadership, but the way to do it is to create advances faster than our enemy. This seems to be the crux of our problem at the present time."
- "The whole problem of security procedures and policies at the present time may be one of the things that is most hazardous to our future R&D activity in this country. . . . I think we can go overboard in letting security stifle our creative activities."

# Congress Hits Defense on Two Fronts

By Katherine Johnsen

**Washington**—Congress is tackling the problem of raising the national level of technology from two directions—increased utilization of the existing pool of trained manpower and stimulation of education in science and engineering.

- **House Civil Service Subcommittee** headed by Rep. James Davis (D.-Ga.) is riding herd on the Defense Department to eliminate waste of technical manpower in duplicative activities and to bear down on defense contractors to end hoarding of engineers and technicians or excessive job-to-job shifting.
- **Senate Government Operations** Subcommittee headed by Sen. Hubert Humphrey (D.-Minn.) last week drafted legislation to establish a Department of Science and Technology headed by a cabinet-level secretary. This is one of numerous proposals to promote scientific education that will be taken up by Congress in January.

After a week of hearings with Defense Department and other government officials, Rep. Davis declared that "it seems a fair assumption that if we could take up the slack and properly utilize our scientists and engineers on a nationwide basis, we would save for critical operations 400,000 man-years of scientific and engineering effort. This is more scientists and engineers than we could graduate from our colleges in 15 years. More than that, they are scientists and engineers who, in addition to college training, have had years of experience in their fields."

Government testimony before the Davis subcommittee was conflicting.

Robert Merriam, Assistant Director of the Bureau of the Budget, reported that "neither lack of money nor lack of manpower" has been a brake on missile programs.

### Engineer Shortage

Dr. Paul D. Foote, Assistant Secretary of Defense for Research and Engineering, told the subcommittee "there most certainly is a shortage in aeronautical and electronics engineers." He noted that components for missiles are being put in specifications, even though they have not been developed and it is known that their development "will take several years of active research." The reason for this situation, Foote said, "is because there is such a shortage of electronics engineers."

Of the 840,000 scientists and engineers in the country, Foote said, the Department of Defense directly employs only 44,000. He discounted wastage of technical manpower through duplication.

"There is some duplication—some desirable duplication," he declared. Some people, Foote said, "try to make out that the reason the Russians got ahead of us on Sputnik is because of duplication and rivalries. That is absolute nonsense. The rivalry and competition that exists in the various services has accelerated our missile program. The real reason that we are behind the Russians is that the Russians started earlier—in 1944 or 1945. We really started around 1951 or 1952. So we are four or five years behind. . . . and it is going to be hard to catch up. I do not want to imply that we are still four or five years behind. . . . I think that we are very close to the position that Russia is in."

Foote noted that after World War II "the Army wanted to pursue missile work, but they did not get very much support." The U. S. missile effort up until 1951, he said, amounted to "playing with captured V-2s."

### Humphrey Proposals

The staff of the Humphrey subcommittee proposes that—in addition to the National Science Foundation, the Smithsonian Institution, Commerce Department's Office of Technical Services and the National Bureau of Standards—consideration be given to including Civil Aeronautics Administration's air navigation development

program in the new Department of Science and Technology. The subcommittee also proposes:

• **Central clearing house** for scientific information within the new department. This would include a large staff of qualified persons to assemble, analyze translate and disseminate scientific data from foreign sources. "The need for this type of service has clearly been established," the subcommittee staff declared.

• **Establishment of an Academy** of Science patterned after the military service academies, with nominations to be made on recommendations of an appointing board of leading scientific educators.

On the international level, Sen. Henry Jackson (D.-Wash.) last week presented to the North Atlantic Treaty Organization a plan for NATO-sponsored scientific education (AW Oct. 28, p. 29). This would include cooperative training and research projects, including a guided missile training center in Europe, a NATO-wide employment clearing house, and a NATO-financed awards program for scientific teachers and students. The program would be administered by an Atlantic Community Foundation composed of two representatives of each NATO nation.

While the move to build the nation's technical manpower reserve continued to gain momentum in Congress, Sen. John Bricker (R.-Ohio) cautioned against a crash training program that would emphasize the outpouring of quantities at the expense of quality. Admitting lack of money is a factor in the deficiency, Bricker said "the major cause . . . has been the steady adulteration of educational standards."

**CLOSE-UP** of short range solid propellant rocket on mobile field launcher.

**PANORAMA** of Soviet missiles moving through Red Square, (above) with ground-to-air missile in lead on mobile field launchers followed by Katushin solid propellant barrage rocket batteries mounted on trucks and Honest John type short range missiles in rear. Closeup of Soviet ground-to-air missile on mobile field launchers (below) shows two stage solid propellant system with large fixed fins for stability and smaller movable surfaces for control. Four small antenna for guidance are located on nose. Launchers carry compressed air power source for elevating missiles to firing position.

## Wilson Says Sputnik Concern Unrealistic

**Detroit**—Charles E. Wilson, who left the Pentagon about a month ago just in time to avoid the clamor raised by Russia's two Sputniks, says the Red technological advances are making Americans jittery and unrealistic.

The former Secretary of Defense, for more than five years scornful of military demands for more scientific research, admits the Soviet satellites "are a measure of their technical competence in the ballistic missile field."

But he also believes U.S. scientists can do the same thing if they want to and that there is no proof the Russians are ahead of this country in missile development. If one country is ahead of the other, he says, it is not more than a few months either way.

Wilson spoke at a dinner given in his honor by his Michigan friends. The former president of General Motors Corp., did admit that the American people are disturbed over the Russian satellites.

He attributed this concern to the realization that for the first time America now may become vulnerable to aerial attack.

Wilson contended that the American people were too complacent last summer when Congress made an attempt to reduce the Defense Department budget from $38.5 billion to less than $36 billion.

He said he favored the higher figure—$38 billion was provided for Fiscal 1958—and indicated that he anticipates an increase in next year's defense budget.

Wilson said people outside the Pentagon, including scientists, approved of the decision to separate the U.S. satellite program from the ballistic missile program.

Wilson also argued: "we have rocket engines many times more powerful than the one that is being used for the initial stage of the Vanguard satellite."

Commenting at the dinner on the obvious evidence of Soviet satellite progress, Wilson said:

"Neither Sputnik I nor Sputnik II is in any sense a military weapon. It should be clear to everyone that bigger and better satellites, space ships or rockets to the moon will not, in themselves, solve or even help solve the problems that the free world faces today in the effort to maintain peace and avoid a suicidal conflict between the East and West."

# U.S. Proposes NATO Establish Missile Defense Training Center

**Paris**—United States delegation to a four day conference of parliamentarians from NATO member nations proposed establishment of a NATO defense missile training center as well as a North-Atlantic institute for defense studies.

American project was one of several presented the NATO group during a lively session which has been marred by stinging criticisms of past and future NATO policies as well as of national defense policies practiced by the United States and Great Britain. The NATO parliamentary group comprises some 180 delegates representing various shades of non-Communist political thinking among 15 NATO nations. Meeting annually, the group serves only in an advisory capacity. This year's meeting, coming one month before the annual NATO ministerial meeting at which heads of all governments, including President Eisenhower, will attend, has special import for NATO.

United States proposal of a defense missile training center was put before the NATO conference after bipartisan approval by the full American congressional delegation. Presented to the NATO group by Sen. Henry Jackson (D.-Wash.), the project reportedly has the "enthusiastic approval" of both President Eisenhower and his new advisor on scientific matters, Dr. James R. Killian. The proposal was well received by the NATO conference and is expected to be implemented by the upcoming NATO ministerial meeting.

Perhaps the biggest news of the NATO meeting was an attack by the so-called "continental NATO group" against American and British defense policies. The attack was contained in a much-discussed report prepared by Arthur Gilson of Belgium and Lt. Gen. Rudolph H. Calmeyer, of the Netherlands.

One charge levied in the report was that NATO ground forces were undergoing "increasing disintegration" mainly due to lack of direction from SHAPE. The report also called for transfer of the so-called military standing group of the Big Three from its present location in Washington to Paris where it could work more closely with North Atlantic Council headquarters.

Main point of the report seemed to emphasize the feeling among NATO continental nations that the present NATO military set-up does not sufficiently protect their interest. Report sharply took American and British policymakers to task for insisting up to the present on nuclear weapons monopoly. In particular the report complained that the British White Paper on defense, if carried out, would mean that continental nations would get even less than minimum support from Great Britain.

While the controversial report does not necessarily present the official at-

## KC-135 Sets Distance Records

Special version of Boeing's KC-135 jet tanker (above) set two non-stop, non-refueling, long-distance records last week as Defense Department attempted to soften the impact of Soviet ICBM statements with a demonstration of Strategic Air Command capability. With Gen. Curtis E. LeMay, USAF vice chief of staff at the controls, KC-135 flew 6,350 mi. from Westover AFB, Mass., to Buenos Aires in 13 hr., 2 min. Maximum speed was 550 mph. Later, aircraft returned to Washington National Airport, covering the 5,000 mi. in 11 hr., 8 min. Aircraft used is prototype of a SAC aerial command post (AW Nov. 11, p. 34).

# Russia's Huge Mil-6 Flies

Size of Russia's new Mil-6 helicopter, shown in first flight photo (above), is shown vividly when it is parked alongside the Mil-1, (below), the first helicopter of the series designed by M. L. Mil. Mil-6 which has five blade rotor, is powered by two turbine engines. Wheel pants and generally clean appearance indicate Mil-6 may have relatively fast forward speed. Payload is more than 12 tons (AW Nov. 11, p. 30).

titude of any continental nations, it was no secret at the session that most continental nations subscribed to most of its views. Main reason it was given such prominence, observers said, was to set the stage for the upcoming NATO summit meeting.

American proposal on a defense missile training center was part of a $10 million program which was outlined to delegates by Sen. Jackson. In addition to a missile training center, Jackson called for a "talent development program" among NATO nations under which at least 500 doctorates in science would be issued annually. He also suggested that NATO sponsor an annual program in mathematical sciences which would involve handing around some 5,000 prizes among high school students. Finally, Jackson called for a European "clearing house" under which scientists and engineers could be exchanged.

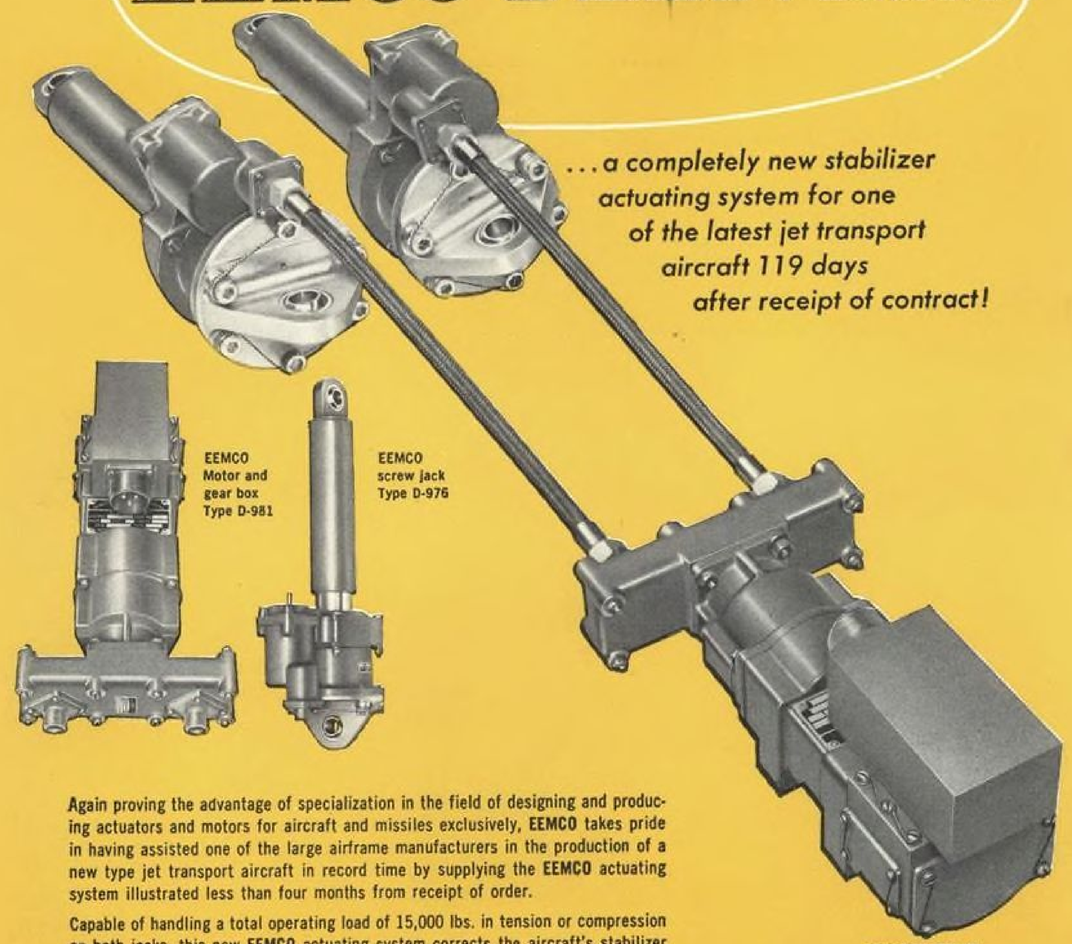
Jackson, commenting on the missile training center, said he was thinking in terms of "delivery vehicles" only and that these missiles could be supplied without any changes in law. However, Jackson and other American delegates were busily assuring their European colleagues during the session that the MacMahon Act would be modified by Congress to permit closer cooperation between the United States and NATO nations on nuclear weapons.

Gen. Schuyler told reporters that a proposed NATO missile training center was "exactly what we want and what we have been trying to get for six months." He suggested that the center be set up in the Mediterranean area.




EEMCO DELIVERS

...a completely new stabilizer actuating system for one of the latest jet transport aircraft 119 days after receipt of contract!




Again proving the advantage of specialization in the field of designing and producing actuators and motors for aircraft and missiles exclusively, **EEMCO** takes pride in having assisted one of the large airframe manufacturers in the production of a new type jet transport aircraft in record time by supplying the **EEMCO** actuating system illustrated less than four months from receipt of order.

Capable of handling a total operating load of 15,000 lbs. in tension or compression on both jacks, this new **EEMCO** actuating system corrects the aircraft's stabilizer in flight. It will operate many times during an average flight, therefore hundreds of thousands of operations will be performed during the life of the unit. **Extreme reliability** of the system was therefore a prime specification in the contract.

The 28-volt motor is equipped with radio noise filter, magnetic clutch and brake, and an integral gear box with dual output shafts that drive the synchronized screw jacks at loads up to maximum capacity. Ultimate load on each jack, which is equipped with non-jamming stops, is 50,000 lbs. tension or compression. The jacks, with a stroke of 8.25 inches at .3 inch per second at maximum load (15,000 lbs.), are equipped with an auxiliary reduction for a control mechanism.

The proven elements of this efficient **EEMCO** actuator system, motor with gear box and the jacks, can be adapted for other uses individually or in similar assemblies.

**Your inquiry is invited.**

**SPECIFICATIONS**

**Voltage:** 28-volt DC
**Stroke:** 8.25 inches
**Speed:** .3 inch per sec. at maximum load
**Maximum load:** 10,500 lbs. on each jack, tension or compression
**Maximum system load:** (both jacks) 15,000 lbs.
**Ultimate load:** 50,000 lbs. on each jack, tension or compression — 100,000 lbs. total
**Military Specs:** Assembly designed to meet MIL-M-8609, MIL-A-8064 and MIL-E-5272A
**Features:** 1. Jacks are equipped with non-jamming stops.
2. Single power unit drives the jacks at synchronized speed.
3. Jacks are equipped with auxiliary reduction for a control mechanism.
4. Motor has magnetic clutch and brake.

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## Fairey Rotodyne Flies for First Time

Fairey Rotodyne takes off vertically at White Waltham Airfield, Berks, England. Airliner is powered by two Napier Eland propeller turbines. For takeoff, compressed air from engines is directed through rotor blades, burns with fuel in tipjets. Aircraft has gross weight of more than 17 tons; will carry 48 passengers or 4½ tons of freight 400 mi. at 185 mph. speed. Diameter of four-blade rotor is 90 ft.

### Chance Vought Readies F8U-2 Prototype

Dallas—Chance Vought Aircraft will soon roll out a prototype F8U-2 for flight testing and prospects appear good for a Navy production contract.

Navy has plans "at the present time" to issue a production order for the F8U-2, according to Rear Adm. Robert E. Dixon, chief of the Bureau of Aeronautics.

The new fighter, a modified version of the F8U-1, will go into flight test phase this winter.

Chance Vought also is working on a new fighter designated F8U-3 (AW April 1, p. 23), and Adm. Dixon said "it is our earnest hope" that Navy will have the funds to bring both the F8U-3 and the competing McDonnell F4H-1 design to the flight test stage.

Chance Vought's F8U-3 is a radically new design for an all-weather carrier fighter to succeed the F8U-1. It is a larger aircraft, designed around a dual powerplant approach using the Pratt & Whitney J75 turbojet engine and a rocket motor.

F8U-3 is scheduled to make its first flight next summer.

## News Digest

**Board of directors** of United Aircraft Corp. declared a 20% stock dividend of one additional share of common stock for every five shares held Nov. 21. Dividend will be paid Dec. 12. Net income for the first three quarters of 1957 totaled $38,300,349, equivalent to $7.13 per share of common stock after dividend requirements of preferred. Sales for the three quarters were $869,241,138, compared to $666,007,899 for the same period in 1956. Company's backlog as of Sept. 30 totaled $1,850,000,000, a drop from $2,050,000 three months earlier.

**Three U. S. Air Force** twin-jet B-66 bombers flew nonstop from George AFB, Calif., to the Philippines in just more than 17 hr. Flight was part of an operation to show that Air Force can deliver a tactical striking force to help subdue brush-fire wars anywhere in the world. Flight refueled in the air off Hawaii.

**Shortly after reporting** it had sold aircraft worth slightly over $1 billion in the first nine months of 1957, Boeing Airplane Co. said that "slight downward adjustments will be made" in most of its production schedules. Under new schedules ordered by the Air Force, rate of B-52 deliveries from the company's Plant 2 at Seattle, Wash., will be "reduced slightly," reportedly from about seven a month to five. B-52 deliveries from the Wichita, Kan., Division will be unchanged. Peak production of KC-135 jet tanker-transports at the company's Transport Division in Renton, Wash., will be reached next July rather than in April as originally planned. Schedules on the Bomarc guided missile will be set back two months.

### New B-58 Contract

Washington—Contract for $12.5 million to speed production of Convair's B-58 supersonic bomber was announced last week by the Air Force. The funds will be used for procurement of long lead time items for production B-58s beyond the 30 aircraft ordered for the test program.

Prototype B-58 already is undergoing Phase II tests at Convair's Fort Worth plant.

Test pilot for the program is Maj. Fitzhugh Fulton, of Air Research and Development Command's Flight Test Center, Edwards AFB, Calif.

# New Rate-of-Return Yardstick Proposed

**Bureau of Air Operations proposes change in CAB rate-of-return stand; fare probe will begin today.**

By Ford Eastman

**Washington**—Increased rate of return for domestic trunk airlines over Civil Aeronautics Board's present yardstick was recommended by CAB's Bureau of Air Operations. Hearings in the investigation are scheduled to begin today before Examiner Ralph L. Wiser.

The Bureau exhibit is an independent report on a fair and reasonable rate of return for trunk airlines prepared by Paul Howell Associates, New York financial and utility consultants.

The report concluded that for airlines to maintain financial integrity and attract additional capital on favorable terms a reasonable rate of return for the Big Four theoretically would be between 9% and 9.7%; for the Little Eight, between 9.90% and 10.90%. In mail rate cases, the CAB has generally held an 8% return as fair and reasonable. Airlines are seeking a return of around 12%.

An increase in the rate of return, however, does not necessarily mean that a fare increase is required in order to boost airline earning power. Even if the higher rate of return level is approved by the Board, airlines must prove that the goal cannot be obtained under current fare levels through economical and efficient management.

### Suggested Rate

The consulting firm based its suggested rate of return on the earnings necessary—over and above revenues required to meet operating expenses—to enable airlines to:

- **Compensate existing stockholders** adequately.
- **Pay fixed charges.**
- **Attract capital** on advantageous terms in the foreseeable future.
- **Maintain the financial** integrity of the airlines.

In connection with this, considerable space in the report was devoted to factors affecting the cost of acquiring the necessary capital to meet airlines' current and future needs.

It pointed out that consumers should expect to pay all costs of providing the necessary capital as well as the customary expenses of wages, materials, depreciation and taxes. The report warned, however, that honest, economical and efficient management must use its best efforts to keep all costs, including that of capital, at a minimum.

So far as jet equipment is concerned, the report estimated that the industry now has on order equipment which will cost approximately $2 billion.

Prospective funds to finance expansion of flight capacity and reequipment will come from the following major sources, the report said:

- **Depreciation**—cash throwoff.
- **Insurance companies**—long-term loan commitments.
- **Bank loans**—for shorter, supplementary requirements.
- **Retained earnings.**
- **Sale of aircraft.**
- **Sale of bonds** to the general public.

Depreciation, retained earnings and gains from the sale of aircraft account for a substantial source of capital available for reequipment at little or no cost.

Long and short-term loans can be obtained from insurance companies or banks at relatively low rates, while the cost of equity financing is about six times as great as debt financing, according to the Howell report.

An outstanding aspect of the reequipment program, the report said, is that many of the carriers already have completed their financing requirements for the next couple of years through debt financing at relatively low interest rates.

An interesting observation to be drawn from this advance financing, the report pointed out, is the confidence which airline managers have in the fundamental long run position of their business and the confidence which informed independent loan officers have in the airline industry. This has a tendency to keep the cost of capital within reasonable bounds.

The higher cost of equity capital can be blamed in part on the low dividend payout which is not popular with stockholders. To meet their current requirements, however, airlines generally have not relied on equity financing, but it may be required in future financing. As a result, the suggested rate of return was determined by weighing the cost of both debt and equity financing for the industry.

### Rejects Operating Ratio

The Howell report also rejected airlines' contentions that an operating ratio approach instead of rate of return should be used to determine rates. Carriers claim that because airlines have a high operating ratio and a rapid capital turnover that the conventional approach to reasonable rate of return is inappropriate. Howell includes these reasons for rejecting the operating ratio approach:

- **Cost of capital** and its earnings price ratio approach already makes full allowance for the nature and character of airline operating ratios and capital turnover.
- **Any use** of the so-called operating ratio approach must necessarily result in certain earnings on investment. The question would seem to be, not what is an appropriate operating ratio, but what should be the end result.
- **Investors are primarily** interested in return on their commitment. Whether the business has a high operating ratio and rapid turnover or a low operating ratio and slow turnover is of secondary concern. The investors are primarily interested in the amount of dollars they get in relation to what they put in.
- **Operating ratio approach** is essentially a "cost plus" concept. The cost plus concept has many infirmities—the chief one, there is little incentive to efficient and economical operation.
- **Operating ratio** approach as indicated by carriers' statistical exhibits is incomplete. No objective data are presented to show what the ratio for air carriers should be and why it should be at this particular level.
- **Administrative** procedure would not be lessened by using the operating ratio. Just as many fare changes would have to be made for the use of operating ratio as for a cost of capital approach.
- **Operating ratio** approach gears profit to volume of business and not to its efficiency, the amount of capital dedicated or the supply price of that capital.

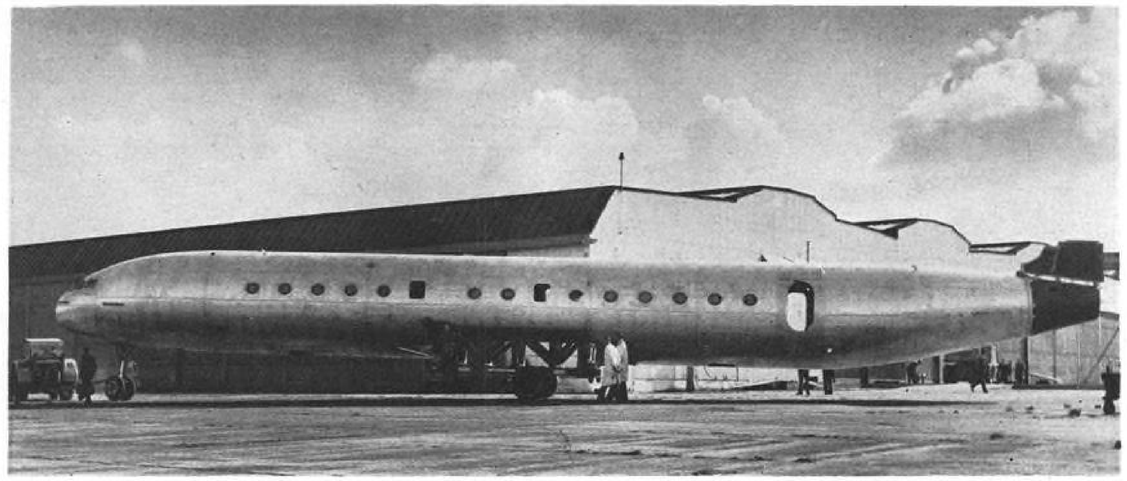
### Continental Petitions

**Washington—Continental Air Lines last week petitioned the Civil Aeronautics Board for a fare increase amounting to an average of 7% over noncompetitive segments of its route system.**

**Continental said although its major routes show a profit the company sustained a loss of one and a half million dollars on its local DC-3 operations. The loss coupled with the present downward trend in national economy will not earn Continental a reasonable return on investment for 1958 even with the proposed increases, the airline said.**

**The increase, if granted, would bring a return of about $600,000 a year. Continental said. Approximately 60% of the increase is related to the former Pioneer system plus local service segments created by the integration of that system with Continental.**





**First Electra Rolls Out Ahead of Schedule**

**Lockheed Aircraft Corp. last week rolled out its first Electra turboprop transport. Plane was a month ahead of production schedule. First actual production began in May, 1956. No new first flight date has been set; original date was Jan. 31, 1958. Initial four Electras will be used in proving program aimed at Civil Aeronautics Administration certification by next Sept. 30. Span is 99 ft., length 104½ ft., powerplants are Allison 501 turboprops.**

# American Protests Capital Subsidy Bid

**Washington**—American Airlines last week protested against a Capital Airlines request for federal subsidy (AW Nov. 11, p. 39) on grounds that a policy of financing competition with government funds is "likely to be unfair."

American asked the Civil Aeronautics Board for an opportunity to discuss whether it is in the public interest for the government to subsidize an airline which competes directly with unsubsidized carriers.

Earlier this month, Capital told the Board it needed immediate financial relief in form of subsidy because of a critical financial condition.

C. R. Smith, American's president, said his company does not oppose subsidy for needed service to communities that could not otherwise support an airline service. He said that, in effect, Capital Airlines is asking the federal government to subsidize its operation and guarantee it a profit, "the better to equip it to compete with airlines which receive no subsidy."

American pointed out that a high percentage of airline service provided by Capital identically parallels services operated by American and other companies and added:

"This proposal, in the opinion of American, raises a basic question of public policy: is it in the national interest to pit subsidized airlines against nonsubsidized airlines?"

# Excursion Fare Use Outlined in Survey

**New York**—Transatlantic 15-day excursion fare was used by business travelers almost as much as pleasure travelers last winter, a Port of New York Authority survey indicates.

Of scheduled passengers departing New York during the November through March period, 2,155 traveling for business purposes and 2,227 traveling for pleasure bought excursion plan tickets.

Another 418 of the excursion fare passengers were traveling for personal reasons.

Total of 4,800 excursion fare passengers was 7% of the 86,000 eastbound passengers during the period, according to the Port Authority's figures. Tourist class passengers accounted for 58% of the total, and first class passengers the remaining 35%.

Of American resident passengers, 43% who used the excursion plan were on business. Fifty-one percent were touring or traveling for other pleasure reasons, and 6% were flying on personal errands. Of foreign resident passengers, 50% of the excursion fare users were business travelers, 34% were on pleasure trips, and 16% were traveling for personal affairs reasons.

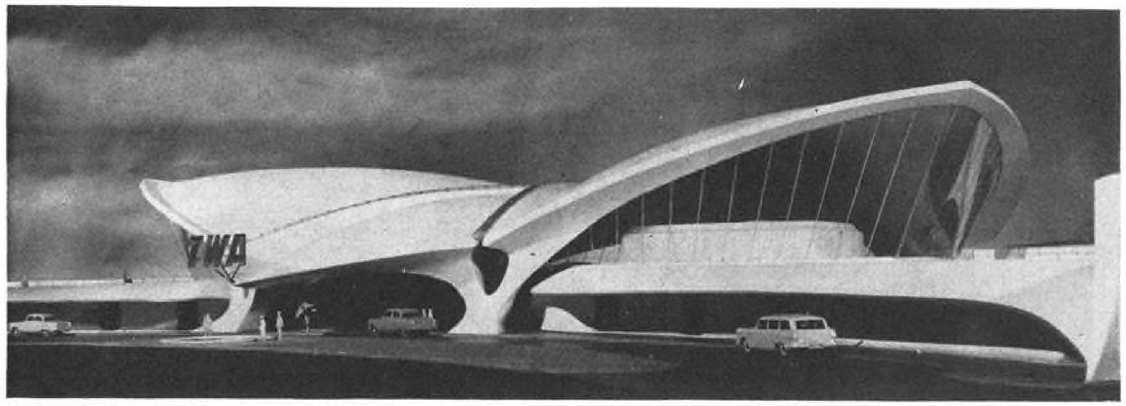
American resident passengers totaled 50,200 for the five months, foreign residents totaled 35,800.

The Port Authority's figures were included in a preliminary report to airlines on the results of the off-season phase of a survey begun in April, 1956. On-season results were reported earlier (AW Aug. 26, p. 38).

Largest percentage of American resident business travelers covered by the winter survey—22%—spent two weeks on their trips. Touring passenger's trips lasted longer: 23%, the greatest number, took four weeks. But 19% of the travelers for other pleasure purposes, such as visits to friends or relatives, stayed only two weeks. This was the largest percentage in the "other pleasure" group. Greatest duration of trips was reported by travelers for personal affairs reasons, of whom 27% among the American residents stayed 12 to 24 months.

American residents traveling for tourism purposes totaled 7,500 during the five months. They were outnumbered by the "other pleasure" travelers, who totaled 17,000, and by business passengers totaling 19,500. The remaining 6,200 passengers were attending to personal affairs.

The Port Authority's survey is based on questionnaires completed by 26,400 passengers aboard 1,000 flights leaving New York for overseas destinations excluding Puerto Rico. A complete analysis of the offseason phase of the survey will be issued in the near future, followed by an analysis of the year as a whole.



**BIRDLIKE** shape of TWA terminal roof design is evident in street side oblique view. Banks of skylighting separate the four thin concrete vaults forming shell over central area of the proposed Idlewild facility. Single-story adjoining structure at right houses ticket and check-in area; similar unit at left contains baggage checkout area. Restaurant patrons will look out of glass walls under the soaring vaults.

# TWA Picks Futuristic Terminal Design

By Glenn Garrison

**New York**—Trans World Airlines plans a $12 million passenger terminal of futuristic design to be completed at New York International Airport in early 1960. The terminal, one of seven individual airline facilities which will populate Idlewild's central terminal city, features a striking vaulted concrete roof over the main building of its complex.

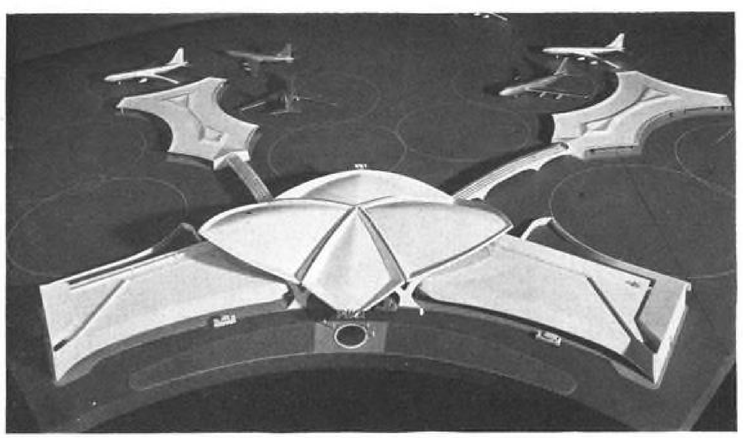
The TWA facility will handle 14 Boeing 707 jet transports at once, and it has been designed to provide passengers with new comfort and convenience in its unorthodox interior.

Among its features are two ramp houses where passengers will wait comfortably to board their aircraft. Fingers equipped with moving sidewalks will connect these ramp buildings with the main structure.

According to present plans, passengers will still climb into their planes from the open ramp and their baggage will move by carts.

Other features of the terminal:

- **Ticket and check-in** counter 150 ft. long, located at street level near entrance doors.
- **Central information desk** with large arrival and departure board, probably electronically controlled.
- **Main waiting area** separated from other activity and designed like a plush amphitheater so that passengers can watch airport activity through glass walls. A second information board will keep them posted on flight times.
- **Self-service** baggage shelf 100 ft. long, situated at street level.
- **Electronically** controlled entrance and exit doors.
- **View of TWA's** operations through a window located near baggage claim area.



**MODEL** of entire terminal shows glass-topped passenger fingers leading to two buildings where passengers will wait to board their aircraft. Fingers feature moving sidewalks for inbound and outbound passengers. Ramp positions for 14 Boeing 707s will be provided under the plan.

Heart of the highly original terminal building is the central unit covered by a thin concrete shell formed by four interacting vaults. Shell spans 300 ft., and its two lateral vaults rise into cantilevers 54 ft. high at their apex. Vaults are poised on four points.

Two projecting arms on either side of the central unit are single-story structures, one containing ticketing and check-in area (at right from street side) and the other containing baggage claim area.

Information counter, shops, restaurants, and main waiting room are under the shell, with the counter at street level and other elements reached by stairs and connected by a bridge.

In announcing plans for the terminal, TWA President Carter L. Burgess said the structure is designed to fit the efficiency, functionalism and drama of the aviation era ahead. The airline hopes to make it the showcase of its route system, Burgess said.

Architect Eero Saarinen said his primary considerations in designing the terminal were two: to provide a natural sequence of movement for passengers, making their activity as painless as possible, and to express the purpose of the building in its design.

An air terminal is a place of transition, Saarinen said, and should look like one. Most air terminals today are honky-tonk places, the architect said, whereas in the past the railroads have built some beautiful structures.

The 125-ft. fingers connecting the main building with the ramp will be topped with glass and lighted from a low level to provide glare-free visibility at night. Each finger will contain a 120-ft.-per-min. moving sidewalk in each direction and a non-moving passageway for those who prefer it. At the ramp end of the fingers will be several boarding rooms in each of the two buildings. The rooms will be built around sky-lighted garden areas and can be divided to separate coach and first class passengers on combination flights.

### Passenger Protection

Although passengers will be exposed to the weather in boarding aircraft, TWA is studying methods of providing passengers protection, according to George Clay, vice president, administration. These include the movable bridge type of device, which Clay said is still in the experimental stage. The overhanging cantilevered roof principal, which Pan American World Airways plans to incorporate in its Idlewild terminal, is not considered satisfactory by TWA because of noise problems of jets taxiing at the building.

TWA presently plans to taxi its jets in and out of the terminal rather than use some means of towing. The terminal design includes a blast fence along each arm building.

Asked about provisions against jet noise, Saarinen said "we will do what we can" with thick windows and rubber insulation but the problem will exist at all airport terminals.

The two ramp buildings have been designed so that a second story can be added for plane-level boarding if devices such as loading bridges are used, Clay said. Also, the ramp ends of the fingers can be adjusted to a second-story level of connection with the buildings.

### Construction Phases

Construction of the facility is planned in two stages. First phase is scheduled to begin next April with mid-1959 completion. This will involve the one-story arm building containing the ticket counter, its adjoining finger, and the ramp house at that finger's end. Central unit and other arm building, finger and ramp house will be completed in early 1960, according to the plans.

This staging depends in part on Port of New York Authority relinquishment of space in the TWA terminal area. The airport's present passenger terminal abuts the area on one side. Adjacent to its other side is the Port Authority's International Arrival Building with its wing buildings for foreign-flag airlines.

TWA is very happy with its location in the 655-acre oval-shaped terminal area at the airport. The airline's futuristic building will catch the eye of passengers approaching terminal city on the main roadway entering the opposite periphery of the oval.

Underground fueling system will serve the ramp of the new terminal, according to Clay. However, most servicing operations are expected to take place in TWA's hangar.

## Airline Penalty Plan Trims No-Shows

**Miami**—A reduction of 49% in the number of no-shows since September, 1956, when domestic airlines introduced their three-phase no-show plan, was reported to the Air Traffic Conference here last week.

Findings of the no-show survey are based on quarterly sampling period, the latest of which was conducted from Oct. 13-19 covering 570,033 passengers or 11% of the total monthly domestic traffic.

The report indicated that actual cancellations had increased by 56% on coach flights and 20% on first class flights since the overall plan was first adopted. Of this amount, 26% of the passengers who called to cancel space were resold on another flight.

The $3 penalty, a charge imposed on passengers who fail to cancel their reservations, has been assessed 2,592 times since Sept. 15, 1957, when this phase of the plan was inaugurated. The reconfirmation phase was adopted July 14, and the first step in the program, minimum limit on ticket pickup, began Sept. 15, 1956.

Passengers paying the penalty amounted to .37% of all domestic coach passengers and .49% of first class travelers.

The conference elected E. O. Cocke, senior vice president-sales for Trans World Airlines, as its president for the coming year. C. M. Britt, vice president-sales for Southern Airways, was elected first vice president and Nelson B. Fry, assistant vice president-sales of Capital Airlines, was named second vice president.

## Hughes Stock Case Strikes Legal Snag

**Washington**—Attempts to settle the Howard Hughes-Trans World Airlines-Atlas-Northeast Airlines stock case has struck a legal snag.

Civil Aeronautics Board Examiner Paul N. Pfeiffer has tentatively rejected a proposed solution and directed all parties to show cause why the hearing should not be reopened for testimony of Hughes. The proposal was designed to terminate the hearing through the establishment of an irrevocable voting trust for beneficially owned shares of Atlas common stock held by Hughes.

Pfeiffer said the primary defect in the establishment of such a trust is the apparent fact that Hughes' Atlas voting shares are not free to go into the trust, and, therefore, the trust is revocable at the will of Hughes as a matter of law.

Counsel will be granted until Nov. 25 in which to file affidavits or memoranda showing cause why the hearing should not be reopened for the testimony of Hughes.

Pfeiffer said that, if submissions are unconvincing, the hearing will be reconvened Dec. 9.

## CAB Prepares Probe Of Missing Airliner

**Washington**—Civil Aeronautics Board said last week it would exhaust every investigative resource in an effort to determine the fate of the Pan American World Airways' airliner lost over the Pacific on Nov. 8.

The airliner's last reported radio transmission was made at 5:04 P.M. as the plane passed the halfway mark on the flight from San Francisco to Honolulu.

The plane, a Boeing 377 Stratocruiser, carried 36 passengers and a crew of eight.

The CAB investigating team will consist of William S. MacNamara, flight operations specialist, and A. B. Hallman, airworthiness inspector, both of Washington, and Leon D. Cuddeback, Earl R. Mitchell, both of Oakland, Calif., and Arnold E. Holstein, Santa Monica, Calif.

## Constellations Boost Flying Tiger Traffic

**New York**—Flying Tiger Line reports highly successful initial results with its new all-Constellation freight service. The cargo carrier began phasing out its DC-6As, C-46s and DC-4s last month and now operates only Super H Constellations.

During the third week of October, traffic was up 44% over the first week and 27% over the second week, according to Flying Tiger Line. New service included through service between the Pacific Northwest and New England, a nonstop flight from the West Coast to New York.

Revenue gain in the New York-New Jersey area was 70% during the first week of all-Super H service over the first week of October.

All terminal cities on the carrier's system have been placed on transcontinental routes under the new scheduling, Flying Tiger reports, providing next morning delivery to the East Coast from San Francisco and Los Angeles, and next morning or next day delivery at most stations.

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# Flight Engineers Bid for Jet Age Role

By L. L. Doty

**Washington**—Flight engineers are pinning their hopes for a jet-age future on a program that is sure to meet strong resistance from airline pilots.

The growing conflict between the Flight Engineers' International Assn.—a union representing about 90% of airline flight engineers—and the Air Line Pilots Assn. has been smoldering for three years. It began to come to a head last November when the pilots adopted a resolution that would require third crew members on jet transports to be qualified pilots (AW Nov. 19, 1956, p. 39).

Full scope of the struggle between the two unions will be brought into the open for the first time in January when comments and arguments are submitted to the Civil Aeronautics Board on a proposed rule governing flight engineer certificates.

The basic issue—whether flight engineers will retain their present professional status as crew members on jet transports without meeting any pilot requirements—will be determined finally at the collective bargaining tables when airlines begin negotiations with the two unions on turbine aircraft operations.

### Engineers Win Round

In this connection, Flight Engineers' International Assn. won a first tenuous hold on its future position as a result of a contract signed with Pan American World Airways (AW Nov. 4, p. 25). A joint interpretation of the agreement, which runs until 1960 reads:

"It is the specific intention of the parties that Pan American shall not assign a pilot-engineer, as the term is understood, in place of a professional engineer to perform the engineering function."

On the other hand, Air Line Pilots Assn. will have gained a significant point in its favor if the proposed CAB rule on flight engineers is adopted. The proposed revision of Civil Air Regulations includes an amendment stating that applicants can qualify as flight engineers if they "have had at least 200 hours of flight time as a pilot in command, or 400 hours of flight time as a copilot, of aircraft having four or more engines rated at least at 800 hp. each or the equivalent thereof in the case of turbine-powered aircraft."

The amendment, if adopted, will give the pilot group legal backing in its demands that pilots be included as third crew members. However, the overall proposal would not exclude present regulations which permit trained mechanics to qualify for flight engineers without actual pilot experience.

Pilots anticipated an outburst from the flight engineers when the third crew member issue was first introduced as a resolution and attempted to soften the blow by emphasizing that engineers who wished to qualify as pilots would have ALPA support. The pilots also stressed that the resolution applied only to turbine powered aircraft and would not affect engineer crew members assigned to piston engine aircraft. Briefly, their stand is this:

Pilots will place major importance on pre-flight planning to fit jet transports into the "inadequate airport, traffic control and navigational facilities." At jet altitudes and speeds, no problem is more paramount than precise planning. "No time is available for in-flight trouble-shooting and trial-by-error solution to emergencies."

The position taken by the flight engineers sharply contests this point of view. In a detailed paper prepared by FEIA President George Petty, Jr., for presentation to Trans World Airlines, engineers stress that increasing problems of air traffic control will add to the electronic complexity of aircraft systems. They add:

This situation "may very well operate in the same way electronic complication has operated in the Air Force—that is, to reduce the pilot workload while increasing the burden on an electronic technician."

### Engineers Reply

In response to ALPA charges that many flight engineer duties will be eliminated on turbine aircraft because of the absence of such piston engine cruise control characteristics as manifold pressure, propeller rpm., mixture settings for percentage leaning or engine analyzer monitoring, Petty has this to say:

"It has been maintained that . . . the operation of the jet transport is 'simpler' because there are fewer controls, switches and displays in the cockpit. As more and more of the cockpit mockups for the next generation of transports are finalized, it becomes more apparent that this argument is specious." He adds:

". . . Because of the increased importance in system security and the extremely high fuel consumption of turbine engines, the functions of the flight engineer in operation and maintenance of flight with regard to systems, powerplant and cruising procedure will be more vital to the safety and efficiency of flight and more exacting in requirements for electrical, electronic and mechanical knowledge than ever before."

### Jet Engineer Functions

Petty cites these functions as essential operational duties of a flight engineer on jet aircraft:

• **Fuel management.** Flight engineers will be required to keep half-hourly fuel logs and maintain computation of center of gravity because of high fuel flows on jet aircraft. Mismanagement of fuel will cause lateral unbalance and a center of gravity shift on swept-wing aircraft under emergency conditions.

• **Powerplants.** Flight engineers will be required to monitor engine instruments during takeoff and landing. Engine failures are difficult to detect because engines are normally noiseless and such instrumentation as rpm., fuel flow and exhaust gas temperature can be almost normal for a measurable length of time after failure.

• **Powerplant icing.** Monitoring of tail pipe temperatures by the engineers will

**Caravelle in Varig Markings**

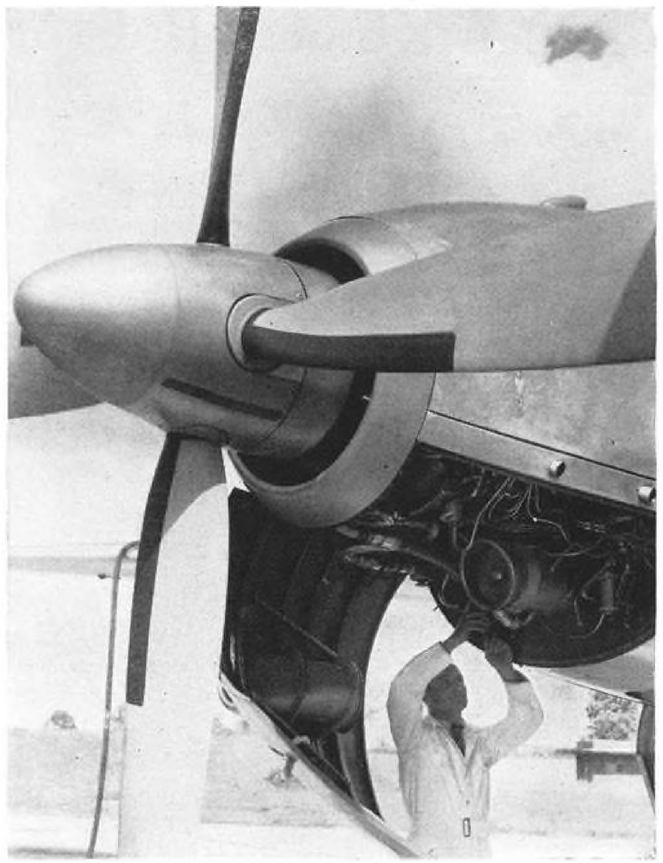
Varig Airlines markings are shown on Sud Aviation Caravelle jet transport which the Brazilian carrier has ordered. Three are on option besides the two ordered.

# Quicker, Simpler

**(and that means CHEAPER)**

# maintenance with the ELAND

EFFICIENT AIRLINES are thinking more and more in terms of propeller turbine propulsion for short and medium haul services. In this field the Napier Eland has a number of outstanding advantages, among them being its extremely low maintenance costs.



***CHEAPER ON THE GROUND***

The Eland engine consists of four main sub-assemblies: reduction gear, compressor, combustion chambers and turbine. Each sub-assembly is a self-contained unit that can be removed and tested separately. This type of construction makes for easier and quicker maintenance and gets the maximum working life from each component.

***CHEAPER IN THE AIR***

The Eland is designed for economy. A Convair with piston engines will carry a full payload 250 miles, but the same aircraft, after conversion to Eland engines, is able to extend its range to 970 miles and increase its speed by 55 m.p.h. The extra 2,000 h.p. that is developed by the Elands enables the same aircraft to carry its full payload under operating conditions of extreme temperatures and altitudes. This economy and flexibility can be expressed in substantially lower operating costs.

***PASSENGER APPEAL***

Passengers need no technical knowledge of aircraft to form stubborn preferences. Once they have experienced (or been told about) the smoothness and quietness of turbo prop flight, they will avoid travelling by piston engined aircraft whenever possible. In addition, the greater simplicity and reliability of the turbo prop engine are factors that weigh heavily with the passenger and influence his choice of airline.

***TO BUY OR CONVERT?***

While the final decision depends on a number of variables—such as the life of the aircraft, its book value and its revenue earning power—it is almost always sounder economics to convert an existing piston engined machine than to buy a new airliner. An Eland conversion can be carried out for less than a third of the cost of a new aircraft with the certainty that this expenditure will be quickly recovered by the increased earning power.

**the era of the ELAND is beginning**

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be necessary to prevent engine performance loss or damage caused by icing.

• **Fuel dumping.** Flight engineers will be required to assist in the safe conduct of fuel dumping operations. Petty adds, "situations can arise from partial failure of the electrical system, the pressurization system or the hydraulic system which could conceivably develop into trouble of serious proportions requiring fuel dumping but because of the presence of a flight engineer could be minimized to the point where continuation of the flight is possible."

Petty admits adjustment of cruise power is a simple matter on jet engines and that levers can be adjusted easily to give desired indicated airspeed. He adds, however, there is no ready and easy way to determine engine thrust.

On this point, he stresses that an aircraft often may require excessive thrust to produce velocity, minimum control (Vmc.), and improperly fitted fairings or cowlings can cause greater drag at higher airspeeds. He adds:

"The one check the operations engineers will have on the thrust required to produce selected cruise speed will be the check performed in flight by the flight engineer."

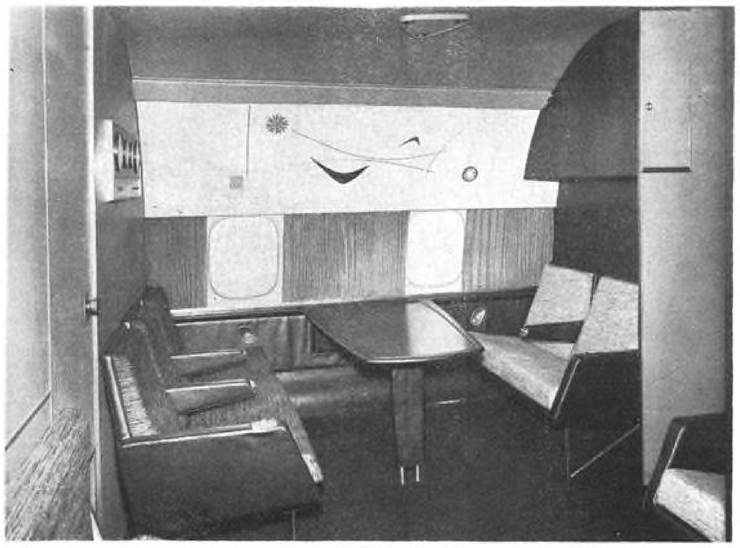
Petty points out that since there is no instrument to determine thrust at altitude, the information from five separate engine instruments must be integrated with indicated airspeed, ram air temperatures and ram air pressure. A thrust figure is derived by comparing these factors with engine power charts. The five instruments he refers to are the pressure ratio or nozzle pressure indicator, exhaust gas temperature indicator, high pressure compressor rpm., low pressure compressor rpm. and the fuel flow indicator.

Petty says that if a flight engineer were to discover through this cross-checking of cruise performance with aircraft specifications, that a Boeing 707-320 were 10 kt. too slow, corrective action could save an airline $10,000 in fuel costs in one year.

The FEIA president states in his report that airlines will operate jet aircraft at the Mach number for minimum direct operating costs that will be higher than the Mach number for best range. At the higher Mach numbers, small variations in air speed or temperature can cause variations in specific range of 3%, he says and adds:

"It will be the responsibility of the flight engineer to monitor the details of the cruising operation and compare the performance of the aircraft with curves provided by the manufacturer. The determination of the thrust produced at any altitude, temperature and airspeed is somewhat more complicated than similar operations for piston engine airplanes and since power will have to be reduced at least once every 25 minutes, these thrust checks will take considerable amount of cockpit time."

Accordingly, Petty reasons that if a transcontinental Boeing 707 flight exceeded the desired Mach number by 1%, fuel reserve for holding would be cut by 30% and range at 20,000 ft. after reaching destination by about 75 mi.



**Mockup Shows DC-8 Lounge**

**Lounge arrangement in Douglas DC-8 mockup exhibits light, modern appearance of seats and table. Only half of the lounge is visible. Design theme emphasizes smooth, uncluttered lines; muted color scheme. First deliveries of the DC-8 are scheduled for 1959.**

## Examiner Urges More Flights at Ft. Worth

**Washington**—Air service to Ft. Worth is adequate in some respects, but additional flights to a number of points are needed, according to Civil Aeronautics Board Examiner Leslie G. Donahue.

In an initial decision in the Ft. Worth Investigation Donahue said the allegation that a third of a million potential Ft. Worth passengers were being siphoned off to air service provided at Love Field in Dallas has not been sustained by the evidence. Actual loss, he said, there probably ranges from 20,000 to 50,000 passengers annually.

Donahue said that Love Field, because of Dallas' greater population and its importance as a connecting point, has a greater passenger potential. This results in a greater number of flights with a wider choice of equipment and schedules. It would appear, the examiner added, that unless the schedules at Ft. Worth are matched flight for flight with those available at Love Field, a large number of true Ft. Worth passengers will continue to use Love Field.

The examiner's complete findings are:

• **Service, equipment and facilities** provided by American Airlines are adequate between Ft. Worth and San Antonio, Chicago, Oklahoma City, Los Angeles, Tulsa, San Francisco, El Paso and Washington.

• **Service of American Airlines** is inadequate between Ft. Worth and New York in that it fails to provide nonstop service, and between Ft. Worth and Midland, Tex., in that it fails to provide commuter service.

• **Service, equipment** and facilities provided by Braniff Airways are adequate between Ft. Worth and Houston, San Antonio, Chicago, Oklahoma City, Tulsa, Austin, Kansas City, Amarillo, Corpus Christi, Denver, Wichita Falls, Minneapolis, Waco and Omaha.

• **Braniff's service** is inadequate between Ft. Worth, New York and Washington.

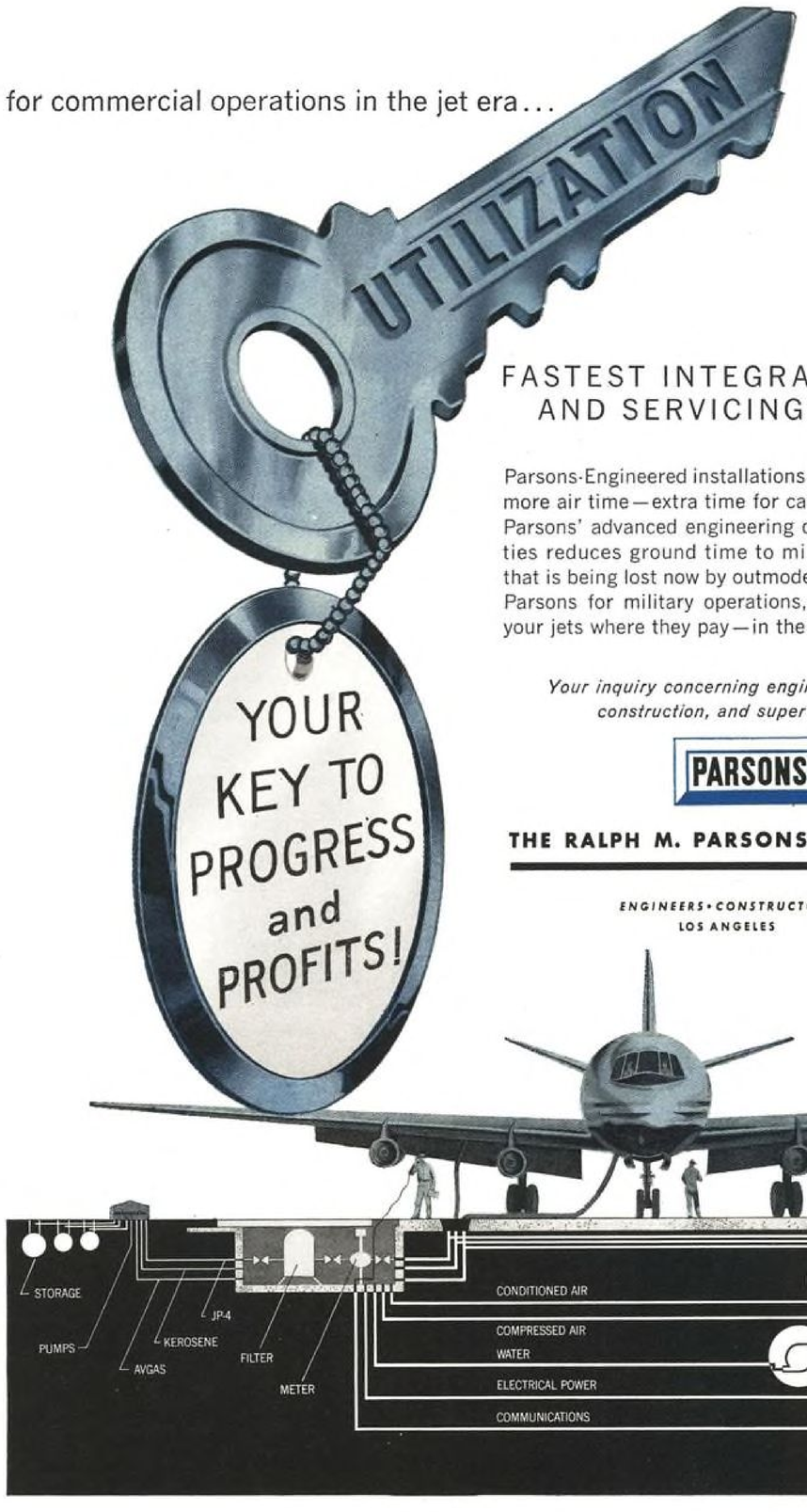
• **Service, equipment** and facilities provided by Delta Air Lines are adequate between Ft. Worth and New York, Washington, Shreveport, Atlanta, Jackson and Birmingham.

• **Delta service** is inadequate between Ft. Worth and New Orleans.

• **Service, equipment** and facilities provided by Continental Air Lines are adequate between Ft. Worth and Houston, El Paso, Midland and Waco.

• **Service, equipment** and facilities provided by Central Airlines, Slick Airways and Trans-Texas Airways are adequate between Ft. Worth and the various points to which the service is authorized.

for commercial operations in the jet era...

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Parsons-Engineered installations are giving thirsty jet-birds more air time—extra time for carrying payloads for profit. Parsons' advanced engineering of aircraft servicing facilities reduces ground time to minutes—EXPENSIVE time that is being lost now by outmoded methods. Originated by Parsons for military operations, these systems will keep your jets where they pay—in the air.

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## SHORTLINES

► **Air France** has appointed Batten, Barton, Durstine & Osborn, Inc., New York as its advertising agency.

► **United Air Lines** reports a new company record for air freight was set in October. The airline flew 5,707,000 freight ton-miles, 3% over the same period of 1956. United also flew 418,401,000 revenue passenger-miles, 11,697,000 revenue airplane-miles, in October. Air mail, including first class, was 2,471,000 ton-miles, a 5% increase over October, 1956. Express was off 26% at 993,000 ton-miles.

► **Swissair** has purchased an additional Douglas DC-7C airliner and a DC-6A cargo transport for delivery in late 1958. The DC-7C purchase brings to 121 the number of DC-7Cs purchased by the world's airlines.

► **The Port of New York Authority** will dedicate its $30 million International Arrival Building and adjacent Airline Wing Buildings in Terminal City at New York International Airport on Dec. 5. Port Authority says the estimated cost of the facilities within the 655 acre Terminal City will amount to $150 million. Previous estimates were $120 million.

► **Seaboard & Western Airlines** flew 1,255,535 revenue ton-miles of scheduled transatlantic air freight in October, a 45% increase over the same month in 1956.

► **Scandinavian Airlines System** will begin tourist class service between Europe and South Africa, with direct connecting flights from the U.S., on Nov. 21. The new service will operate with Douglas DC-6Bs which will seat 45 passengers—25 in tourist configuration, 20 in sleepers and first-class dormette seats. Next April, SAS will begin operating the route with Douglas DC-7Cs.

► **Mohawk Airlines** established new October traffic records for the company by carrying 42,062 passengers 7,865,594 revenue passenger-miles. The new records were 6.6% and 12.4% respectively over October, 1956. Mohawk also carried 73,014 lb. of air mail, 201,217 lb. of express and 241,236 of freight.

► **American Airlines** had added a fourth Douglas DC-6A air-freighter to its overnight transcontinental cargo service. Service is scheduled to leave Newark Airport, at 11:00 P.M., EST, and arrive in Los Angeles at 10:30 A.M. PST, with stops at Buffalo and Chicago.

## AIRLINE OBSERVER

► **United Air Lines' window shopping spree for additional jet transports is keeping manufacturers on edge. Convair is still hopeful the airline will settle on the 880 turbojet for its medium range needs (AW Oct. 7, p. 38) but Boeing feels its sales pitch on the 727 turbojet has made a deep impact on United's engineering team which last week moved from Seattle to Santa Monica. As of late last week, it appeared likely that United will purchase an additional 10 DC-8s and Douglas is hopeful that an order for DC-9s will follow as a logical airplane to fill out a well integrated fleet.**

► Capital Airlines petition to the Civil Aeronautics Board seeking a return to subsidy (AW Nov. 11, p. 39) is not expected to touch off similar requests from other carriers in the immediate future. However, such requests may come later. Capital has consistently hinted during the past year that it may be forced to resort to a subsidy request unless it received some relief in the form of a fare increase or an improved route pattern. Majority of other domestic trunklines are being hurt by the current profit pinch (AW Nov. 11, p. 39) but have not run into immediate emergency conditions. Exception is Northeast Airlines, which has been on an open service rate since July and which reported a net loss of $2,369,465 for the first nine months of the year. Continental Air Lines, which requested discontinuance of subsidy payments on April 28, had received $172,308 this year compared to $679,806 for the nine months of 1956. Net profit for the first three quarters of 1957 was $259,566 as compared with $561,833 for the same period last year.

► **Aeroflot, Soviet-owned airline, is planning to inaugurate Tu-104 jet transport service between Moscow and Budapest "in the very near future." The airline also will soon begin Tu-104 service on the Moscow-Petropavlovsk route.**

► Growing conviction of municipal officials that a heliport should be at least as self supporting as a conventional airport presents a challenge to transport helicopter designers. High price of downtown real estate probably dictates a performance that will permit single-engine safety out of 200 ft.-by-400 ft. landing areas. Some experts now believe real short-haul service will not materialize until there is a test of relative merits of pure helicopter and transport convertiplane.

► **Western Air Lines flight engineers have certified Flight Engineer's International Assn. as their collective bargaining agent. The group voted 69 to 8 against continued representation by the Air Carrier Flight Engineers Assn.**

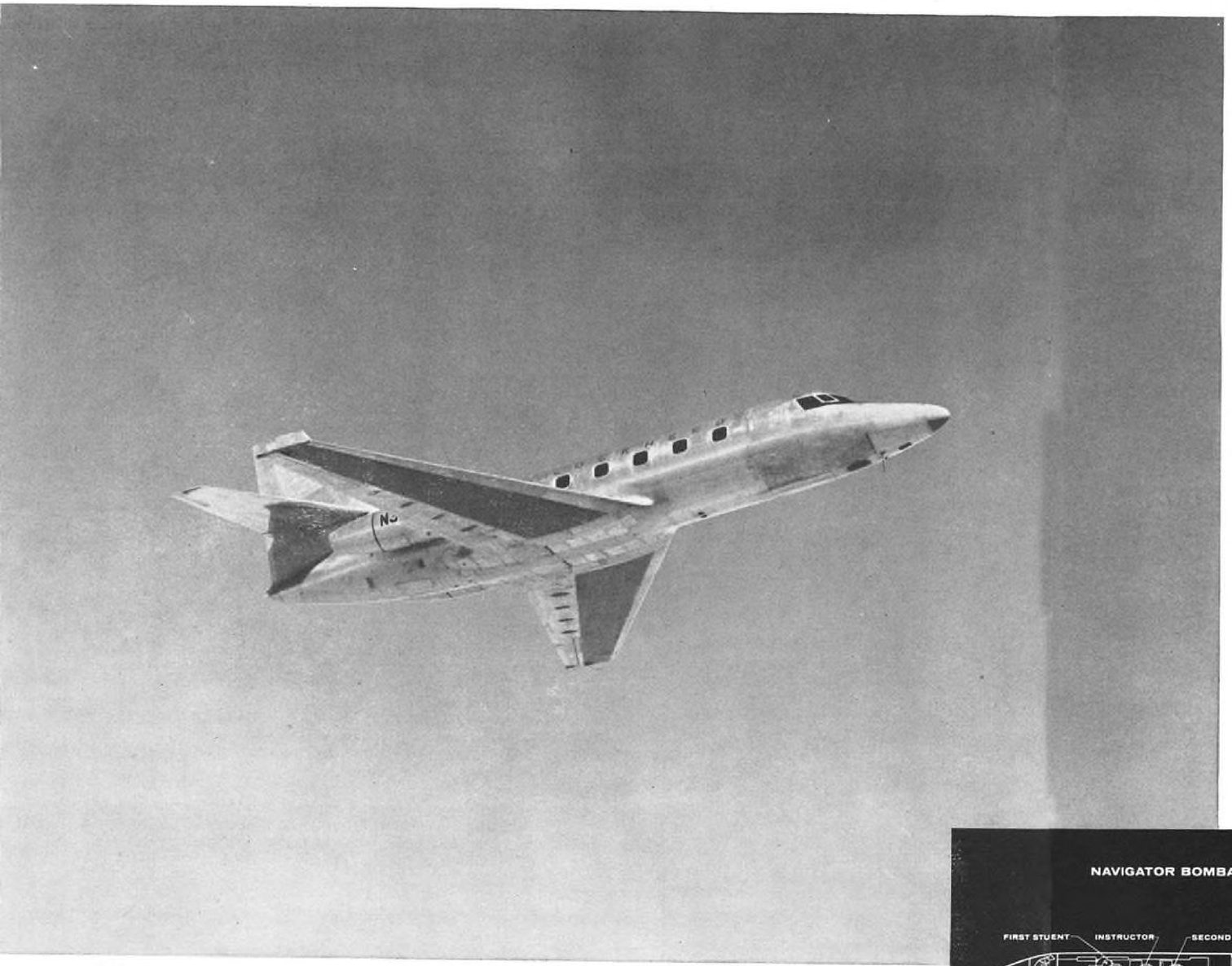
► Trans-Canada Airlines continues to stand firm in its position that no fare increase is necessary (AW Sept. 23, p. 38). TCA President G. R. McGregor, pointing to improved economy of operation with the turboprop Viscounts, said he felt "justified in prophesying that the cost of air travel in the turbine era will be no more, and probably less, than it is today."

► **Latest Air Transport Assn. long-range forecast indicates turbine powered aircraft will be carrying 30% of all domestic traffic by 1959. Turboprops and turbojet transports will be the basic aircraft by 1961 and will then be producing about 40 billion seat-miles annually.**

► United Air Lines has again reversed procedure in its seat assignment system on long-range DC-7 flights. Originally, the carrier assigned seats at the time reservations were made. Last September, it revised the system to provide seat assignment at check-in time but unfavorable reaction caused the airline to return to the original advance reservations system last month. Seat assignment at check-in time will continue on certain DC-7 coach flights.

► **Iceland Airways reports a payload of 75% on Viscount operations from Reykjavik to Glasgow, Oslo, Copenhagen, London and Hamburg compared to a 58% payload prior to the introduction of the turboprops. The carrier began Viscount service in June.**

# Now flying—the new multi-mission Lockheed JETSTAR



## —the Answer to the Air Force's Urgent Need for a Jet Utility Trainer-Transport

Designed, built, and flown in record-breaking time, the new "economy size" Lockheed *JetStar* can perform the following missions (just as well as the big jets—*and for only a fraction of their costs):*

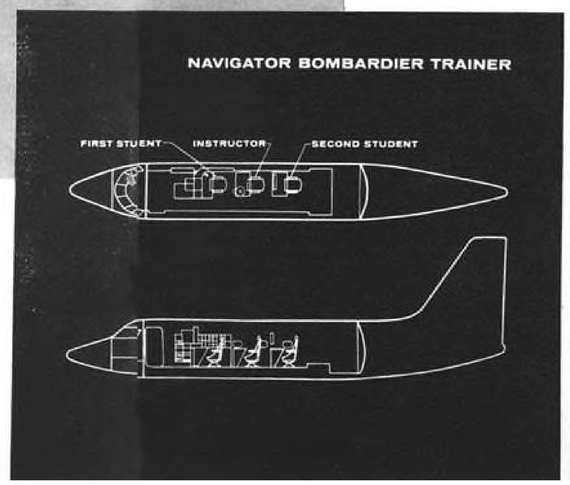
**For ATC:** The *JetStar* fills an indicated need of the Air Training Command for a "top-off" navigator bombardier trainer aircraft which more nearly equals the speed of jet bombers on operational duty. Cruising faster than 450 knots at altitudes up to 45,000 feet, the *JetStar* fills existing speed/altitude gaps between trainer and tactical aircraft in current use.

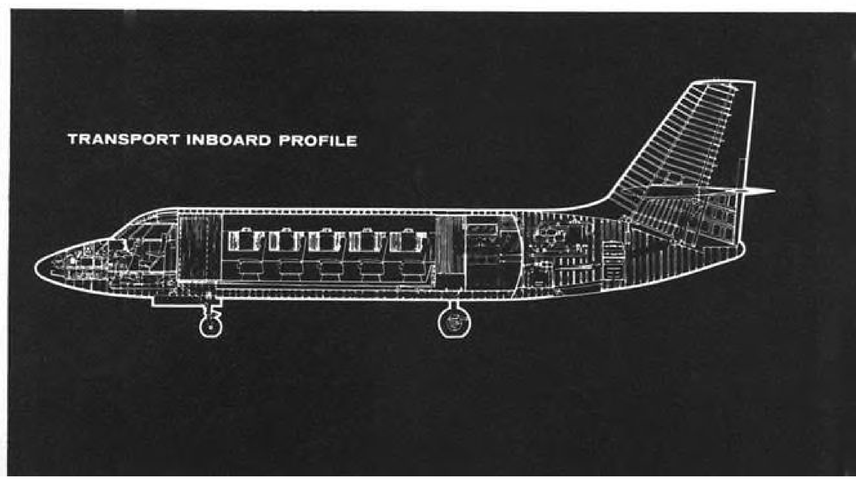
**For MATS:** The Aids to Airways Communication Service, operated under the Military Air Transport Service, is charged with the responsibility of airways inspection. The *JetStar's* high speed and altitude capabilities—comparable to today's tactical aircraft—will permit more thorough and effective airways inspections.

**For SAC:** The Strategic Air Command depends upon high speeds to rush high priority cargo from its headquarters to its retaliation bases. The new Lockheed *JetStar* can transport critical parts for bombers and navigation instruments to SAC bases—with jet speed (but at much lower cost than the big jets).

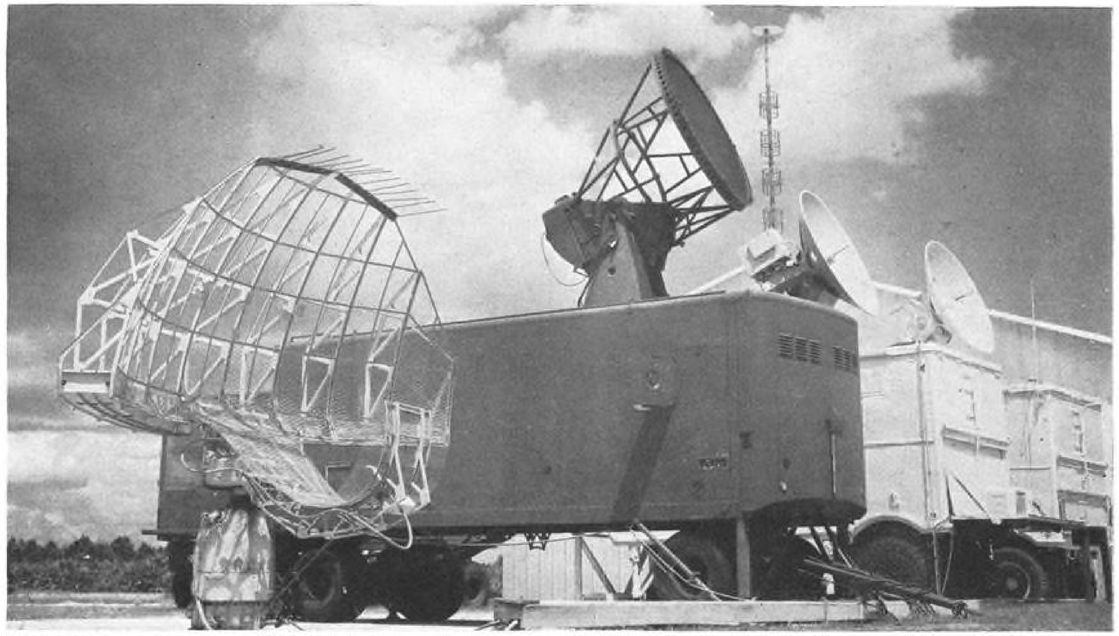
In addition to those above, the new Lockheed *JetStar* can perform many other essential military missions. Like all Lockheed planes the *JetStar* is easy to maintain, and has the inherent stamina to insure optimum utilization—qualities that are more important today in military aircraft than at any time in our history.

GEORGIA DIVISION, *Lockheed Aircraft Corporation, Marietta, Georgia*




**LOCKHEED** ***means leadership***



**ELECTRONIC** countermeasures (ECM) techniques and devices are evaluated to determine their effectiveness against variety of surveillance and missile guidance radars at test ranges like this one operated by Radiation Inc. under Air Force sponsorship.

***Exclusive Report on Countermeasures: Part I***

# Avionics Fights Its Own Silent War

By Philip J. Klass

**New York**—Electronic countermeasures, the silent, highly secret weapons of electromagnetic detection, disruption and deception, have become a crucial factor in modern warfare.

Any missile which employs radio, radar or infrared for guidance can be misguided by electronic countermeasures. Bombers which formerly relied on guns for defense are fast shifting to electronic countermeasures which are far more effective against radar-directed interceptors and radar-guided missiles.

### Remarkable Growth

This year the Defense Department will spend close to $400 million for electronic countermeasures—more than the U.S. spent for them during nearly five years of World War II. This remarkable growth of electronic countermeasures effort reflects the vastly increased military dependence upon radar, radio and infrared for target detection, surveillance, weapon guidance and communications.

Electronic countermeasures action by an enemy, designed to obscure the attack, confuse the defenders and interrupt vital communications, could be the first harbinger of an all-out attack. Jamming of Arctic Distant Early Warning Line radars would constitute an unofficial declaration of war, some top Air Force officials say.

### Who's Who in Countermeasures

Avionics companies known to be active in the field of electronic countermeasures include the following: Airborne Instruments Laboratory, CGS Laboratories, Collins Radio, Electronic Communications Inc., Electronic Specialty Co., Emerson Radio & Television, Engineering Research Corp., Farnsworth, Federal Telecommunication Laboratories, General Electric, General Mills, Gilfillan, Haller Raymond & Brown, Hallicrafters, Hoffman Electronics, Litton Industries, W. L. Maxson, Melpar, Motorola, Radiation Inc., Radio Corporation of America, Ramo-Wooldridge, Raytheon, Sanders Associates, Sperry Rand, Stanford Research Institute, Stavid Engineering, Sylvania and Westinghouse Electric Corp.

Limited electronic warfare is being waged today, and every day, as both sides probe the other's electronic defenses. Objective is to determine location of radar and radio transmitters and analyze their operating characteristics in order to develop equipment suitable for jamming in event of a shooting war.

This probing usually takes place without fanfare because electromagnetic radiation does not stop at national boundaries. Sometimes a probing airplane or submarine ventures too close to a foreign boundary. If the opposition is in a trigger-happy mood, guns blaze and there is a small international incident.

Men are killed, planes are lost, but the probing goes on.

### Types of Countermeasures

Electronic countermeasures perform a variety of missions, but generally may be classified into one of three categories:

• **Reconnaissance** electronic countermeasures are used to detect and analyze electromagnetic radiation from aircraft, missiles and other military vehicles as well as from fixed radio-radar installations. Objective is to pinpoint their location and to determine type of electronic countermeasures which must be developed or employed to deny the enemy their effective use.

• **Passive** electronic countermeasures employ devices and techniques which do not themselves generate electromagnetic radiation but change the nature of the energy reflected back to the enemy radar or seek to prevent its return. Best known example is "chaff," thousands of strips of tinfoil dumped overboard by bombers during World War II to create spurious radar echoes that obscured the echoes from the bombers and confused the enemy radar operators.

• **Active** electronic countermeasures generate electromagnetic radiation intended to interfere with enemy radio or radar signals and/or to confuse the radio or radar operator. One type of active electronic countermeasures commonly is called "jamming."

### Important Side Effects

In addition to these primary objectives, electronic warfare can produce tactically important side effects. For example, electronic countermeasures carried by Allied bombers proved so effective in jamming Germany's vast network of air defense radars that by late 1944 (according to a U.S. government estimate) nearly 90% of Germany's high frequency engineers were working on anti-jamming techniques.

Even using a more conservative figure of 50%, this means that roughly 4,000 German scientists were occupied in unraveling an electronic countermeasures knot that had been tied by fewer than 400 American scientists who had developed the electronic countermeasures.

When an Allied bomber equipped with a newly developed radar, the first to operate at microwave frequencies, crashed in Germany, that country's scientists were too busy working on anti-electronic countermeasure problems to adapt the new radar to anti-aircraft use where it could have been extremely effective.

The importance of reconnaissance in conventional military operations is well known. Electronic reconnaissance is even more important because of the considerable time required to develop active electronic countermeasures with which to counter a new enemy radar or radio technique.

Fortunately the task of electronic reconnaissance is somewhat easier in certain respects because electromagnetic radiation propagates in all directions except at the higher frequencies. Even at these frequencies there is considerable energy that spills outside a radar or scatter communications beam. (One important advantage of the newly developed meteor-burst scatter communications is its comparative privacy.)

Heart of all electronic countermeasure reconnaissance equipment is the one (or more) sensitive receiver which can be rapidly tuned over a sizable portion of the spectrum in search of electromagnetic radiation. Suitable direction finding means for pinpointing the direction to the transmitter is also generally provided.

Recently developed traveling wave tubes, which have excellent sensitivity and can be tuned quickly (electrically) over a relatively wide frequency range, have proved a great boon to electronic reconnaissance. An even more recent development, with far greater promise, is the Maser (atomic) amplifier which may boost receiver sensitivity by a factor of 100 or more.

When electromagnetic radiation is intercepted, automatic direction finding techniques provide information on bearing to the transmitter. If the signal is from a radar, it must be analyzed further. For a pulse radar signal, for example, this "structure analysis" includes determination of operating frequency, pulse repetition rate and pulse width.

### Automatic Analysis

In World War II electronic countermeasure reconnaissance receivers like the SCR-587, an intercepted signal was displayed on a cathode ray tube and analyzed by the countermeasures operator. In newer equipment now in use, this structure analysis is performed automatically and instantly. If the intercepted signal is a pulse-coded form of communication, such as data link, analysis of the message structure can be extremely difficult.

Generally speaking, the range at which a radar transmitter's energy can be detected is considerably greater than the effective target detection range of the radar. The reason is that the energy reflected back to the radar is only a small fraction of the energy that reaches

**MISSILE** can be fooled by attaching special reflectors, like Luneberg Lens shown on tail of Firebee, which give very strong radar echo, making small drone look like large bomber.

**CHAFF,** consisting of thousands of tinfoil strips, is dropped from aircraft to produce spurious radar echoes or smokescreen effect which obscures bombers from ground radar.

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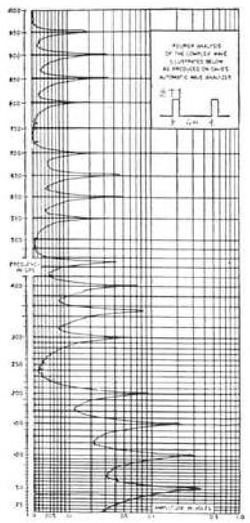
Do you have magnetic tape recorded data from vibration, noise, shock or flutter analysis of vehicles, aircraft, missiles or ships?... or seismic recordings, powerline disturbances, or other phenomena characterized by fluctuating data? Feed this tape recorded information to a Davies Automatic Wave Analyzer, flip the switch, and a complete Fourier series is automatically plotted and printed in permanent record form.

Davies Automatic Wave Analyzers can accurately plot these data as either amplitude-versus-frequency or power-versus-frequency. Davies Analyzers are also equipped with a "quick-look" facility. Series 9020 provides a quick analysis across its frequency range of 3 to 2,000 cps in only 15 minutes. Series 9050 will span 3 to 10,000 cps in just 15 minutes. Linear or square law output, as desired, is recorded by a Brown *ElectroniK* Potentiometer.

Multi-channel inputs permit analysis of as many as six channels simultaneously. By adding the Davies Input Switching Panel, a serial analysis of up to 14 channels can be made.

The Davies Automatic Wave Analyzer can process data in as little as 3% of the time required by digital methods, thus permitting the analysis of large samples, resulting in statistically reliable information.

Complete technical information and application data for the Davies Automatic Wave Analyzer can be had by requesting a copy of new Bulletin 9100—write to Minneapolis-Honeywell Regulator Co., Davies Laboratories Division, 10721 Hanna Street, Beltsville, Maryland.



From tape-recorded data—to permanent chart . . . a complete Fourier analysis in minimum time with maximum accuracy . . . with a Davies Laboratories Automatic Wave Analyzer.

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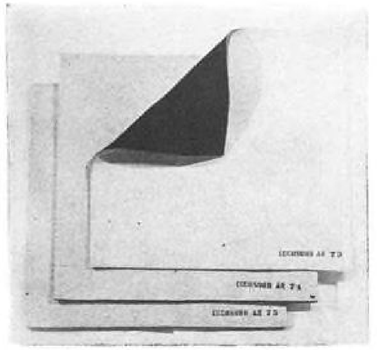


**ECCOSORB,** flexible foam sheet microwave absorbent material, reflects only two percent of radar energy that hits it.

the target and its reconnaissance receiver.

Any airplane, missile or other vehicle that employs radar for navigation, guidance, bombing or surveillance runs the risk of giving away its position by tattle-tale radiation. This explains the postwar emphasis on inertial systems for guidance, navigation and bombing and the use of infrared or passive (non-radiating) radar for surveillance. These newer techniques do not radiate electromagnetic energy, thus provide far greater security.

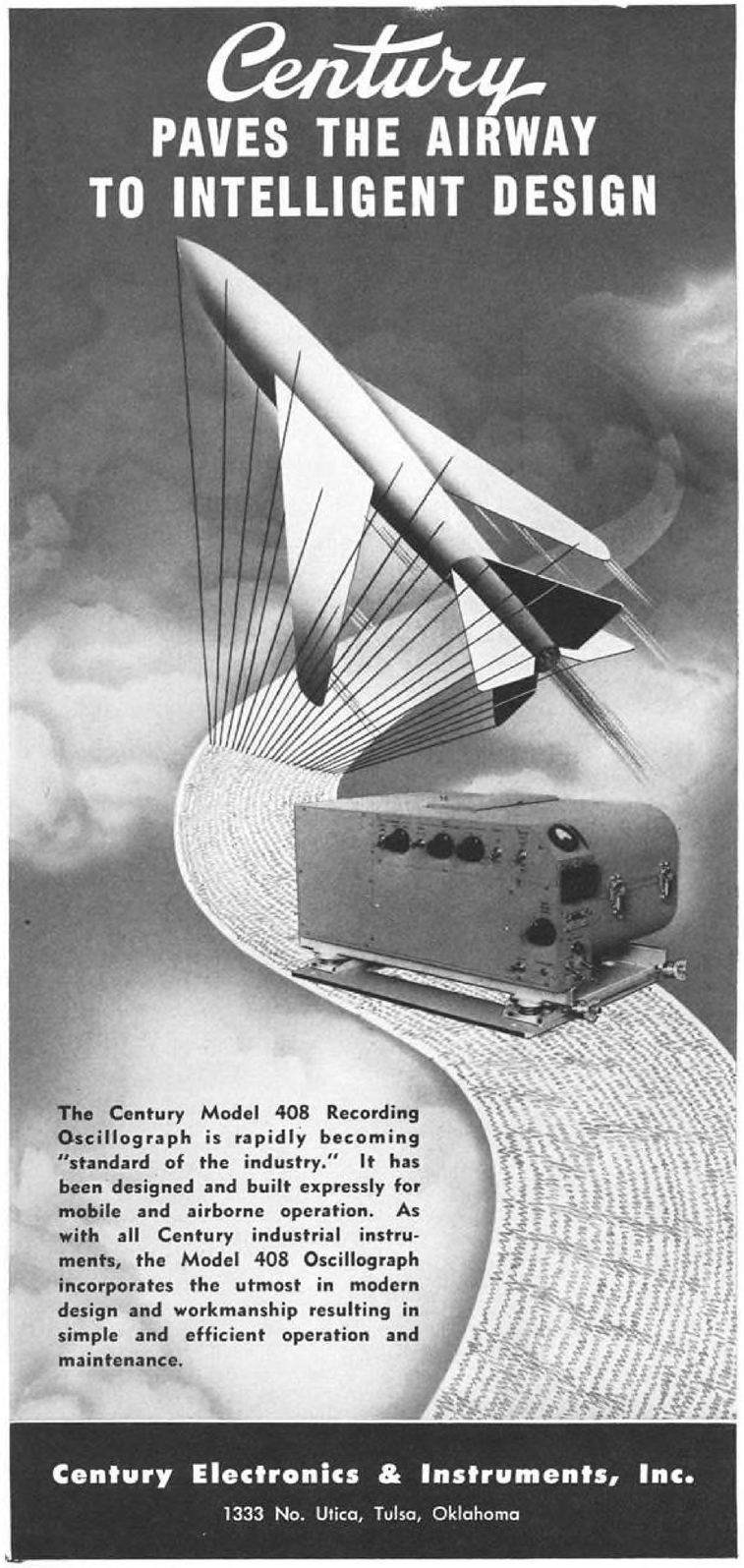
One of the first U. S. airborne electronic reconnaissance missions against ground radar took place early in 1943 against Japanese-occupied Kiska in the Aleutians. Reconnaissance photos of Kiska showed two large structures had been erected which resembled a low-frequency Japanese radar captured on Guadalcanal. An Air Force B-24 was outfitted with electronic countermeasure receivers and flown close to Kiska. Two unfamiliar radar signals were detected and traced to the suspected site.

Similarly equipped U. S. aircraft, subsequently called "ferrets," were employed shortly afterward in North Africa to spot German air defense radars. Later in 1943 Navy patrol bombers were outfitted with reconnaissance receivers equipped with automatic direction finders which proved extremely effective in spotting radar-equipped German U-boats.

### Radar Gaps

Electronic reconnaissance is valuable also for spotting gaps in radar coverage and in determining effectiveness of enemy radar operators. For instance, reconnaissance of the Japanese Kiska radar revealed that its "vision" was blocked in one quadrant by a large volcanic mountain. With this knowledge, U. S. aircraft could approach from this direction and stage surprise raids without being spotted by Japanese radar.

A clever enemy will not necessarily

operate all of his radar simultaneously, particularly in peacetime. This means that ferret aircraft must sometimes "bait" the opposition by venturing closer than necessary merely to detect a radar signal.

During wartime the baiting is made easier because a ferret aircraft can employ active jamming. For example, prior to the invasion of Sicily the Allied Command needed to know whether German coastal radars, normally used only against shipping, could be elevated sufficiently to be employed against aircraft. To find out, a ferret aircraft equipped both with reconnaissance receivers and active (jamming) electronic countermeasures was flown near the coast of Sicily.

The ferret's receivers showed that the three German air defense radars were trained on it, but the two coastal radars continued to follow ships at sea. Then the ferret turned on its jamming equipment, putting the air defense radars out of action.

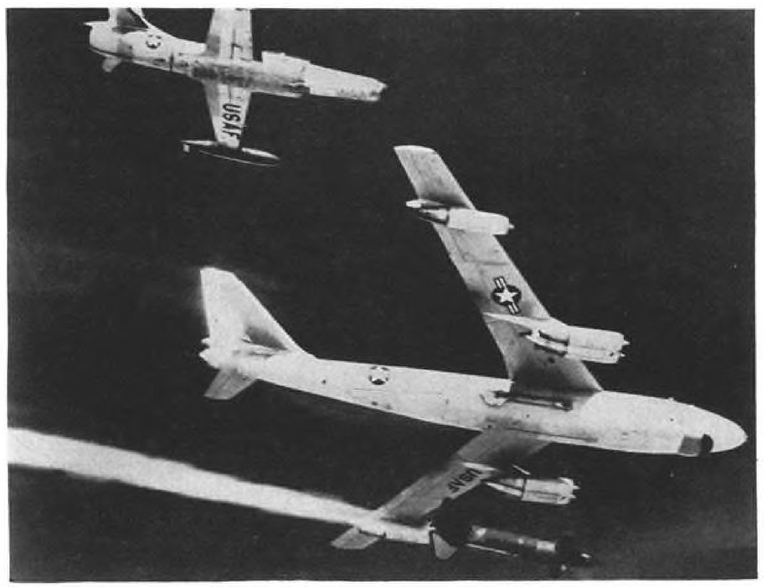
After only a short delay, the coastal radars suddenly stopped their normal duties, aimed skyward and followed the ferret. This was the information sought. Both the air defense and coastal radars were heavily bombed before the invasion began, and aircraft were equipped with jammers capable of countering the coastal radars.

Newer U.S. bombers carry equipment which detects when the airplane is being illuminated by radar energy from the ground, from an interceptor or missile. In the case of an enemy interceptor, momentary illumination at regular intervals tells the bomber crew that the interceptor's radar is in its search mode and has not yet spotted the bomber. When radar illumination of the bomber remains on continuously, the latter's crew knows that the interceptor has locked onto the bomber and is pressing its attack. This warning enables the bomber crew to take evasive action, or turn on its own active electronic countermeasures.

Where ground or shipboard radar is used for tracking, the presence of continuous illumination likewise is a warning to the aircraft crew. If recently developed track-while-scan techniques are employed, however, the target may

### Price of Secrecy

German scientist hit upon the idea of using chaff (thousands of strips of tinfoil) to confuse radar operators more than a year before it was first employed by Allied bombers in 1943 with great effectiveness. But the idea was classified "top secret" and not disclosed even to German radar engineers. When British began to drop chaff, it came as a complete shock and surprise to German radar engineers who had not devoted any efforts to anti-chaff techniques. It required more than a year before Germans could put even partially effective anti-chaff techniques into use.



**Rascal Is Directed Toward Ground Target**

Air-to-surface GAM-63 Rascal guided missile (AW Feb. 11, p. 28) is released from B-47 at Air Force Missile Test Center, N. M. Bell Aircraft Corp. weapon, scheduled to become operational with Strategic Air Command, is 32 ft. long, 4 ft. in diameter.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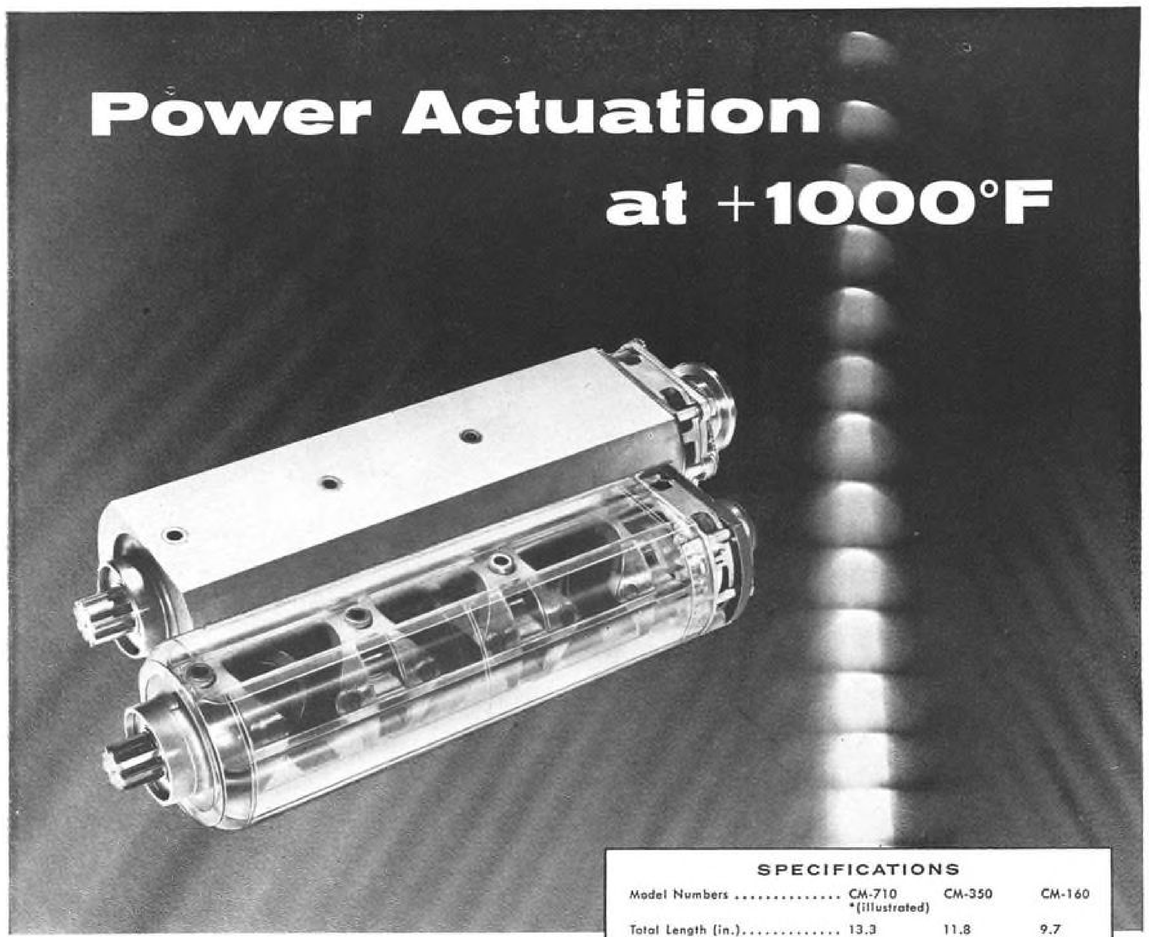

**SPECIFICATIONS**

| Model Numbers | CM-710 *(illustrated) | CM-350 | CM-160 |
|---|---|---|---|
| Total Length (in.) | 13.3 | 11.8 | 9.7 |
| Min. Height (in.) | 3.1 | 2.9 | 2.5 |
| Max. Dia. Envelope (in.) | 4.0 | 3.2 | 2.5 |
| Weight (lb.) | 22 | 15.5 | 7.5 |
| Output at 200 psig supply pressure and 1200 rpm (hp) | 18.5 | 9.1 | 4.2 |
| Starting Torque at 200 psig supply pressure (inch-pounds) | 1800 | 890 | 400 |

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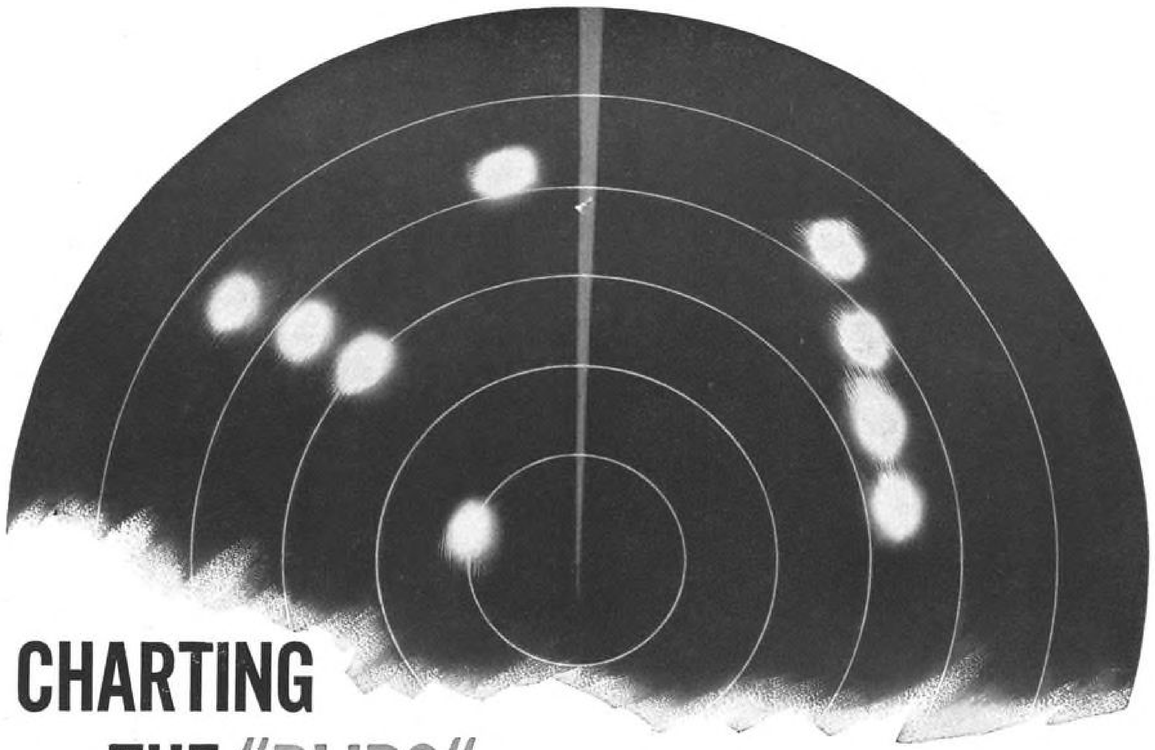

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be under close surveillance without any tell-tale change in the momentary illumination usually associated with normal search-surveillance.

### Use of Subterfuge

Electronic reconnaissance requires considerable skill and ingenuity on the part of the electronic countermeasures operator because things are not always as they seem. For example, in the fall of 1940 the Germans set up a powerful radio transmitter whose apparent purpose was to bombard Britain with propaganda.

In reality the transmitter had a more important mission: to provide guidance for German bombers. Shortly before a German raid its beam was narrowed to about 3 deg. without interrupting the steady stream of propaganda. German bombers flew down this radio beam to where it intersected the beam from another German transmitter directly over London, then dropped their bombs.

Londoners who were tuned to the German station began to notice that the signal strength (volume) increased sharply just prior to an air raid and used this as a warning to take shelter. Simultaneously, persons outside London observed that the signal strength dropped sharply, just before an air raid.

When the British discovered the secret, they developed two countermeasures for foiling the enemy. One was to rebroadcast the German transmission simultaneously from an omnidirectional antenna in Britain which effectively washed out the beam from the German transmitter. The other was the use of directional antennas for rebroadcast which effectively shifted the intersection of the beams to a point over the channel. The latter prevented the Germans from knowing that their secret had been discovered with the result that many bombs fell in the channel instead of in London.

### Passive Countermeasures

First recorded use of chaff, or "window" as it sometimes is called, took place in a British saturation raid on Hamburg in July 1943. The results, to quote a government report, "were spectacular. Royal Air Force losses were cut to a small fraction of those sustained in previous attacks. German radar operators were heard to exclaim: 'The planes are doubling themselves.'"

This passive electronic countermeasure was extremely cheap and easy to use. It consisted of small bundles, dropped from bombers, which opened and sent thousands of strips of tinfoil floating down. Each strip was of such length that it was resonant at the frequency of the German radar, thereby returning a tiny echo. Collectively the thousands of tinfoil echoes presented a target (echo) which was larger, brighter than the bomber itself.

The chaff served both to confuse the radar operators and to mask the bomber, much like a smoke screen.

### Obsolescent Chaff

The vastly increased speeds of today's bombers has decreased the usefulness of conventional chaff. The very significant difference in speed between the floating chaff and the supersonic bomber makes it easier for radar operators or automatic tracking equipment to distinguish between the two. Furthermore, the bomber moves ahead so rapidly that it may leave its chaff smokescreen far behind.

A partial solution to this problem is to dispense chaff from aerial rockets fired ahead, behind, above or below the bomber. A more sophisticated approach is to use a guided missile chaff dispenser to seed a corridor in advance of the bomber to provide a more effective smokescreen. Such chaff dispensing techniques presumably are under development or in operational use.

If ground radars are designed to quickly change operating frequency to a different portion of the spectrum, chaff effectiveness is reduced because the length of the foil strips is no longer resonant at the new frequency—


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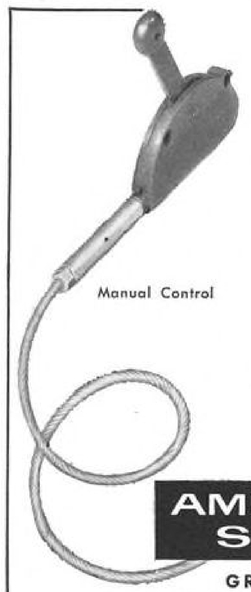


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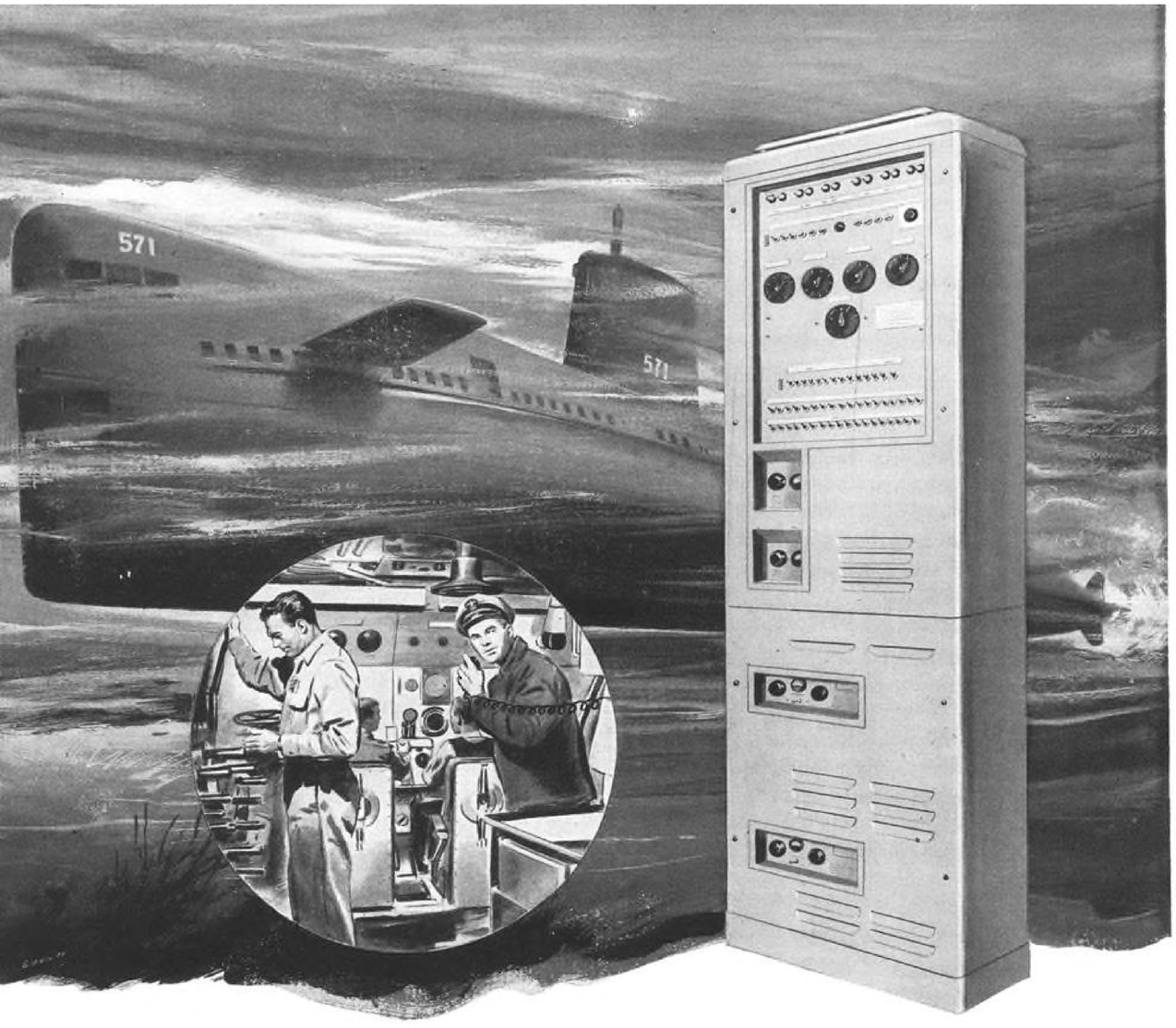


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unless the bundle of chaff contains foil strips of assorted lengths resonant over the full operating range of the radar.

The corner reflector is a simple type of passive electronic countermeasure which tends to focus or reinforce the radar energy that strikes it, returning a much stronger echo that would be obtained from a flat object of the same external dimensions. The corner reflector consists generally of three mutually perpendicular flat plates joined so that they have a common corner.

The device returns the strongest echo when the radar energy is directed toward the reflector corner because a triple reflection occurs from all three sides.

As the angle of beam incidence relative to the corner increases, the signal enhancement falls off somewhat. The amount of signal enhancement and rate of fall-off with incidence angle depends upon the shape of plates used in the corner reflector.

A more effective, but more expensive, type reflector is the Luneberg lens. This is a plastic sphere which is so constructed that it has a variable dielectric constant which focuses incoming radar energy from a wide angle of incidence onto a metal coated internal surface where it is reflected back to the radar with considerable signal enhancement. For example, one 12-in. diameter reflector of this type, manufactured by Emerson & Cuming, produces a radar echo equivalent to a target with a 700 sq. ft. cross section.

### Decoy Missile

When one or more corner reflectors are installed on a small airplane or other vehicle, the enhanced radar signal returned makes it appear to be a much larger object on the radar scope or to a radar-guided missile. A bomber under attack by a radar-directed interceptor, for example, might launch a decoy missile equipped with a corner reflector. The stronger radar echo returned from the decoy can fool the attacking interceptor's radar or its radar-guided air-to-air missile into following the decoy instead of the bomber.

Corner reflectors were used widely during World War II. During the Normandy invasion, the Allies sent out a group of small British motor launches outfitted with corner reflectors that made the small boats appear to be of warship size on German coastal radar scopes. These decoys then made diversionary feints along the coast, misleading the Germans as to where the Allied fleets intended to put troops ashore.

A more sophisticated way to employ corner reflectors is to mount them so that they can be rotated to produce an amplitude modulation of the radar signal returned. This amplitude-modu-


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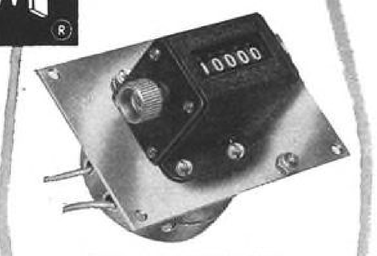

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**ELECTRONICS** Center of much of Vought's recent pioneering, Vought's electronics team now is nine times larger than in 1950. Promises further advances in reliability, antenna design and auto-stabilization.

**MACH 2-PLUS FIGHTER** Due soon from Vought, an all-weather, missile-carrying, carrier-based fighter that can exceed Mach 2. Will provide performance normally reached only by research aircraft.

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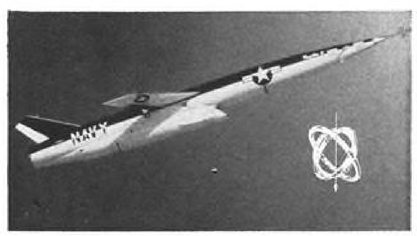


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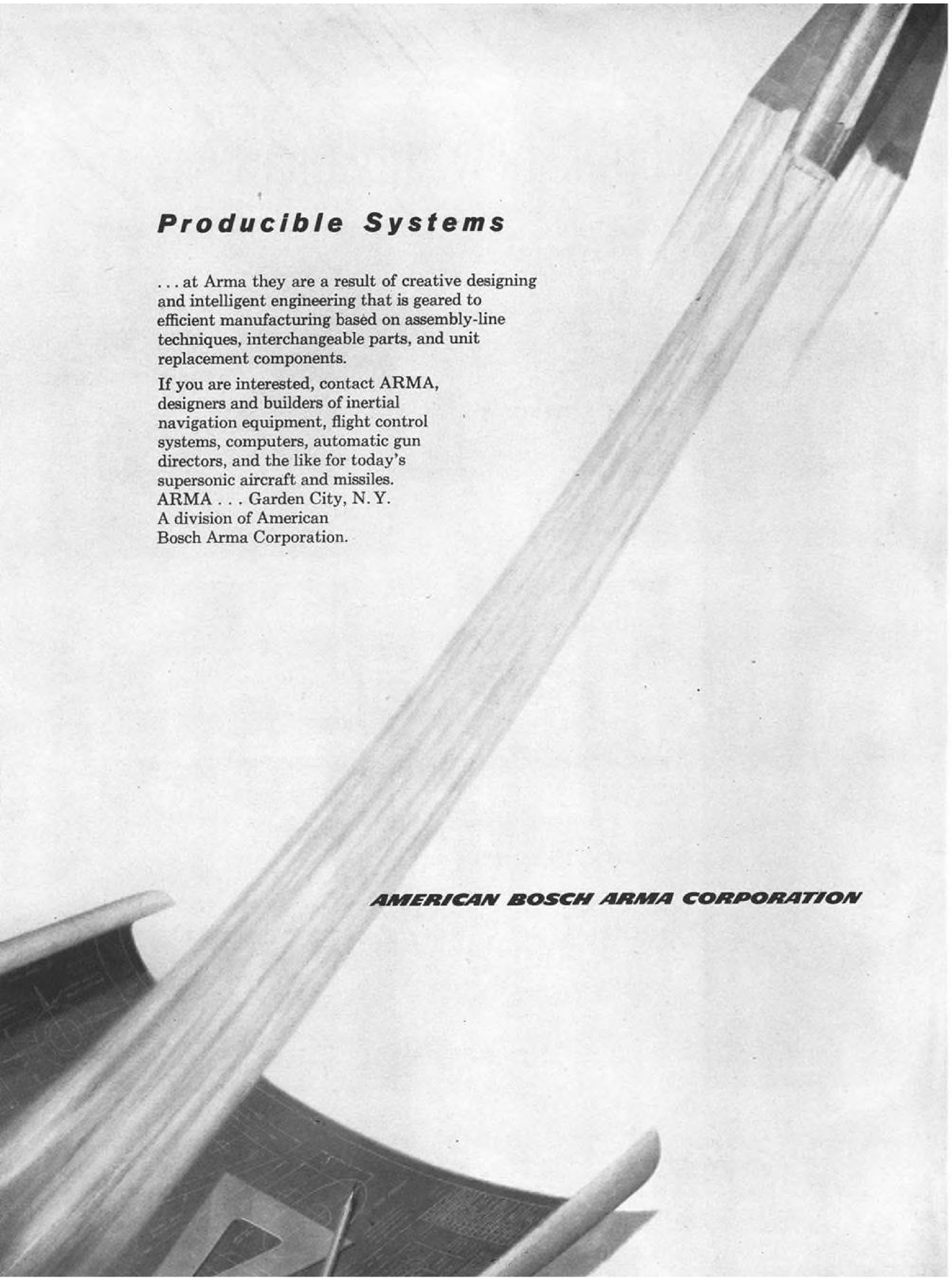



lated radar echo can confuse an interceptor or radar-guided missile that employs conical scanning of its beam to obtain aiming or steering information on target position.

The art of camouflage is as old as warfare so it is not surprising that considerable thought has been given to the possibility of techniques which would make an object invisible to radar. Despite periodic claims of "basement inventors" that they have discovered a paint which "blinds radars," there is no indication that a feasible technique applicable to high-speed aircraft or missiles has yet been uncovered. Most experts in the field doubt whether it ever will.

### Radar "Blinders"

To make an object invisible to radar, it is necessary to prevent energy from being reflected back to the radar antenna.

There are two general types of "radar blinders:"

• **Destructive interference:** This type, analogous to the anti-reflection coatings applied to optical lenses, produces a reflection of radar energy from its inner surface which is opposite in phase to that reflected from the outer surface of the coating, thereby producing destructive interference between the two which greatly reduces the energy returned to the radar. Germans developed such coatings for radar camouflage of U-boats during World War II. The destructive interference coating has the serious disadvantage of being extremely frequency sensitive. While it can provide some camouflage at one radar operating frequency, it is ineffective against radars at other frequencies.

• **Energy absorber:** This type seeks to completely absorb (and dissipate internally) incident radar energy. Germans also developed an absorbent radar camouflage consisting of a 2½-in. thick sandwich of alternate layers of conducting and dielectric material. The foam-type plastic had a dielectric constant nearly the same as air, provided good radar energy absorption over a fairly broad band (about 4 to 13 cm.).

Several companies currently produce absorbent materials for lining the inside of rooms used to test radar and radio antennas. One material, produced by Emerson & Cuming, reportedly absorbs 98% of incident radar energy over a relatively wide frequency band. Material suitable for operation at X-band and above measures about ¼-in. in thickness.

It is difficult to conceive of a high-speed aircraft or missile whose fuselage is encased with spongy material of this type for camouflage against radar. A more feasible possibility, particularly for missiles, would be to use a high-temperature ceramic with dielectric constant approaching that of air, whose inner surface was lined with absorbent material to dissipate the radar energy.

One of the most challenging areas in the field of electronic warfare is the development and operational use of active electronic countermeasures and electronic counter - countermeasures. Both subjects will be discussed in the concluding article of this series in a subsequent issue of AVIATION WEEK.

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| Oster Type | 8-5001-00 | 10-5052-00 | 11-5101-00 | 15-5153-00 | 18-5201-00 |
| Electrical Characteristics: | | | | | |
| Frequency (cps) | 400 | 400 | 400 | 400 | 400 |
| Torque at Stall (oz. in.) | .15 | .30 | .63 | 1.45 | 2.35 |
| No Load Speed (rpm) | 6500 | 6500 | 6500 | 5200 | 5200 |
| Speed at Half Torque (rpm) | 4000 | 4000 | 4000 | 3200 | 3200 |
| Time Constant (sec.) | 0.03 | 0.015 | 0.016 | 0.017 | 0.013 |
| Reversing Time (sec.) | 0.051 | 0.025 | 0.028 | 0.030 | 0.022 |
| Theo. Acceleration at Stall (rad/sec²) | 22500 | 45000 | 41500 | 31000 | 40000 |
| Operating Temp. Range (°C.) | −54 to +125 | −54 to +125 | −54 to +125 | −54 to +125 | −54 to +125 |
| Slot Effect | 1.6v/26v | 1.0v/36v | 1.0v/40v | 1.0v/40v | 1.0v/40v |
| Duty Cycle | Cont. | Cont. | Cont. | Cont. | Cont. |
| Fixed Phase | | | | | |
| Voltage | 26 | 115 | 115 | 115 | 115 |
| R (Stall) Ohms | 196 | 1270 | 1250 | 490 | 280 |
| X (Stall) Ohms | 183 | 1560 | 1780 | 890 | 570 |
| Z (Stall) Ohms | 268 | 2210 | 2175 | 1030 | 640 |
| P.F. (Stall) | 0.73 | 0.57 | 0.58 | 0.49 | 0.45 |
| Effective R (Stall) Ohms | 366 | 3840 | 3800 | 2160 | 1460 |
| Parallel Tuning cond. for unity P.F. (Stall) Mfd. | 1.0 | 0.13 | 0.15 | 0.33 | 0.55 |
| Control Phase | | | | | |
| Voltage | 40/20 | 40/20 | 40/20 | 40/20 | 40/20 |
| *R (Stall) Ohms | 480 | 124 | 145 | 58 | 39 |
| *X (Stall) Ohms | 445 | 215 | 204 | 103 | 77 |
| *Z (Stall) Ohms | 660 | 248 | 250 | 118 | 86 |
| *P.F. (Stall) | 0.73 | 0.50 | 0.58 | 0.49 | 0.45 |
| *Effective R (Stall) Ohms | 910 | 495 | 430 | 240 | 190 |
| *Parallel Tuning cond. for unity P.F. (Stall) Mfd. | 0.4 | 1.4 | 1.3 | 2.9 | 4.1 |
| Mechanical Characteristics: | | | | | |
| Rotor Inertia (gm. cm²) | .47 | .47 | 1.07 | 3.3 | 4.0 |
| Weight (oz.) | 1.2 | 2 | 4.5 | 8 | 14 |
| Mounting Type | Synchro | Synchro | Synchro | Synchro | Synchro |
| Motor Length | .863 | .672 | 1.703 | 1.625 | 2.03 |
| Type Shaft | Pinion | Pinion | Plain | Plain | Plain |
| Shaft Extension | .375 | .218 | .437 | .540 | .540 |
| Outside Diameter | .750 | .937 | 1.062 | 1.437 | 1.750 |
| Type Connection | Leads | Terminals | Terminals | Terminals | Terminals |

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Size 11

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Size 18

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material to emit light in the pattern of the original image but with considerably brighter intensity. Image can be erased instantly if desired. Second display-storage device, developed under Signal Corp contract for high-resolution radar storage and display, consists of tiny cells of photoconductive and electroluminescent material, with up to 1,600 cells per square inch. When light falls upon a cell, current flows in photoconductive material, causing light to be emitted by electroluminescent material, which maintains photoconductive material in conducting state. Laboratory models have achieved storage times of 15 min. but longer storage periods appear theoretically possible, RCA says.

► **Featherweight Traveling Wave Tube**—Traveling wave tube which weighs only ½ lb., requires no focusing magnet, and delivers 2 watts over S-band frequencies will be available shortly in sample quantities from Radio Corporation of America's Electron Tube Division in Harrison, N. J. New "Estiatron" differs from earlier experimental electrostatically focused traveling wave tube in that it requires only one pair of helices for focusing. Simplified construction should cut tube manufacturing cost and improve reliability.

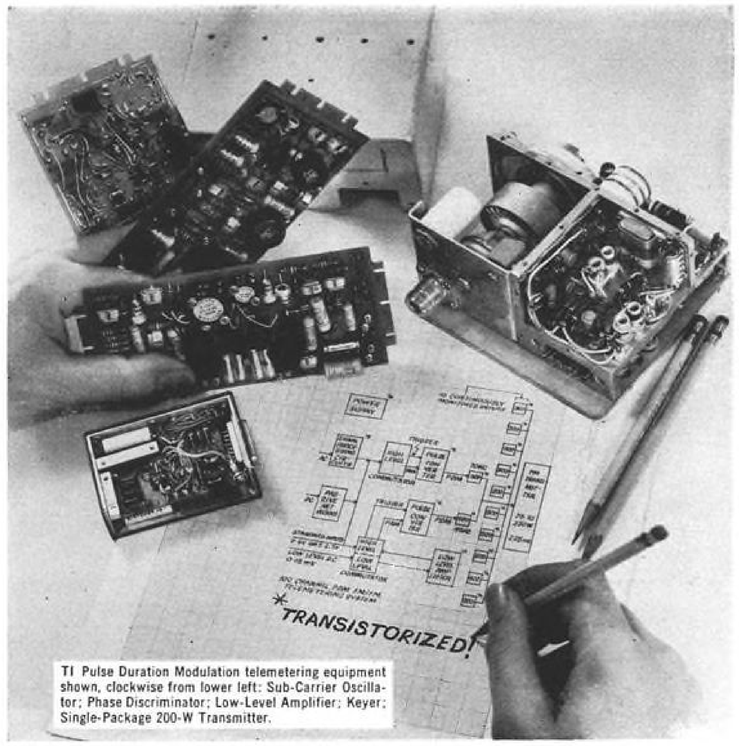
► **Super-Power Radar**—Microwave signals with peak power of 17 million watts have been obtained with new microwave generator developed by Cornell Aeronautical Laboratory under contract with Army Ordnance. Cornell's announcement implies that average power is higher than previously attainable, but gives no figures on pulse length or duty cycle. Generator should have application to long-range missile trackers.

► **Minitrack Report Available**—First of a series of reports of the Minitrack system for tracking earth satellites, is now available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. The 31-page report, priced at $1.00, is identified: PB 1311220 and entitled: "Project Vanguard Report No. 18, Minitrack Report No. 1—Phase Measurement."

## Expansions. Changes In Avionics Industry

Instrument Corporation of Florida is newly formed company which will specialize in development and manufacture of instrumentation. New firm, located at the Melbourne-Eau Gallie Airport, is headed by M. S. Friedland, former Florida Division manager of Reeves Instrument Corp. William F. Wrye, Jr., vice president, also is former Reeves employe.

Other recently announced expan-


TI Pulse Duration Modulation telemetering equipment shown, clockwise from lower left: Sub-Carrier Oscillator; Phase Discriminator; Low-Level Amplifier; Keyer; Single-Package 200-W Transmitter.

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# strays
**and**
# long shots

**with TI transistorized PDM/FM/FM telemetering systems**

Out-of-sight missiles, particularly those off course or in the far reaches of terminal flight, can now send back signals loud and clear – providing data previously blocked by attenuation and noise. This promise can be made because TI-developed transistorized telemetering can now transmit 200-W *and more* without exceeding the space and weight previously required by most 50-W systems. Not "frozen" to old production designs, rugged TI systems and components will *always* represent the practical state of the art. This is the TI policy which resulted in the 200-W *single package* transmitter shown above.

Your requirements in telemetering systems or components can normally be met by existing TI equipment, but your most unique developmental problems are equally welcome. And fast, flexible production facilities will deliver *on time*.

***WRITE TODAY*** for more information on TI telemetering equipments.

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**Look at this new flight-test oscillograph—**

CEC's new 5-122 operates in a temperature range of −65°F to +250°F at altitudes to 120,000 feet. Twenty-six channels (plus two static reference traces) can be recorded. The 5-122 also meets the challenge of minimum size, consists of three small, separate modules—oscillograph and magazine, master timing unit, and control unit. Both the control and master timing units can be installed in remote locations.

Other features include new jump-speed selection method, flash timing, and improved automatic record-identification systems; explosion-proofing in accordance with military specifications; crash-resistant magazine; and provisions for synchronizing the 5-122 into an over-all data-acquisition system. Compact size is 11" wide by 8" high by 18½" long. Weight is 80 lbs. fully loaded, 55 lbs. without magazine. Power requirements: 200 volts, 400 cycle, 3 phase. Contact your nearby CEC field office, or write for Bulletin CEC 1585-X6.

*. . . and 7 new high-temperature galvanometers*

Another important *first* in flight-test recording is CEC's new family of High-Temperature Galvanometers. Accuracy is guaranteed in ambient temperatures to 250°F for extended periods with a flat response from 0 to 3000 cps.

**Consolidated Electrodynamics**

*300 North Sierra Madre Villa, Pasadena, California*

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD


sions, changes and mergers in the avionics industry include:

• **Textron Inc.** has purchased **Accessory Products Corp.**, Whittier, Calif., maker of pneumatic and hydraulic control devices for aircraft and missiles. New acquisition will continue to be headed by Robert G. Rogers as president.

• **Chicago Aerial Industries, Inc.**, has opened new Western Regional office in Los Angeles, headed by Charles Z. Becker.

• **Sperry Rand** is stepping up plans for expanding its Sperry Utah Engineering Laboratories, Salt Lake City, where company will build Sergeant missile. New 100,000 sq. ft. addition is nearing completion and company plans to add another 50-100,000 sq. ft. next year—an expansion originally scheduled for 1959.

• **Taber Instrument Corp.**, North Tonawanda, N. Y., has opened new Electronics Division to produce pressure transducers and transistor amplifiers.

• **L. A. Young Spring & Wire Corp.**, Detroit, has purchased the **Link Radio Corp.**, New York City. Link's manufacturing operation, which produces AM and FM mobile radio equipment, will be moved to parent company's Gonset Division in Burbank, Calif., which also produces communication equipment.

• **Howell Instrument Co., Inc.**, Ft. Worth, Texas, has opened a branch affiliate in Hato Rey, Puerto Rico, which will manufacture precision aircraft instruments and sub-assemblies for electronic test equipment. New plant is expected to reach full production by January and employ about 50 persons. John Pipes is general manager of new plant.

• **Stavid Engineering, Inc.**, Plainfield, N. J., will shortly move its manufacturing operations to new 65,000 sq. ft. building adjacent to company's administration-engineering building. New addition brings total plant area to 160,000 sq. ft.

• **Marion Electrical Instrument Co.** has completed 20,000 sq. ft. addition to its plant at Grenier Field, N. H., a 50% increase in plant floorspace.

• **Haller, Raymond & Brown, Inc.**, State College, Pa., will build new facility about a mile distant from building now nearing completion. When new facility is completed next summer, firm will have approximately 71,000 sq. ft. of floorspace.

**Avionics Engineers:**
**MAKE AVIATION HISTORY AT RYAN**

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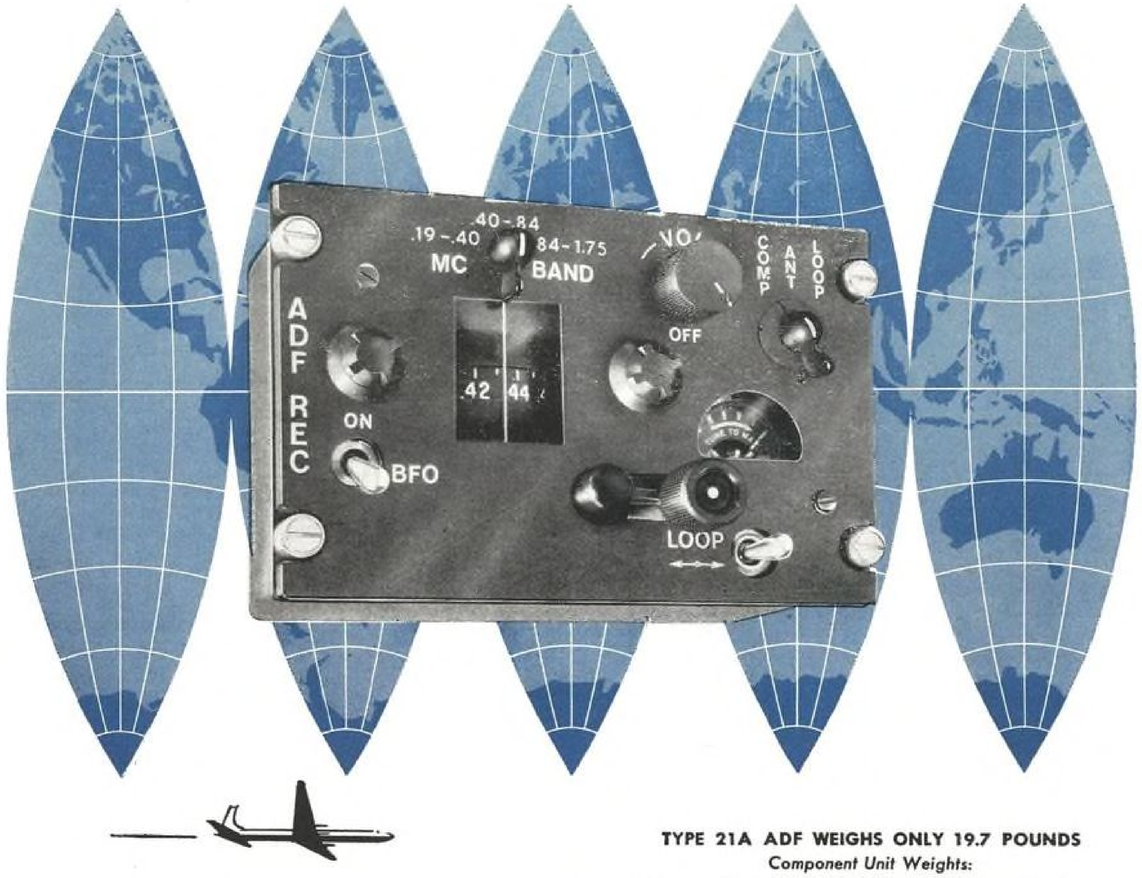


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*Component Unit Weights:*

Receiver, 6.8 lbs.; Loop, 4.3 lbs.; Loop Housing, 0.5 lbs.; Indicator, 1.3 lbs.; Control Unit, 1.6 lbs.; Power Unit, 5.2 lbs.; CAA Certificate No. 1R4-9 U.S. Military: AN/ARN-59 British Certificate of Approval VC-78

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The ADF is a basic air navigation instrument, used in all parts of the world, turnable to some 60,000 transmitters. But the important thing now about the ADF is that ARC has engineered an ADF system down to less than 20 pounds in weight, with a comparable saving in space.

Now pilots enjoy the advantages of dual installations of this compact miniaturized equipment in tolerable weight and space requirements.

The ARC Type 21A ADF is built to today's more critical speed and environmental demands. It has hermetic sealing of vital components, such as the entire loop assembly. It covers all frequencies from 190 kc to 1750 kc . . . operates on only 2.8 amps at 27.5 volts dc input or equal power at 13.5 volts. A significant feature is the extremely low loop drag—only two inches outside the aircraft skin.

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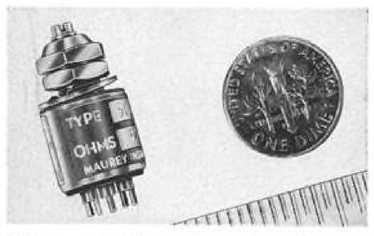
## Components & Devices

• **Precision crystals,** manufactured to military and commercial standards, have frequency tolerance of ±0.0001% with aging of only one part per hundred million per week. Hermetically sealed

in glass T5½ enclosures, 5 mc. crystals are available with pigtail leads or 9 pin Bakelite base. Reeves-Hoffman Division of Dynamics Corp. of America, Carlisle, Pa.

• **Vacuum ionization tube,** Type GIC-001, indicates ultra-low pressures in the $10^{-12}$ mm. Hg region, possesses sensitivity of 100 microamperes per micron. Output is linear through range of 5 x $10^{-4}$ to $10^{-12}$ mm. Hg. Collector voltage is −25 volts, with grid operated from 150 to 240 volts. Tube envelope is 7 in. long by ½ in. in diameter. Write for Bulletin No. P9-10. Rochester Division Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.

• **Trimmer potentiometer,** Type 50-M14, will dissipate ¼ watt at an ambient temperature of 150C, derated at 250C. Wire wound trimmer is housed in ½ in. long, ½ in. diameter stainless steel case.

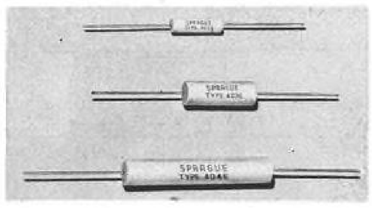



Unit can withstand 1,500 volt rms. dielectric breakdown test at room temperature. Maurey Instrument Corp., 7924 S. Exchange Ave., Chicago 17, Ill.

• **Pressure pickup,** Type 4-380, is designed for absolute and differential pressure measurements of non-corrosive fluids in ranges up to 100 psi. High level d.c. output eliminates need for signal amplifier. Operating temperature range is −65 F to +200 F. Weight is 8 oz., height is 1⅜ in. Mounting flange is 2¼ in. square. Consolidated Electrodynamics Corp., 300 Sierra Madre Villa, Pasadena, Calif.

• **Thermocouple reference junction,** with 8, 12 or 24 channels, has temperature stability of ±¼C over environmental range of MIL-E-5272A. Units are preset to order at temperatures be-

tween 100 F and 300 F and can be specified for use with any type or combination of thermocouples. Cardinal Instrument Corp., 4201 Redwood Ave., Los Angeles 66, Calif.




• **Ceramic-jacketed film resistors,** called Filmistors, meet requirements of MIL-R-10509B. Tubes 402E, 403E and 404E are rated at ½, 1 and 2 watts respectively. Filmistors use hermetically-sealed dense ceramic cases with ceramic to metal solder seals. Ceramic case is both water and vapor resistant and permits direct mounting in contact with conducting surfaces. Performance characteristics are given in Engineering Bulletin No. 7010. Sprague Electric Co., Marshall St., North Adams, Mass.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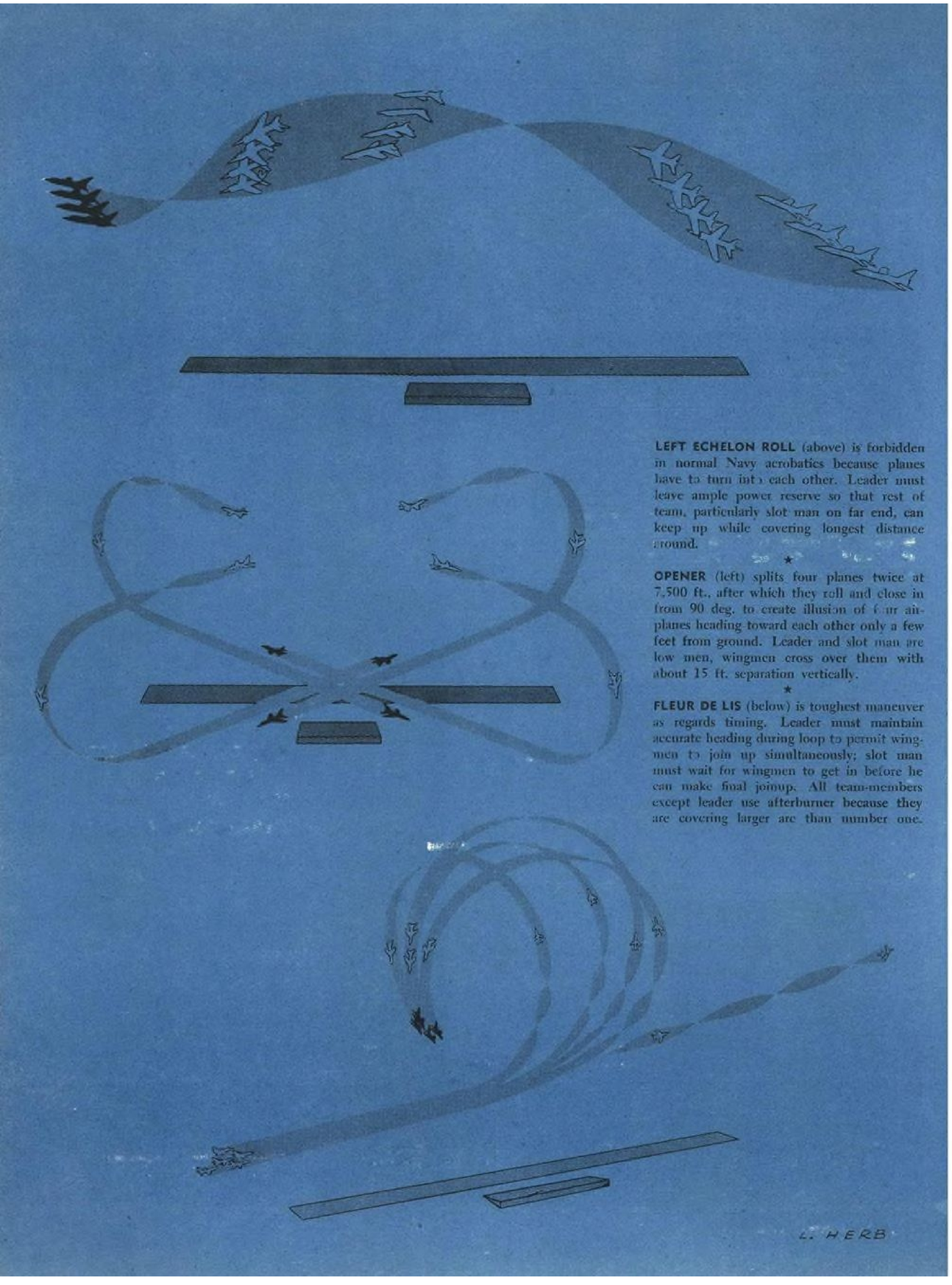



**LEFT ECHELON ROLL** (above) is forbidden in normal Navy acrobatics because planes have to turn into each other. Leader must leave ample power reserve so that rest of team, particularly slot man on far end, can keep up while covering longest distance around.

★

**OPENER** (left) splits four planes twice at 7,500 ft., after which they roll and close in from 90 deg. to create illusion of four airplanes heading toward each other only a few feet from ground. Leader and slot man are low men, wingmen cross over them with about 15 ft. separation vertically.

★

**FLEUR DE LIS** (below) is toughest maneuver as regards timing. Leader must maintain accurate heading during loop to permit wingmen to join up simultaneously; slot man must wait for wingmen to get in before he can make final joinup. All team-members except leader use afterburner because they are covering larger arc than number one.

# Blue Angels Do Serious Job for Navy

By Erwin J. Bulban

**Pensacola, Fla.**—Two serious naval aviation missions underlie the spectacular aerial showmanship of the Blue Angels flight demonstration team and explain sustained backing from high ranking officials for more than a decade, including lean budget years.

Blue Angels rate high as an effective Navy service and public relations medium, their personal appearances before mass audiences at naval air stations symbolizing the epitome of fleet pilot flying skill in the latest combat-type equipment.

Prime missions of this novel service organization are to:

- **Encourage precision flying** habits in normal naval aviation activities and develop interservice pride in fielding an acrobatic team competitive with U.S. and foreign military units.
- **Channel air-minded youngsters'** ambitions towards naval aviation as a career.

To meet these responsibilities, the Blue Angels have evolved a 22-min. action-packed six-man precision flying routine containing something for fellow service pilots and layman public. Maneuvers utilize standard acrobatics taught Navy pilots, tightened up to a hair-raising degree and brought down to several hundred feet altitude to show what can be done with practice.

For crowd appeal there are flourishes of colored smoke and water and the boom of afterburners being cut in on the team's new Grumman F11F-1 Tigers.

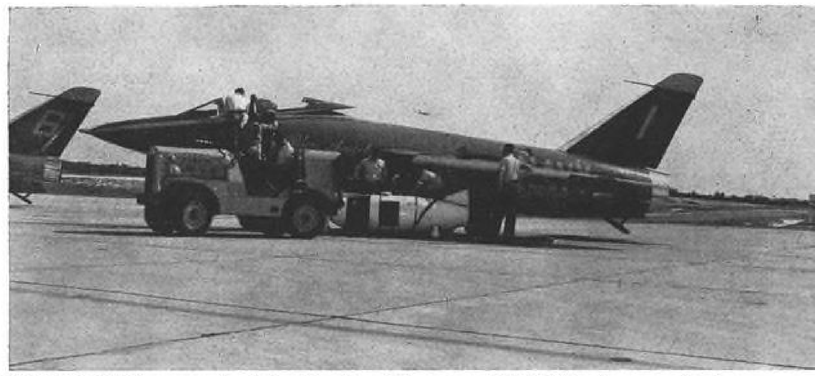
## Tight Formation

The Blue Angels strive to fly the tightest formation in the business; normal vertical separation is about three feet with about half of the wingmen's inner wings overlapping those of the leader's.

In diamond, the slot man is stepped down seven or eight feet from the leader's tail.

If there's turbulence, the formation spreads out a foot or so, depending on conditions.

Flying this tightly, the Angels meet an aerodynamic phenomenon called proximity effect, a cushion of air flowing ahead and around the surfaces of their planes. This proximity effect extends outward 20 ft., tends to push adjacent parts of the nearest airplane away. In diamond, Cmdr. Edward B. Holley, the leader, feels the effect the most; both wingmen tend to push his airplane up and the slot plane exerts an upward pressure on his tail. Effect is so strong that the three other mem-



**GROUND CREW** prepares to start a Blue Angel Grumman F11F-1 Tiger for a practice hop; preflight checks and starting routine is handled with drill-team precision at an actual air show by linemen who precede team to shows in a Douglas R5D transport fitted with shops. Hard schedule of shows, daily practice hops gives pilots and ground crews little time off all year.

**COMPRESSOR** gives air start to Tiger Wright J65-W-18 turbojet. Airplanes are standard carrier fighters with only guns deleted to provide baggage space for much-traveled team. When team gets new planes, earlier models are turned over to Navy's Training Command.

**TEAM LEADER** Cmdr. Ed Holley (left) checks a point on a maneuver with slot-man Lt. Nello Pierozzi using familiar pilot sign language. Comdr. Holley joined Blue Angels in Aug. 1956; Lt. Pierrozi, leaving soon for a carrier assignment, joined the team in Oct. 1954.

**RIGHT ECHELON ROLL** is practiced high in the air near Pensacola; Blue Angels start this maneuver at about 300-ft. before an audience.

bers of the team could easily roll the leader's airplane if he were to let them.

Airplanes may be stable neutrally trimmed, but as soon as they join up proximity effect tends to put them violently out of trim. So pilots each have to feed in proper trim to counter proximity effect. This is not nearly as simple as it sounds because there is this factor working against them: proximity effect is not constant. Angels say it is much less predictable on the Tiger than on their earlier F9F-8 Cougars and airplanes tend to pop in and out of position. Also, as the airplanes change positions in the course of the maneuvers, proximity effect varies rapidly during the changeover and the Tigers have to be trimmed accordingly.

The trick is not to wait until the airplanes move into their new places to put in the necessary trim, but to develop knowledge of the maneuver so that pilot is building in approximately trim he knows he will need while his plane is getting there.

### Positive Trim

Necessary at all times is some positive pull trim on the stick, perhaps a quarter G, to overcome possibility of developing pilot induced oscillation as the airplanes bob.

From the ground, the four airplanes seem to swing through their maneuvers so smoothly that it appears that they are tied together; actually a close look would reveal them bouncing as the pilots fight turbulence, proximity effect and work to keep their airplanes evenly spaced. Wingtip trimmers are moving up and down and flaperons, which Grumman jets use in place of conventional ailerons, are constantly popping in and out atop each wing.

This is strictly a stick and throttle operation. Seat is far down to bring the pilot's knees up high to provide a foundation on which to rest the right forearm. His elbow is held tightly against his side for improved leverage. Stick is constantly moving around in an arc of less than six inches. Stick arm gets a good workout and each of the Blue Angels develops a right forearm noticeably heavier and more muscled than the left.

A pilot trying out for a Blue Angel vacancy laboriously peeled off high leather flight gloves after a practice session here. Not yet onto the trick of putting in trim to hold his wing against the proximity effect of the airplane flying with him, he had been fighting to hold the airplane mainly with the stick. His right hand, swollen nearly twice normal size, attested to the physical punishment it had taken.

There is almost no watching of gages; the 22-min. show goes on with the pilots eyes glued to the leader and other airplanes. They use radio and the acute sense of timing and rhythm developed through innumerable practice hours. Talk to the Angels and they have only a ball-park guess as to their speeds and the Gs they are pulling.

Team doesn't wear G-suits. Maximum force pulled during any of the maneuvers is about 6 G in the fleur de lis and that so briefly it doesn't bother the pilots. At other times they go to 3½-4 Gs, but again only for an instant. Speeds are held well below the maximum of the F11F-1's supersonic capability; they will range from a high of approximately 600 mph. in the high-speed low-altitude opener during which the planes cross from four different points, to 300-400 mph. in most of the maneuvers.

### Two Shows

Angels have two shows in their repertoire: the complete treatment, covering 20 maneuvers including solos, if ceiling is at least 10,000 ft. and visibility five miles, and a "flat show" if the ceiling goes down to 3,000 ft. and visibility to three miles. Latter, understandably, deletes vertical maneuvers such as loops, opener and fleur de lis.

Generally the team flies from its home base at Sherman Field, Pensacola, to the show site two days before the show opens. Early arrival not only gives pilots a chance to practice and to pick necessary landmarks they will use in timing their maneuvers, but is also designed to give the team maximum public exposure in personal appearances, luncheons and television and press sessions.

Takeoffs, usually down an 8,000-ft. runway, use a finger formation, with wingtip clearance: Cmdr. Holley flying ship Number 1, Lt. Robert L. Rasmussen in Number 2, Lt. Sheldon O. Schwartz in Number 3 and stepped off his wing, slot-man Lt. Nello Pierozzi flying Number 4. Solos, Lt. Thomas K. Jefferson in ship Number 5 and Lt. Herbert P. Hunter in Number 6, take off separately.

After the four-plane group lines up on the runway, Cmdr. Holley gives turn-up signal by hand, goes up to 100% power to check thrust, brings the power back to 97% and locks the throttle. When Holley drops his hand, he takes his feet off the brakes and the four planes start to roll together. Next signal is his quiet monotone, "Burner on. . . . Now," and he applies 97% afterburner power. Remainder of the quartet does likewise.

By leaving a margin of power, leader gives team-mates an essential reserve to play with so that they can move off together otherwise, should he move out ahead of the group, they would have no way to stay with him.

As soon as the Angel's wheels leave the ground, slot-man Lt. Pierozzi is sliding his airplane over behind Cmdr. Holley using rudder while simultaneously retracting his gear. By the end of the runway the team is in a tight diamond formation which it holds for about three miles. Lineup is by watching key reference points on each other's airplanes. Wingmen, for example, sight along the leader's wing leading edges, line up the center of three barrier detents projecting from his wings with the top of his fuselage; slot man will put the canopy hoop onto the leader's skag (tailskid) or carrier hook.

For their opener the Navy jet quartet comes over the spectators at 8,000 ft. at 320 mph. indicated airspeed in trail formation, nose to tail. At a predetermined point in front of the spectators preferably a runway, Cmdr. Holley gives the monotone cue, "Ready Break," which splits the team into two sections, Comdr. Holley and Lt. Ras-

**ON THEIR BACKS** over the water, trailing colored water from wingtips, Blue Angels demonstrate superbly tight diamond formation roll they perform at 300-ft. altitude at shows.

**BLUE ANGELS FLIGHT DEMONSTRATION TEAM** (l. to r.): Lt. Cmdr. Willard Olsen, maintenance officer; Lt. Sheldon "Lefty" Schwartz, left wing; Lt. Nello Pierozzi, slot; Lt. Thomas Jefferson, solo; Lt. Cmdr. Edward Holley, leader; Lt. Robert "Ras" Rasmussen, right wing; Lt. Herbert Hunter, solo and Lt. Mark Perrault, public information officer and pilot of two-seat F9F-8T.

**Bill Remmert** brought R-W services to Pompano. Behind him, a DC-3 conversion nears completion.

**Bob Werner** works most of his time at Remmert-Werner's home-base operation in St. Louis.

# Remmert-Werner...
# Big-Change Artists

*Over 200 aircraft conversions . . . thousands of corporate planes maintained and serviced . . . millions of gallons of Shell Aviation Fuel sold to satisfied customers—that's Remmert-Werner's 10-year record!*

In June '56, a caravan of three giant mobile units left Remmert-Werner's home base, Lambert-St. Louis Municipal Airport. It was headed for Pompano, Florida.

Bill Remmert met the caravan. Utilizing its complete machine, woodworking, and electrical shops plus radio racks, stockroom and expert mechanics, he established another R-W-staffed base.

"When we took over the Pompano field," recalls Bill, "we needed fueling equipment—fast. Shell engineers came down and designed our bulk plant. And almost before we knew it, there were the three 15,000-gallon storage tanks we ordered waiting out there on flatcars, ready to go. Shell helped us zoom into business."

Besides servicing a good number of America's 28,000 corporate planes, Remmert-Werner also converts surplus commercial and military aircraft into luxury planes for private owners and corporations.

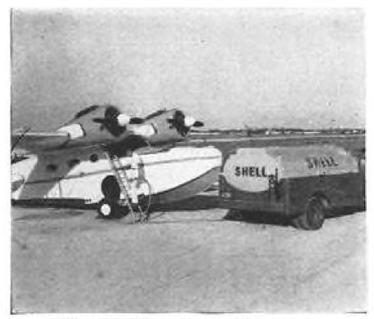
In an ordinary conversion job, R-W rips out every bit of wiring and piping, and installs completely new systems to customer specification. Lounge chairs and sofas, tables, lamps, galleys and any other special furnishings are designed and built by R-W craftsmen.

Among the organizations that happily fly Remmert-Werner conversions are Olin Mathieson Chemical, Grumman Aircraft, Hercules Powder and Owens-Illinois Glass.

"It didn't take long for us to find out that when you're a Shell Dealer, business flies your way," says Bill. "Shell works right along with you, helping you build your business. They've even helped us locate old DC-3's when they've been hard to get. A Shell man spotted some while traveling in Turkey last year. We went right over there and bought them. Most of those '3's' have already been converted into flying yachts."

If their first 16 months at Pompano is any indication, Bill Remmert and Bob Werner are on their way to making R-W service available to America's ever-increasing fleet of corporate aircraft.

***Before:*** C. S. Weaks (right), R-W sales manager, and client discuss plans for a Grumman "Goose."




***After:*** R-W serviceman fuels a converted "Goose" with Shell Aviation Gasoline.

***Before:*** R-W craftsmen remodel interior of DC-3. They'll install new wiring, insulation, picture windows, and furnishings to order.

***After:*** Betty Remmert (right) shows prospective client through completed interior. R-W conversions sell for as much as $300,000.

**It pays to be a Shell Aviation Dealer**

***—and the Shell office nearest you will be glad to show you why***

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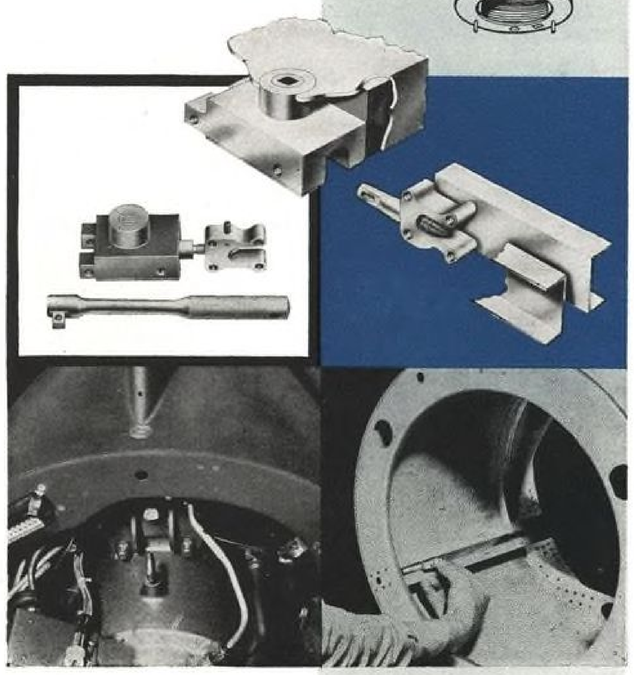
# new

**STRUCTURAL ROTARY LATCHES**
*for jet bombers, jet transports and missiles*

**CONVAIR** B-58 HUSTLER, the U.S.A.F.'s first supersonic bomber has a new and important application for latches.

***HARTWELL*** Type H-119 Rotary Latches (3) are used for fastening each variable inlet-air diffuser to each engine in the nacelles.



**ROTARY LATCH FEATURES**

ULTIMATE LOAD: 7,000 lbs. tension. (CONVAIR 4605 lbs.)

TOTAL UNIT WEIGHT: .39 lbs.

ADJUSTABILITY: A total adjustment of .30" is provided in an axial direction normal to the abutting structures, and is accomplished in half turn increments (.011") of self-indexing the threaded eye-bolt.

OPERATION: Driven by a standard socket wrench handle (¼ square drive) the rotary cam disengages the eye after 180° rotation. Axial take-up as latch cam is revolved from open to closed positions is .20". All moving parts are self-lubricated.

INSTALLATION: Both latch components are channel-mounted. All holes and cutouts in structure or skin can be drilled to simplify installation.

SAFETY: Positive locking is provided in latched position to prevent unlatching under severe vibration. A visual indicator signifies the latched or unlatched condition.

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mussen heading left, Lt. Schwartz and Lt. Pierozzi heading right. Twenty seconds later, Holley calls the second break, each pair splits again and the team is flying apart at 90 deg. from each other. Almost instantly comes the cue, "Ready Roll," and the F11Fs roll once and are heading downwards releasing white smoke from the tubes alongside the port side of the fuselages terminating at their tailpipes to provide spectators with optimum visual impact as they come tearing across the field towards each other at a closing speed of 1,750 ft./sec.

### Crossover Technique

Each man is watching the others on the back curve downward, tracing progress by smoke trails, gaging closing rates and adjusting power to attempt to make the crossover appear simultaneous. If the airplanes are going to cross the runway at right angles, the two low ships, Cmdr. Holley and Lt. Pierozzi, coming across the field about 10 ft. off the ground are separated horizontally by the width of the runway. If timing is right, Lt. Rasmussen and Lt. Schwartz will pass over them at right angles with about 15 ft. separation. Separations are worked out by eye, not by the gage. According to the Angels their smoke makes this an easy maneuver to calculate.

While Cmdr. Holley is racking around 90 deg., pulling up a steep climb to kill speed and calling off his airspeed to guide the others in the join-up, Jefferson and Hunter in the solo Tigers come diving in at about 575 mph., using each side of the runway for separation. They cross in front of the grandstand, at about 100-ft. altitude, then on the signal, "Roll," they make three vertical rolls to the left, which, if true verticals, will take them to about 12,000 ft.

Purpose of the solos between each maneuver of the quartet is to divert the crowd from the four Tigers that are reforming for the next maneuver, thus keeping the air filled with action.

Lt. Jefferson cues the solo acts, which are so timed that when he gives the signal, Lt. Hunter knows that ship Number Five will pass over the center of the field 30 seconds later. Solos come down from altitude. Lt. Jefferson from about 6,000 ft., and Lt. Hunter from between 6,000-7,000 ft. because he has worked out his timing from the higher altitude. Solos use the runway for separation in all of their passes, make their rolls to the left. On the knife edge passes they go in canopy to canopy. On rolls and the knife edge, the aircraft tend to lose altitude, requiring the pilot to get the nose up, arcing the airplanes down the runway. By the top of the arc they are feeding in full rudder.

Toughest of the solo maneuvers is th

## How Blue Angels Plan Show

How Navy plans a Blue Angels flight demonstration team show at one of its air stations to get maximum community and public relations coverage is detailed in this typical schedule which budgets every available hour that the team is not flying. This was a recent appearance at Spokane, Wash.:

SEPT. 26

1300: Indoctrination flight for local press by Lt. Mark Perrault, Blue Angels' public information officer in Grumman F9F-8T Cougar two-seater.
1430: Team appears on Rod Clefton's "The Women" show, station KHQ-TV.
1615: Blue Angels appear on Jack Bainter's "Mr. Engineer" show, station KHQ-TV. Angels make evening visit to Shriner's Hospital for crippled children.

SEPT. 27

0900: Further press flights by PIO in F9F-8T.
1200: Blue Angels featured at luncheon with armed services committee of Spokane Chamber of Commerce (each team member makes a three-minute speech).
1300: Additional press flights in F9F-8T.
1400: Team arrives at station KHQ-TV for interview with "Date With an Angel" finalists in contest conducted by station.
1500: Arrive at station KXLY-TV for appearance on Dick Jones show.
1600: Arrive at Davenport Hotel swimming pool lounge for sandwiches and refreshments with "Date With an Angel" finalists.
1800: Free time to prepare for evening program.
2000: Meet the five "Miss Naval Air Spokane" queen finalists at Ridpath Hotel for dinner on hotel roof garden.
2200: Transportation arrives to take queen finalists home.

SEPT. 28

0800: Flights in F9F-8T for news media.
0900: Briefing on Civil Aeronautics Administration Regulations regarding air exhibition.
0930: Blue Angels put on practice show for familiarization.
1200: Depart for Pullman, Wash., with five queen finalists to watch Washington State College vs. University of California football game.
1400: Arrive at stadium. Winners of "Date With an Angel" and Miss Naval Air Spokane contests to be announced over public address system during half-time. A Blue Angel and winner to appear on station KNEW during half-time ceremonies.
1630: Leave Pullman for return to Spokane.
1830: Arrive at Spokane, free time for Blue Angels; Miss Naval Air Spokane and her court taken home to freshen up.
2000: Girls are taken to air station officers club where they are guests of Spokane Chapter of Navy League for dinner.
2030: Transportation arrives to take girls home.

SEPT. 29

0900: Complete media flights in F9F-8T.
1000: Blue Angels have lunch in station cafeteria with Navy League "buddies" (9-14 yr. olds).
1315: Station commanding officer Capt. Frank Holt welcomes aboard team and distinguished visitors, introduces Miss Naval Air Spokane and the mayor and coronation of the queen ceremonies are staged.
1400: Blue Angels take off for formal air show for spectators.
1500: Blue Angels start flight demonstration.
1530: Team lands and taxis to the line.
1600: Blue Angels arrive at officers club to meet invited guests.

Here's how the Lockheed Electra prop-jet airliner will look on its maiden test flight early next year. The Electra—first all new four-engine transport ordered by U. S. airlines in a decade—is one of 12 Lockheed planes in or nearing flight test stage.

# *Engineers*... How Lockheed's aircraft fleet assures you a variety of assignments

To the engineer who seeks variety in his work, Lockheed offers an assortment of challenging aircraft projects that is unequalled in the industry.

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high-speed 600-mph.-plus pass under the quartet which is making low-altitude carrier-type pass by the crowd at about 160 mph. with wheels, flaps and carrier hooks extended. Aim here is to meet under the team exactly in front of the grandstand.

### Left Echelon Roll

A specialty of the Blue Angels is a four-plane left echelon roll, considered taboo in military flying because doctrine is that a pilot never should turn into anyone in echelon.

Tiger quartet comes across the field in front of the crowd from the right stepped down 45 deg. at about 300 ft. altitude and 500 mph. At the start of the roll, Cmdr. Holley is pulling about 90% thrust; as he starts up in his roll, he begins to ease back on power. Lt. Rasmussen maintains his position until Cmdr. Holley's wingtip is aiming down at him. Then he starts to roll, Lt. Schwartz and Lt. Pierozzi following his cue. All the while the roll is in progress, the pilots are trimming as their airplanes move in a giant arc which goes up to about 2,000 ft. at the top, pulling power off down the line to maintain position on the leader until they are over on their backs. Then on the back side the power starts coming in again, with Lt. Pierozzi describing the biggest arc, having to make the largest power increase to stay in position. He estimates that he might go from a low of about 80% power all the way to 100% to keep from sliding away. At high speeds a fraction of lag in getting power would break up the formation in split seconds.

### Reverse Echelon Roll

Reverse echelon is another tricky one, with the four Tigers stepped down on the right with about eight feet separation vertically. As Cmdr. Holley goes up into a climb, he says, "Okay" and starts coming back on the throttle as he starts the roll.

In the first 90 deg. of the roll, the other three airplanes are fighting to slide smoothly underneath and slightly behind each other to maintain this lineup all the way around. At the finish the airplanes are sliding out to left echelon. According to the team, if properly done, there is illusion from the ground that Cmdr. Holley is stationary and the other three airplanes are rotating around him.

Colorful fleur de lis, in which the diamond breaks up as it goes into a loop and then makes a rendezvous on the back side, is considered by the Angels to pose the trickiest timing problems of all their maneuvers.

Starting out as a five plane diamond, with a solo pilot flying just under Lt. Pierozzi, the team comes across the runway at about 300 ft. indicating 500 mph. In front of the grandstand, Cmdr. Holley gives the signal, "Ready Break." At the letter "B" in the cue word, he has pulled up to 6Gs. At the last letter, "K," Lt. Rasmussen and Lt. Schwartz start fanning out at about 45 deg. Cmdr. Holley continues forward and up. Lt. Pierozzi watches the wingmen, lets them get out and then calls, "Roll." Right wingman and Cmdr. Holley roll once to the right, left wingman and slot man roll left. After the roll, the wingmen and slot-man kick in afterburner, zoom up and over the top of the loop at about 7,500 ft., Lt. Pierozzi making the greatest arc.

Cmdr. Holley, using about 95% power climbing in his loop, fights to maintain his heading so that on the back side of the loop, the wingmen racing in to join up will have the best possible chance of sliding in on either side of him smoothly and simultaneously. Key to a good fleur de lis is to have the four airplanes rejoin in a perfect diamond on the back side of the loop. Lt. Pierozzi's problem is to catch a glimpse of the two wingmen coming in and gage his join-up right behind theirs, snapping in with application of dive brake at the last second.

Where does the fifth man in the diamond go? As the other four planes pull into their loop, he keeps going down the runway, rolling.

The split-second sense of timing and rhythm that makes these difficult maneuvers seem so easy from the ground takes hours of practice for every one of the 22 minutes that the six blue-and-gold F11Fs are over the spectators. Practice, tied in with a heavy annual show schedule, ensures that the Angels don't get much time off except around Christmas and New Year's.

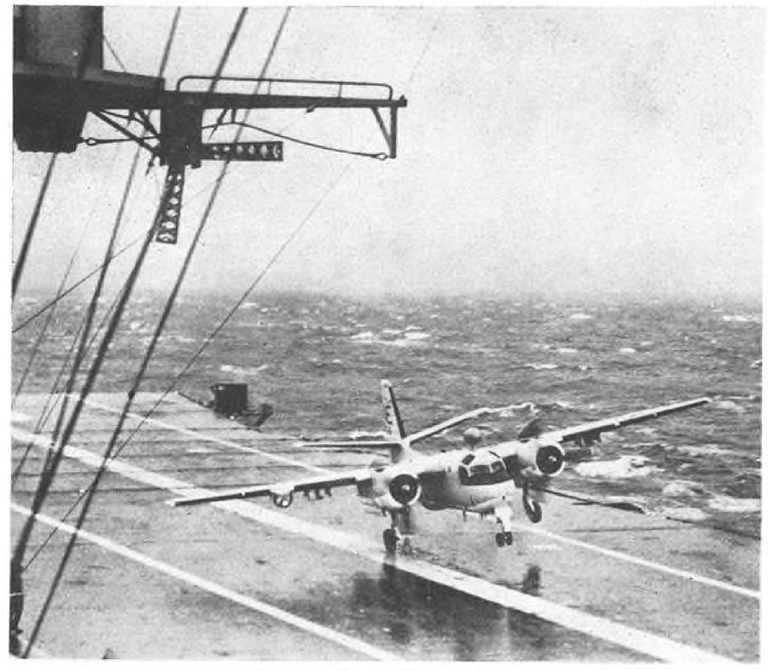
### Show Season

Typical show season starts Feb. 1 and runs through Nov. 15. In that period the Blue Angels put on 55-60 shows at Naval Air Stations across the country and spend approximately 150 days on the road. It gets especially rough when, as earlier this year, they put on three shows 1,000 mi. apart in four days with recently acquired F11Fs replacing F9F-8s.

When not on the road the team puts in two practice shows at Pensacola every day.

Between seasons is especially critical because this is the time normally required to train two replacements for the pilots who have completed their two-year tour with the organization and are headed for new duties, usually sea duty.

This is the last season for slot-man Nello Pierozzi, who has been assigned to duty on the carrier U.S.S. Randolph and for Lt. Schwartz, whose new billet



## Dancing Tracker

Grumman S2F Tracker anti-submarine aircraft applies power for another go-around after missing the arresting gear on the angled deck of the aircraft carrier Essex in the Norwegian Sea. Aircraft was with Anti-Submarine Squadron 36, which was participating in anti-submarine operations.

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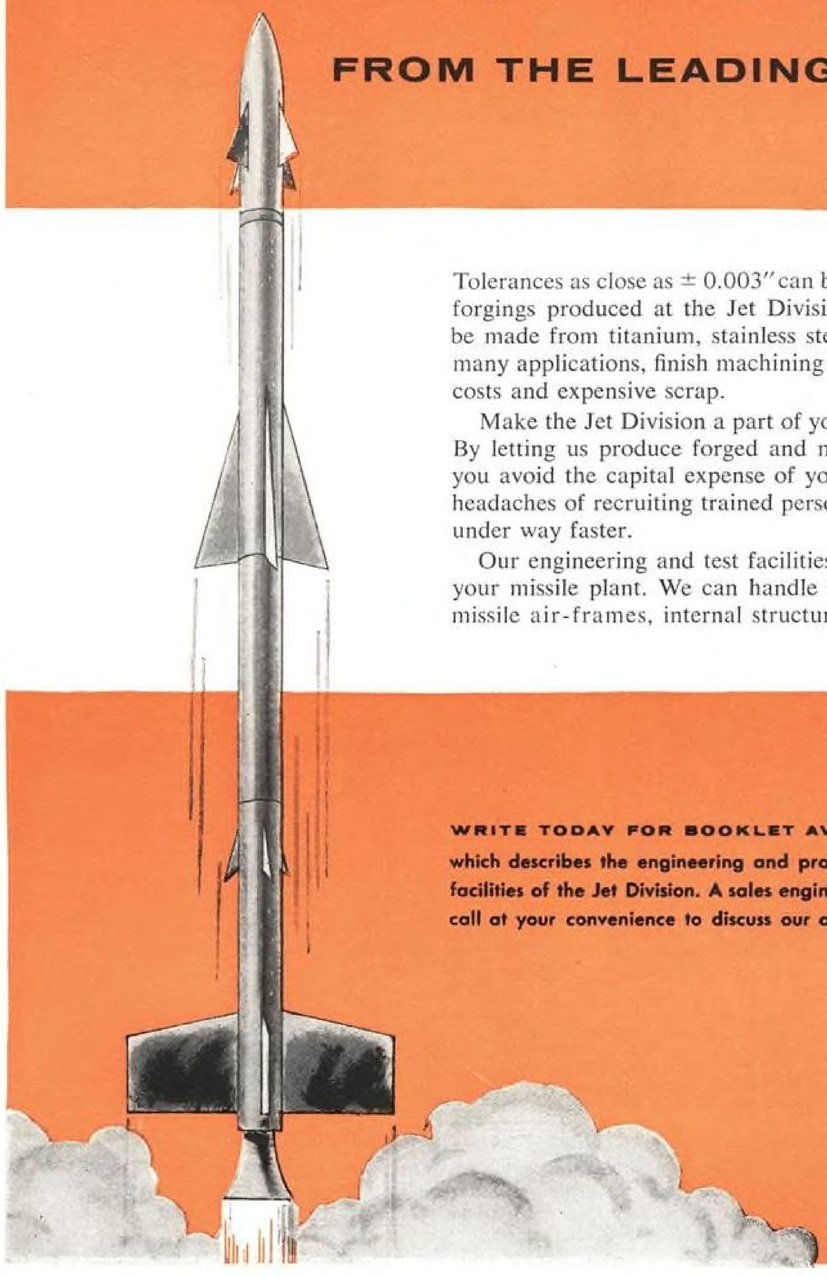

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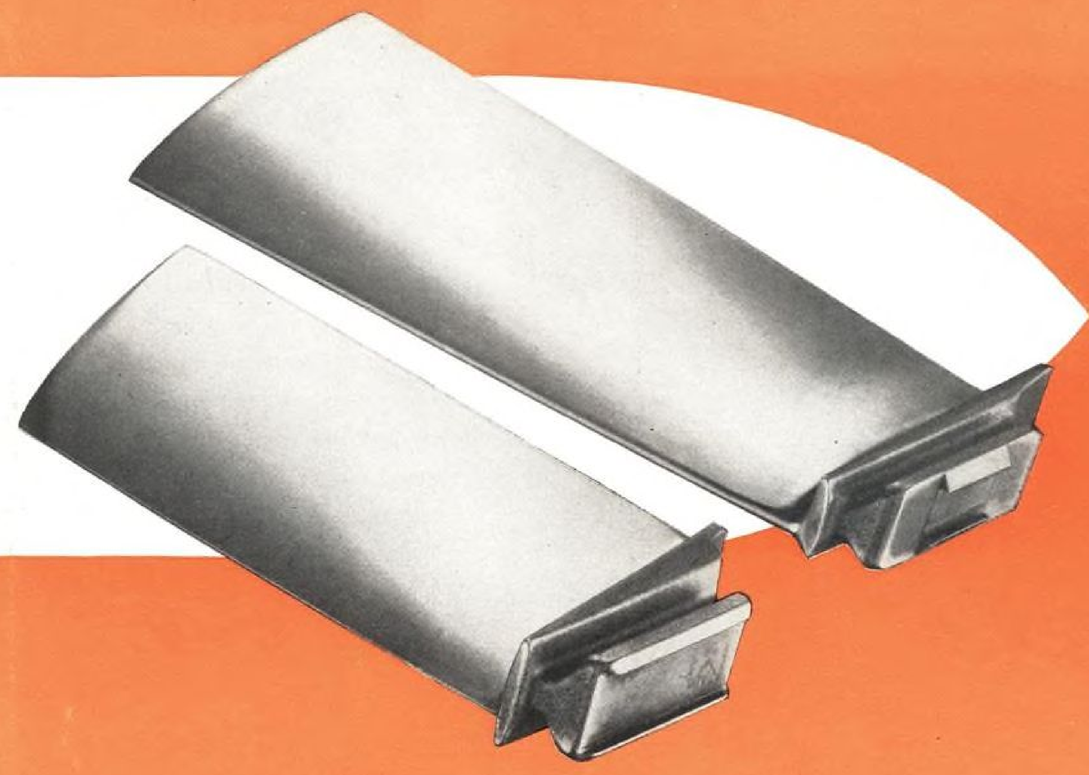

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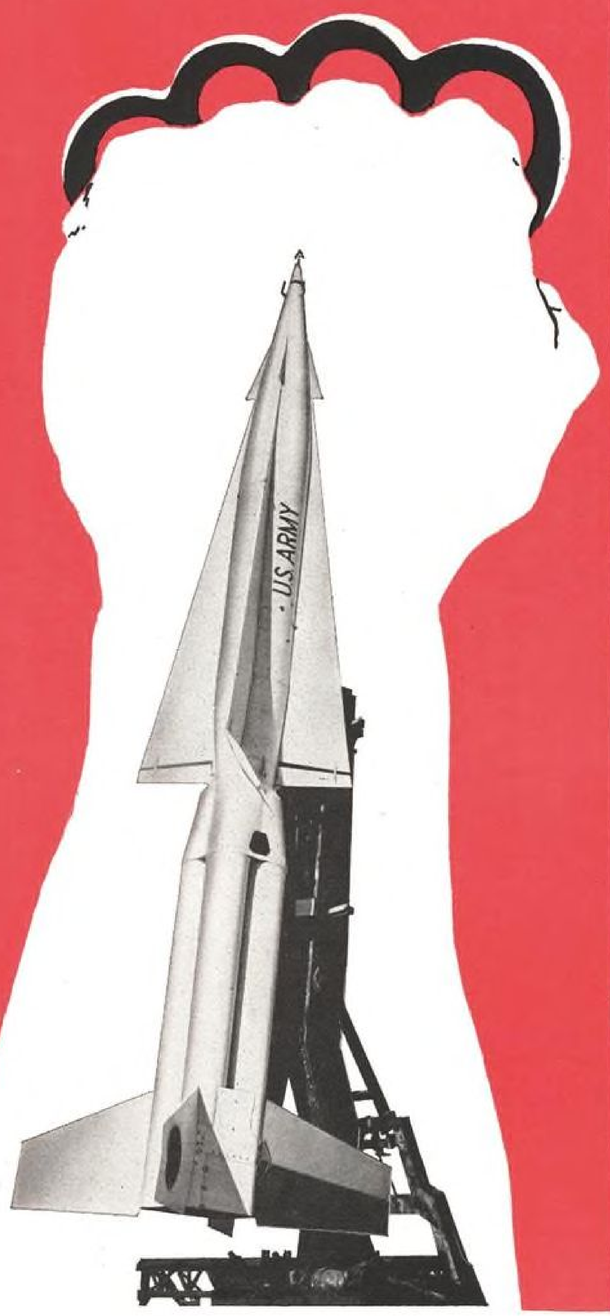

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is flag secretary with Adm. Ramsey on the West Coast.

Candidates for the Blue Angels are seasoned fleet pilots, holding down instructor's slots with Training Command who volunteer for acrobatic duty. Ten candidates are to be checked out by the team to fill two openings. It takes approximately six weeks to bring a new man into the diamond and three months of tough practice before the team is polished in its routine and ready for the road.

Forty-five enlisted men headed by Lt. Cmdr. Willard F. Olesen, maintenance officer, handle maintenance, with Chief Thomas Kelley as maintenance chief. Crews are hand-picked. Since there are more applications than spots to fill, Cmdr. Olesen gives volunteer candidates a thorough screening and takes those with best records as mechanics and sailors providing they can put in a minimum of two years with the outfit.

### Hard Work

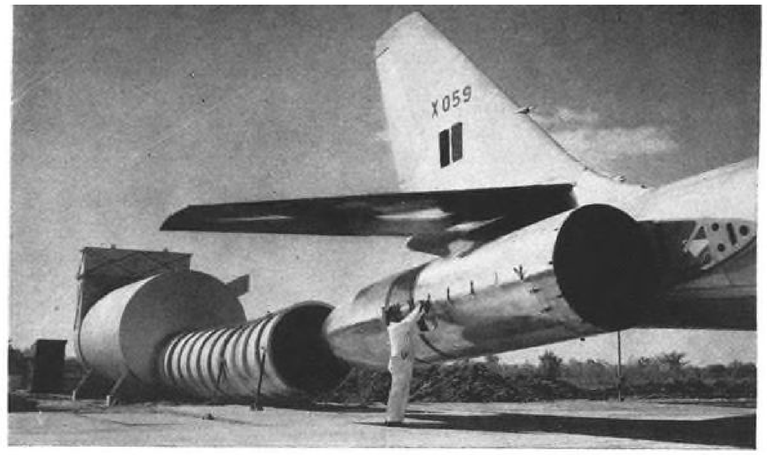
Cmdr. Olesen lays out the hard facts of working on the team to candidates: long hours, many week ends of work keeping ships in shape for shows and considerable amount of traveling. Latter is especially hard on the enlisted men. Because they travel in a group (about 23 men, Chief Kelley and Cmdr. Olesen spearhead each show date in a R5D fitted with work benches), they don't get per diem and actually wind up spending more money than they would on normal shore duty tour. Work schedule is so tight that during show season, time off for holidays is rare, since they are generally show days for the team. Also, it is not uncommon for crews to work until midnight for days getting ships ready for a show and then have to fly cross-country for a holiday exhibition.

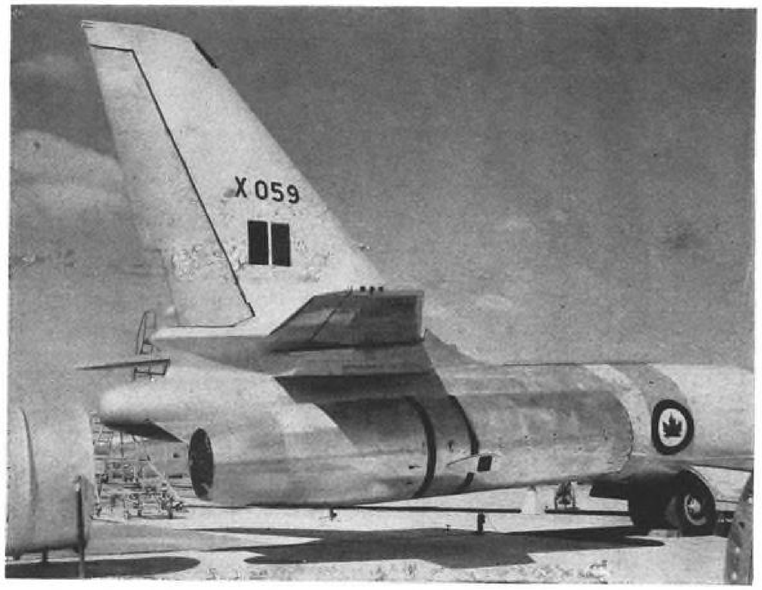
### Spotlight on Crew

In turn, the team has worked out the line service of its airplanes so that all of the ground crew gets out in front of the crowd.

Dressed in special suits, they go through the routine of checking the airplanes, pre-flighting them with drill team precision.

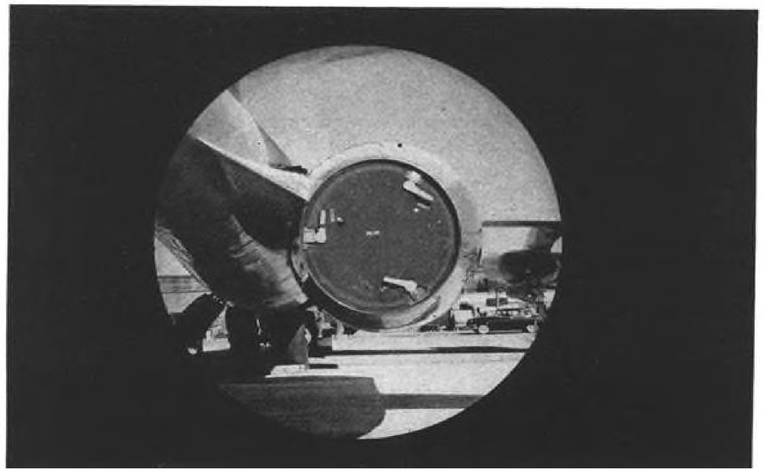
To expedite acquisition of needed parts, the airframe and engine manufacturer have representatives assigned to the Blue Angels on a full-time basis: Dave Scheuer of Grumman and Tom Larson of Curtiss-Wright. For example, if an aircraft is out of commission for need of a part and part is not available in the Navy's supply system, Scheuer can call directly on the Philadelphia Aviation Supply Office, get a dispatch number for the needed part, which he then gives to Grumman, which in turn airmails him the item.




## Iroquois Installed in Testbed

Orenda Iroquois turbojet engine is almost ready for its first flight testing in the Boeing B-47 installation shown here. After modification by Canadair Ltd., in Montreal the aircraft was delivered to Orenda at Malton, Ontario. During ground running the engine noise is softened by the large unit (top). Rear view of the experimental engine installation is shown below from inside the silencer. Design of the engine support pylon was particularly troublesome.



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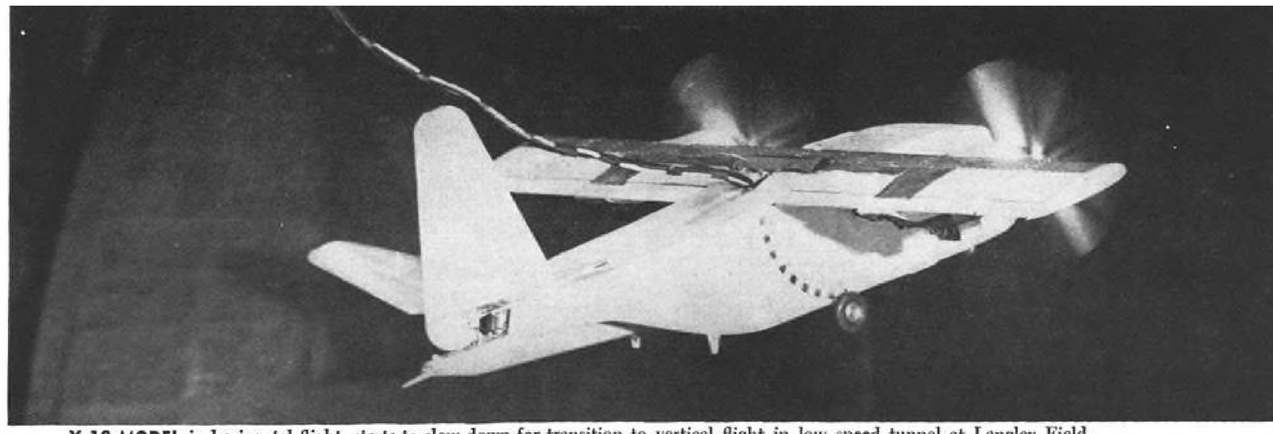


**X-18 MODEL** in horizontal flight, starts to slow down for transition to vertical flight in low speed tunnel at Langley Field.

# Hiller X-18 Model Free Flight Tested

Hiller X-18 VTOL design has successfully passed free flight model evaluations at the National Advisory Committee for Aeronautics Laboratory at Langley Field, Va.

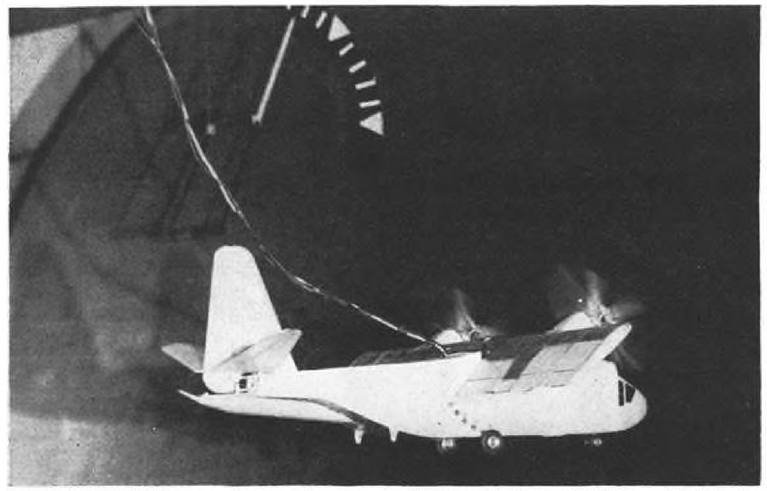
A six foot wingspan model of the tilt-wing research VTOL was remotely flown in NACA's large low speed wind tunnel which has been used for other NACA studies of STOL and VTOL aircraft.

The model incorporated full provisions for remote control of all aerodynamic surfaces, wing tilt, propeller pitch and power changes of its electrical motor drive, Hiller said. Each flight in the free flight program simulated a takeoff and complete transition sequence. Hovering and transition were continually performed with ease, Hiller said.

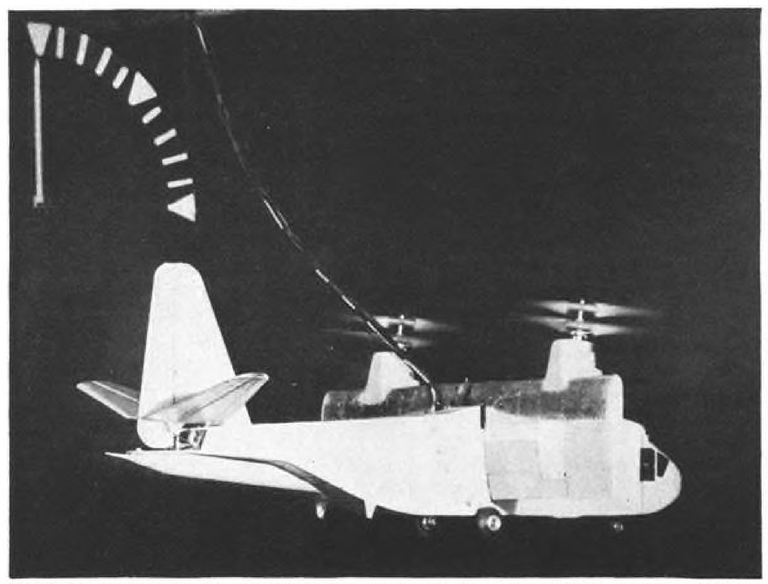
Stability and control were tested over a wide range of speeds, power variations and extreme center of gravity locations. Conditions during takeoffs, landings and sustained hovering in and out of ground effect were also explored.

Hiller said that the results were interpreted as further encouragement that a propeller driven tilt-wing configuration is practical.

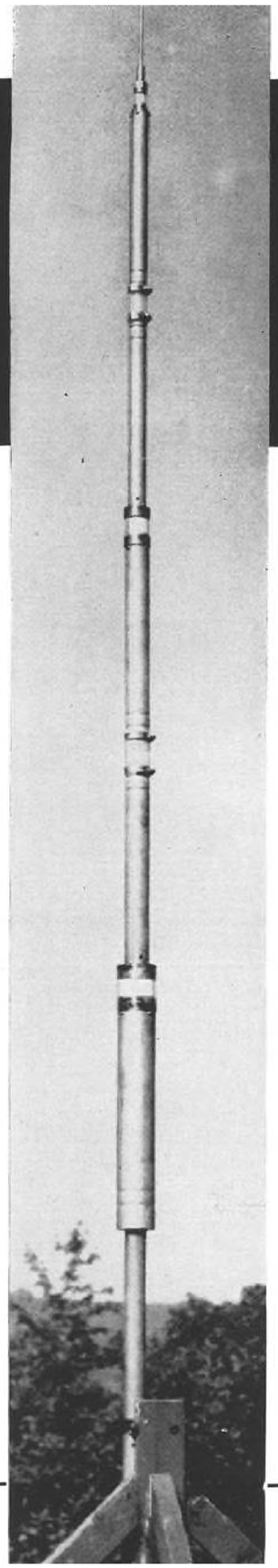
Next phase of the X-18 program will be the flight test of the full scale aircraft which is now in advanced stages of construction at Hiller's Palo Alto, Calif., plant. The X-18 has been built around a Chase transport body to which has been added a new tilting wing carrying two Allison 4,850 eshp. YT40-A-14 turboprops turning contrarotating propellers. Jet orifices extending from underneath the tail have been added to provide control moments during VTOL flight.



**X-18 HALFWAY** between horizontal and vertical flight. Pendulum behind model indicates tunnel windspeed has decreased. Power and control come through cables.



**NOW IN VERTICAL MODE,** X-18 is ready to let down for VTOL landing. Stinger-like projection from underside of tail is for jet which supplies control during VTOL.



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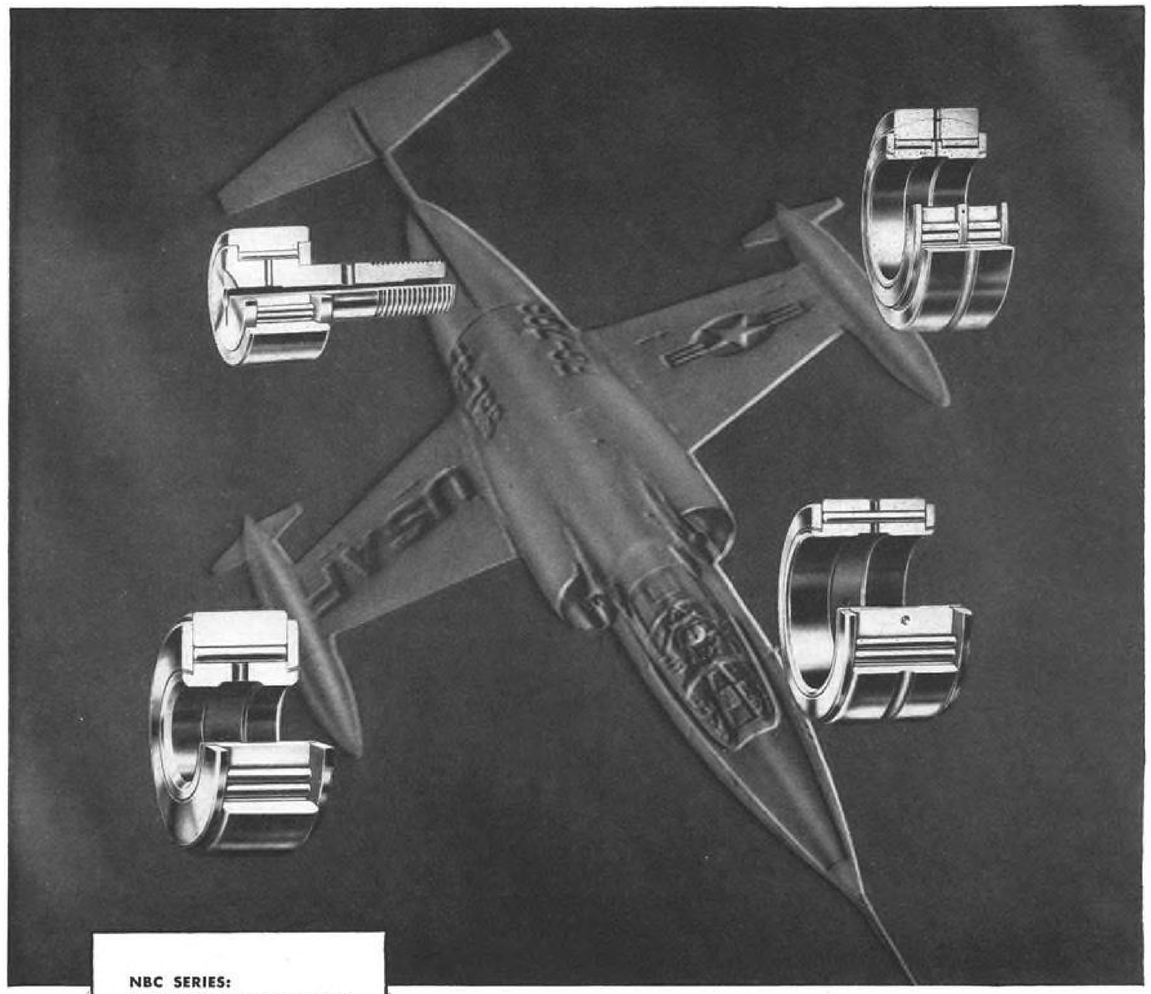

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double row of rollers and self-aligning spherical OD outer race mounted in spherical ID ring.

**CR SERIES:**
heavy outer race and integral stud permitting cantilever mounting for use as cam or track roller.

*Photo shows Lockheed's F-104A Starfighter, world's fastest, most advanced jet fighter, which is equipped with Torrington Aircraft Bearings.*

# Light for flight...

*complete series of high-capacity Torrington Needle Bearings for aircraft application*

Torrington Needle Bearings, offering maximum radial capacity in minimum cross section, are ideal for aircraft applications requiring dependable performance with light weight.

Torrington has developed four basic types to cover a complete range of application requirements. All are nonseparable units, made to AFBMA standards, constructed to have low radial clearance when mounted to keep vibration and backlash in mechanisms to a minimum.

Carefully selected quality steels and the most modern manufacturing methods are used in the production of these efficient aircraft-type Needle Bearings. At low unit cost, they bring efficient anti-friction operation for reliable performance and long service life. For further information on their selection and application, just call your nearest Torrington representative or write: The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.

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*District Offices and Distributors in Principal Cities of United States and Canada*

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ELECTRO SNAP

# FOUR PROVEN ANSWERS TO SWITCHING PROBLEMS

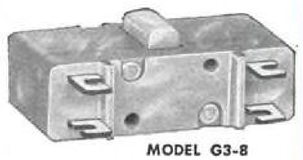
**Subminiature sealed switch is environment-free; mounts interchangeably with MS25085**

MODEL EF-3

Single Pole, Double Throw
Move. Differential, .004 Max.
Overtravel, .003 Min.
Oper. Force, 5 to 17 oz.
Release Force, 60 gram
Elec. Life Ratings:
150,000 ops. @ 125/250 V. A.C., 2.5 AMP.
100,000 ops. @ 125/250 V. A.C., 5.0 AMP.
50,000 ops. @ 30 V. D.C., (2.5 AMP., IND.; 4.0 AMP., RES.)
Amb. Temp., −65° to +180° F.

Sealed in a corrosion-resistant, treated aluminum enclosure, this tiny switch is environment-free; highly vibration and shock resistant. It carries 5 amps. at 125/250 V.A.C. with an electrical life rating of 100,000 operations. Low operating force and small movement differential make it ideal for bi-metal temperature, diaphragm operated and other "feather-touch" devices, while small size permits mounting singly or ganged in restricted space. Rugged and dependable, it has positive snap action.

**Tiny 40 amp. basic switch has high capacity, longer life and constant stability of tolerances**



MODEL G3-8

Measuring only 1¾" x 43/64" x 35/64", the Electro-Snap G3-8 Basic Switch handles current ratings up to 40 amps. A new method of combining Electro-Snap's double-break action with a heavy-duty switching element assures electrical and mechanical life of 100,000 cycles at large capacities; also provides constant stability of tolerances and accurate repeatability. New plastic compound case gives the switch an ambient temperature rating of —100° to +300° F. with extreme shock resistance. Small size makes it ideal for motor controls and compact automation set-ups. A wide range of actuators is available.

OPERATING CHARACTERISTICS

Single Pole, Double Throw
40 AMPS @ 125/250 V. A.C.
@ 30 V. D.C. Res.
Oper. Force, 45 oz. Approx.
Overtravel, .015" Min.
Move. Differ., .055 ± .010

ELECTRO SNAP

PRECISION SWITCHES

BASIC SWITCHES

DIECAST ENCLOSED SWITCHES

HERMETICALLY SEALED LIMIT SWITCHES

CONFORM TO MIL & AN SPECIFICATIONS

**Simultaneous triple-pole switch interrupts 3-phase ac. circuits; 6-circuit control in a small package**

MODEL K3-4

Triple-Pole, Double Throw
15 AMP., 125/250 V. A.C.
30 V., D.C. Res.
10 AMP., 30 V., D.C., Ind.
Overtravel, .015 Min.
Move. Diff., .028 ± .007
Mech. Life, 1,000,000 ops.
Elec. Life, 500,000 ops.

This Electro-Snap triple-pole switch simultaneously reverses current flow through three windings of a 3-phase motor up to 1 H.P. and interrupts other types of multi-switching installations. Instantaneous "make" and "break" snap-action of the three poles is independent of the speed of actuation—even extremely slow moving cams can be used.

The K3-4 Series offers designers a wide variety of 3-phase circuit hookups for servo-controls, to limit movement of machine members and as a start-and-stop switch which formerly were possible only with complicated relays or a number of separate switches. A large selection of standard actuators is available.

**Small basic switch is low cost; directly interchangeable with AN3234 Specs**

F2 SERIES

These Electro-Snap F2 Series snap action switches are extra-compact with extremely high electrical capacity for their size. Mechanical and electrical life at 1/32" overtravel is 150,000 operations, minimum, with accurate repeatability and constant stability of tolerances. Self-aligning springs provide contact wiping action rare in a switch of this size.

Durable case of special plastic gives the switch an ambient temperature rating of —100° to +275° F. or +375° F. Available, *at low cost*, in three basic models with a wide selection of actuators.

SERIES F2 BASIC SWITCH: F2-3: Single Pole, Double Throw
F2-2: Single Pole, Normally Open; F2-1: Single Pole, Normally Closed

OPERATING CHARACTERISTICS

Electrical Rating: 10 AMP. 125/250 V. A.C. 60 cycles
30 V. D.C. inductive and resistive (6 AMP. 30 V. D.C. for Airborne Application)
Operating Force, 7 to 12 oz.
Reset Force, 4 oz. Min.
Pretravel, 3/64 Max.
Movement Differential, .011 ± .005
Overtravel, 1/32 Min.

*SEND COUPON FOR MORE DATA*

ELECTRO-SNAP SWITCH & MFG. COMPANY
4232 W. Lake St., Chicago 24, Ill.
Please send data sheets on switch checked:

- ☐ EF-3 — subminiature sealed
- ☐ G3 — 40 Amp. basic
- ☐ K3 — Triple-pole
- ☐ F2 — Extra-small basic

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COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____


# Comet 4C Aimed at Intermediate Stages

**Hatfield, England**—De Havilland Aircraft Co.'s new version of the Comet, designated the Comet 4C, is aimed at intermediate stage length operation.

The Comet 4C will be equipped with the same Rolls-Royce RA. 29 engines fitted to the Comet 4 and 4B. Comet 4A is to be dropped.

The new Comet combines the large-capacity fuselage of the 4B with the full-span 115-ft. wing of the Comet 4. Company designers say this has been done in order to provide greater payload capacity than the Comet 4 without reducing the range to that of the short-range Comet 4B.

With a gross weight 3,500 lb. heavier than the 4B and a capacity payload 183 lb. less, the Comet 4C will have a maximum stage length 300 mi. longer.

The company says the formula costs per mile of the Comet 4B and the Comet 4C are practically identical and that costs per seat-mile and per ton-mile will be the same.

The 4C will have the 118-ft. length of the Comet 4B with the 115-ft. wingspan and 2,121 sq. ft. wing area of the Comet 4.

Its gross weight will be 156,000 lb., same as that of the Comet 4, while its maximum landing weight will be 118,500 lb., 5,500 lb. heavier than the Comet 4 and equivalent to the Comet 4B. It will have a first class seating capacity of 84 and a maximum tourist capacity of 99. This is the same as the 4B. The Comet 4 carries 60 first class passengers and 76 tourists. Range will be 2,475 statute-miles at 500 mph.

The Comet 4, designed to operate from moderate-sized airfields, is for stages of 2,000-3,000 mi. The 4B's shorter, stiffer wing permits the aircraft's normal operating Mach number of .74 to be achieved at a lower altitude. Thus the cruising speed can be increased at lower altitudes and block times reduced significantly on short stages. This, combined with the greater payload capacity resulting from increased fuselage length, provides an aircraft economically feasible over stages as short as 300 mi. and up to 2,000 mi., according to de Havilland.

British Overseas Airways Corp. has 19 Comet 4s on order while British European Airways has ordered six Comet 4Bs.

The Comet 4C "combines the superior operating economies of the continental Comet 4B with a payload-range capacity only slightly short of that of the intercontinental Comet 4," the company reports.

De Havilland believes the new aircraft will find its principal application among operators having medium-to-long stages branching out from a metropolitan network of short-stage routes.

Structural considerations resulting from the increased payload and fuselage weight of the Comet 4C will make it necessary to reduce slightly the normal operating indicated air speed limit as compared with the other two versions, the company says. This reduction will affect true airspeed only when the aircraft is operated below its maximum-speed height of 33,000 ft. Normal operating Mach number remains at .74.

"Since, however, the Comet 4C is intended mainly for the longer stages for which a cruising altitude of more than 33,000 ft. is appropriate, the block time which can be achieved in most cases will not be reduced," a company spokesman says.

The Comet 4C offers a substantial increase in payload capacity over the Comet 4 with a reduction in range in the neighborhood of 600 mi. The company points out that in this role the aircraft should be "extremely profitable" and that it will generally be able to use existing airfields without extension. Its principal application might be on routes connecting Europe with Australia, the Far East, South Africa and South America, the company says.

The 4C also can be used over the short stages of the Comet 4B without any penalty in operating economics, according to de Havilland.

"The small increase in block time consequent upon its slightly lower normal operating indicated air speed limit will be no handicap except perhaps in those parts of the world where speed and extreme flexibility, which are the special attributes of the Comet 4B, are of paramount importance," the company says. "It is therefore likely to find short-range application on the major stages of the European networks, in the Far East, in the Caribbean and in South America."

"This looks like the airplane we should have come up with in the first place," one company source said.

Capital Airlines still has not renewed its order for Comet 4As and this version of the Comet is "dead," a company spokesman says. If Capital reactivates the Comet order, it is expected to be for 4Bs.

## Comet Specification Comparison

| | Comet 4 | Comet 4B | Comet 4C |
|---|---|---|---|
| Overall length (ft.) | 111.5 | 118 | 118 |
| Span (ft.) | 115 | 107.8 | 115 |
| Height to fin top (ft.) | 28.5 | 28.5 | 28.5 |
| Wing area (sq. ft.) | 2,121 | 2,059 | 2,121 |
| Max. gross weight (lb.) | 156,000 | 152,500 | 156,000 |
| Max. landing weight (lb.) | 113,000 | 118,500 | 118,500 |
| Max. zero fuel weight (lb.) | 95,000 | 102,500 | 102,500 |
| Usable fuel capacity (imp. gal.) | 8,990 | 7,890 | 8,990 |
| Max. stage length with capacity payload (statute mi.) | 3,100 | 2,175 | 2,475 |
| Corresponding capacity payload (lb.) | 16,800 | 21,968 | 21,785 |
| Typical tourist seating capacity | 76 | 99 | 99 |

## Takeoff Performance of Comet 4C

| Gross Weight | Condition | Runway Length |
|---|---|---|
| 156,000 lb. | Sea level, 15C | 6,770 ft. |
| 156,000 lb. | Sea level, 37½C | 8,080 ft. |
| 156,000 lb. | 4,000 ft., 20C | 9,500 ft. |

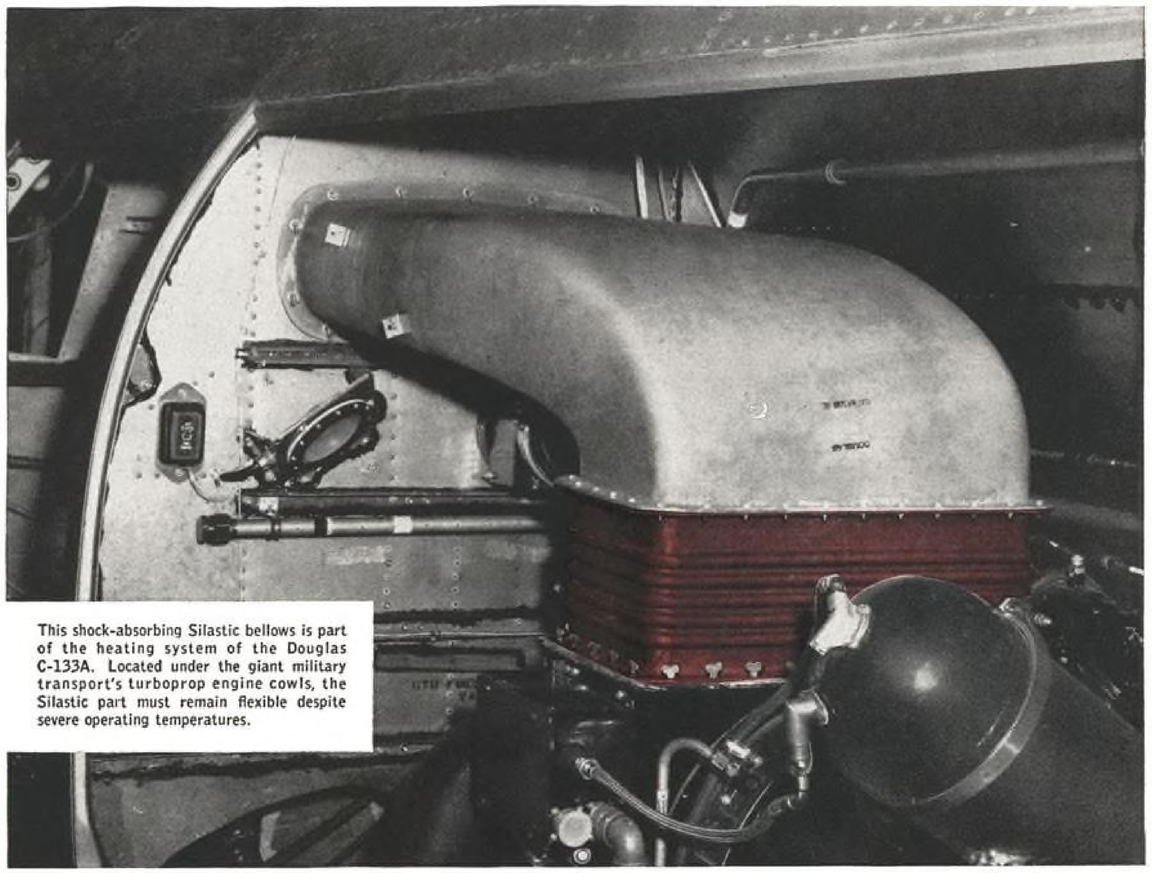
## American Subsidiary Formed by Rotol

Rotol Ltd., Gloucester, England, has formed a wholly-owned American subsidiary, Rotol, Inc., with headquarters at Arlington, Va.

Purpose of the branch is to provide service and technical assistance to North and South American airlines and aircraft manufacturers using the company's propellers, landing gear and other aircraft products, such as accessory gear boxes. Rotol, Inc., will also establish technical liaison with prospects.

Rotol props are used on Vickers Viscounts being flown on this continent by Trans-Canada Air Lines and Capital Airlines, and those to be delivered to Continental Air Lines. Two turboprop planes being built in this country which have specified Rotol props and other equipment are the Fairchild Friendship and Grumman Gulfstream, both twin-engine aircraft.

Rotol Ltd.'s subsidiary, British Messier, will supply the landing gear for Bristol Britannias now on order by airlines as Northeast and Canadian Pacific.



This shock-absorbing Silastic bellows is part of the heating system of the Douglas C-133A. Located under the giant military transport's turboprop engine cowls, the Silastic part must remain flexible despite severe operating temperatures.

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**SILICONE RUBBER**

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| • Oil resistance | Dependent on type of oil |

• Light weight • Weather resistant • Flexible

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# Laboratory Studies Missile Reliability

By Richard Sweeney

**El Cajon, Calif.**—Operational requirements of today's ballistic missiles and weapon systems have drastically changed conceptions of reliability standards.

What once was the concern of a few engineers and inspectors has become an integral part of top management planning and a responsibility of management from top to bottom, according to Dr. Leslie Ball, technical director of Stellardyne Laboratories, Inc., and a consultant on reliability in electronic and missile components.

Regarding a new philosophy on reliability, Dr. Ball says:

• **Any part,** component or system, is inherently unreliable until every mode of failure is known, understood, measured and controlled.

• **No longer** will functional tests and conformance to specifications be adequate. These, along with traditional quality control methods and a statistical base for selecting test articles, are not sufficient for today's and future complex weapon systems.

• **Early and random** failures are the dominant cause of unreliability in today's highly complex systems.

• **Reliability upgrading** must be obtained by a closed loop of detection, analysis and recurrence prevention.

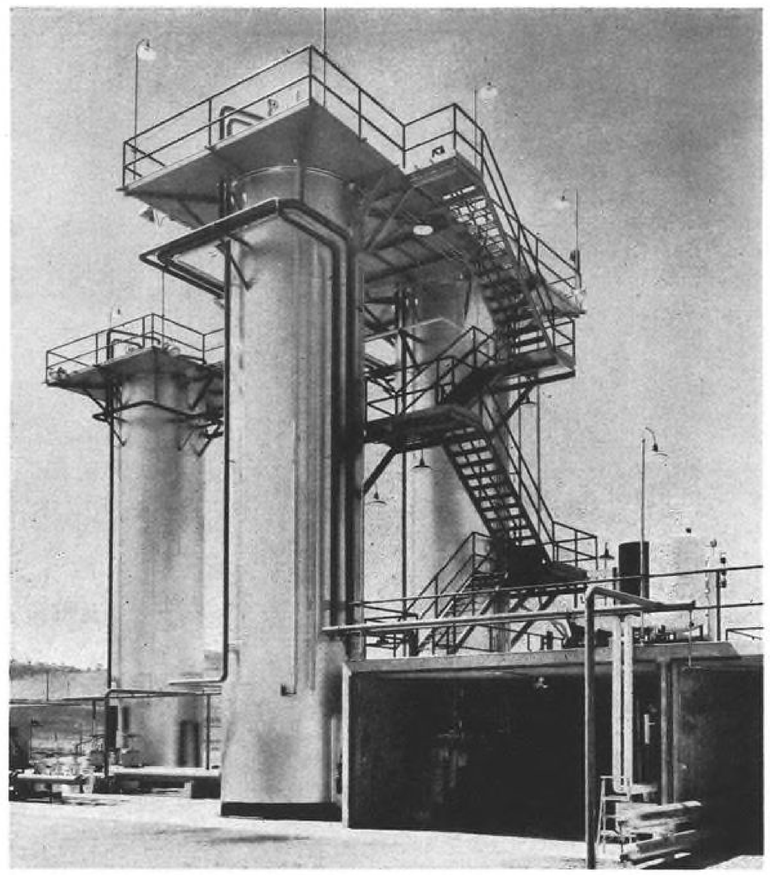
## Elusive Failures

Dr. Ball's thesis is that basically, unreliability results from those failures which occur once in perhaps 10,000 articles, and are subtle modes of failure not described in handbooks, which never would be thought of in normal design, fabrications and testing procedures.

In addition, articles comprising today's complex systems are not from homogeneous production populations, Dr. Ball says, for if they were, failure rate and cause curves would all start at service stress points. Also, there are so many buried parts that conventional quality control and functional tests are inadequate, he believes.

To overcome this, he calls for production environmental testing of each component and system to the point where the good pieces are not damaged but those with potential early and random failures are weeded out.

Basic to Dr. Ball's philosophy is compilation of reports which would create a bank of organized knowledge on failure in all parts, components and systems with which a contractor is concerned. This bank would furnish information to designers and quality control personnel who are embarking on new designs, and would be of such a nature that reports on the company's reliability position could be audited at any time for presentation to top management in the same manner that accountants compile and present financial data to indicate the company's fiscal position.



**HYDRO-PNEUMATIC** test system at Stellardyne Laboratories includes two concrete test cells (foreground); vacuum tank (center) that simulates pressure changes missile undergoes in flight. Right rear tank simulates missile; left rear tank is a water receiver. In operation water fills the missile tank in the same way that liquid oxygen and fuel fill a missile.

## Nationwide Reliability

Carried further, pooling of failure mode knowledge on an industry-wide basis rather than considering each discovery a proprietary matter would yield information which would be available to all involved in weapon system work, to produce a national, across-the-board reliability upgrading which, Dr. Ball believes, would be to the ultimate good for all concerned.

Indicative of the status of reliability today, Dr. Ball points out that one major contractor has, on an existing program, two-thirds of its manpower working on reliability of equipment, one-third in design and manufacture.

Approximately 30% of the total expenditures in a missile program today, according to Dr. Ball, are involved in reliability.

Reliability substantiation and upgrading must be built into any program from conception, Dr. Ball indicates. Prime contractor and customer attor-

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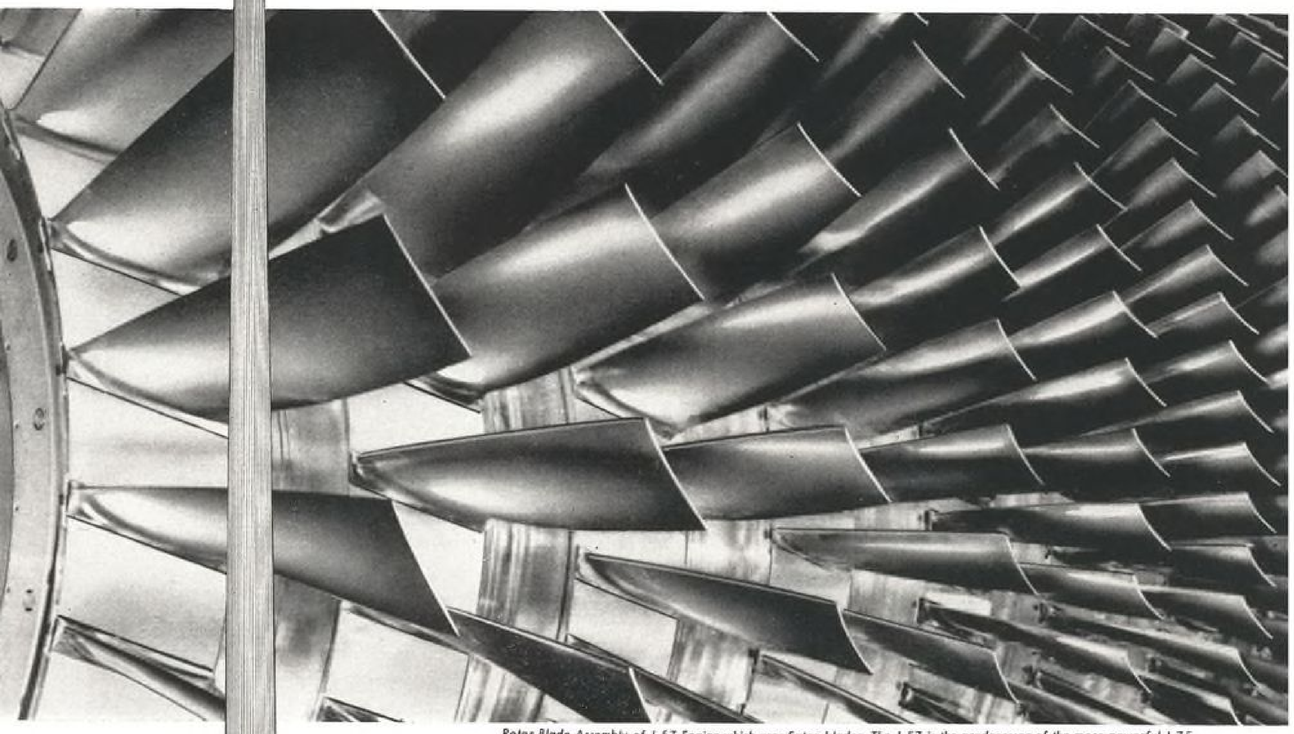
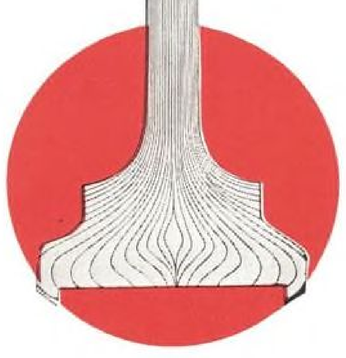


Rotor Blade Assembly of J-57 Engine which uses Eaton blades. The J-57 is the predecessor of the more powerful J-75.



### Eaton Roll-Form® Blades—Selected for Pratt & Whitney Aircraft's New J-75—Have Superior Fatigue Resisting Qualities

In selecting Eaton Roll-Form® Compressor Blades for its distinguished new J-75 engine, Pratt & Whitney Aircraft has chosen blades of superior physical properties, which particularly provide greatest strength at the point of critical stress—the junction of the root and the blade. The Roll-Form process by which all Eaton blades are produced, is a rigidly controlled rolling operation in which the grain structure of the metal is rolled to conform to the blade contour and root section. The result is a blade that is strongest in the plane of maximum stress with superior fatigue strength characteristics throughout.

Eaton is proud to have been selected as a supplier for this and other great American-built turbojet engines now in production to power America's most advanced military and commercial aircraft.

**EATON** AIRCRAFT DIVISION MANUFACTURING COMPANY
Battle Creek, Michigan


neys negotiating a contract will have to see that tight reliability provisions are included. Top management should work out a series of contractually binding reliability hurdles so placed at stages along the design and manufacturing sequence that causes of unreliability are discovered by specific analysis and testing steps.

### Detailed Vendor Data

Subcontractors and vendors must be required to furnish comprehensive reliability data in great detail for desk analysis early in the development program. Scope of these data should encompass:

- **What tests** are to be performed?
- **Where they** will be accomplished—at the contractor's plant and under whose supervision—or at an outside laboratory facility?
- **Who will make** decisions concerning quality of tests and results; that is, will the deciding person be completely free of prejudice concerning the part under investigation?
- **Exactly what** equipment will be used in tests; what capabilities does it have in detail to substantiate the quality and accuracy of data yielded by tests accomplished with the equipment?
- **Reporting procedures** which clearly indicate the closed loop of failure detection, analysis and recurrence prevention.

Discovery of all modes of failure, Dr. Ball declares, is dependent on two things. First, independent evaluation outside the company making the part and second, complete desk analysis along with testing of the part.

Carrying out the theme of an impartial laboratory capable of conducting tests under the new reliability concept resulted in establishment of Stellardyne Laboratories, Inc., on a 13-acre tract at Gillespie Field here.

To clearly keep the facility free of prejudicial involvement, financial support is provided by an Eastern group whose investments center in textiles, hotels and other non-aviation fields.

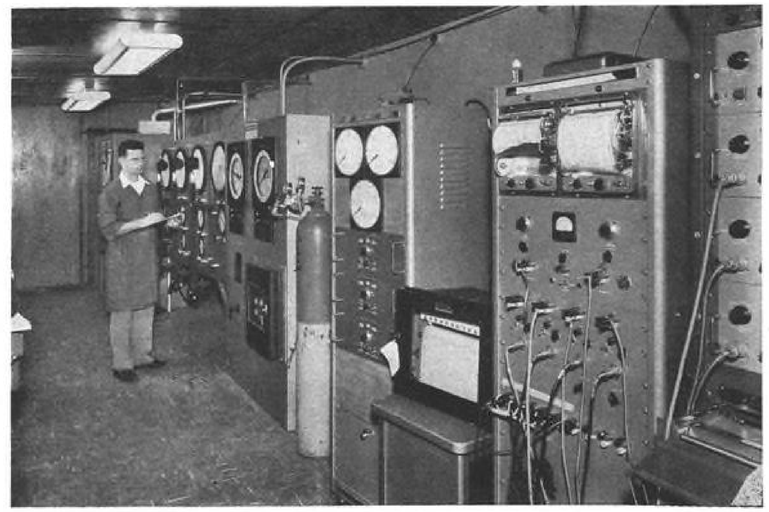
Currently, about $500,000 is invested in land and facilities.

### Reliability Discipline

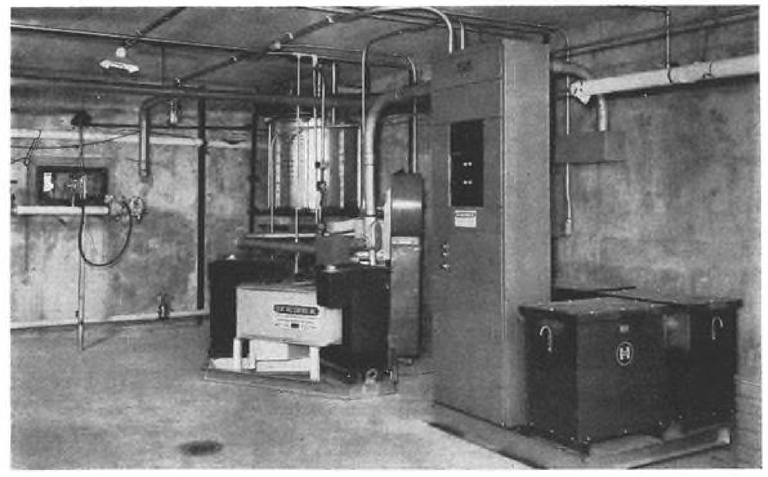
Stellardyne is organized to provide complete reliability discipline for all segments of the aerial weapon system industry, under the Ball philosophy, including establishment of reliability requirements, testing and reporting on reliability position.

The laboratory now has in operation an installation capable of production environmental testing of intercontinental ballistic missile hydro-pneumatic systems and components under simulated flight conditions and environments. Five acres is devoted to this activity.

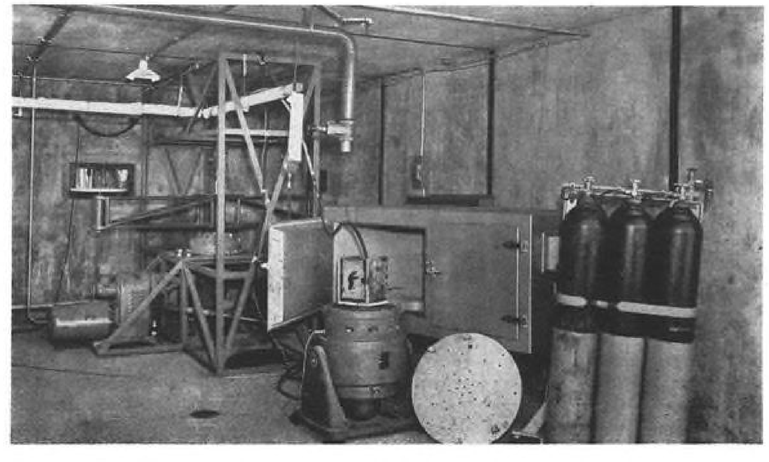
Work is under way on $50,000 addi-



**INSTRUMENTATION** and control room (above) at Stellardyne shows pressure gages, recording oscillographs, etc., that program and measure performance of system and test units.



**INTERIOR** view (above) of reinforced concrete explosion-proof test cell shows electronic heat exchanger that simulates missile temperature transitions. Test unit below is on vibrator.



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tion which will yield capability in cold flow work. Located remotely on another four-acre section of the tract, the facility will incorporate its own special test cells with provisions for the hazards inherent in working with liquid oxygen. This unit will be tied in with the hydro-pneumatic section, giving added versatility for certain types of test work. The cold liquids unit is expected to be in operation about the first of the year.

Another five-acre section will be the site of electronics test facilities and administration buildings. Some electronics testing already is in progress, and present test facilities include smaller standard environmental chambers and related equipment.

### Flight Conditions Simulated

To provide reliability data under valid conditions, Stellardyne facilities are geared to simulate flight conditions with the accent on their highly transient nature. Wide and rapid changes in temperatures, pressures and stresses are reflected in the laboratory's facilities, and complete account is taken of both magnitude of variations and the time involved.

The hydro-pneumatic facility includes tanks, ducts, control valves and helium pressurization sources which simulate the fuel and oxygen systems of existing missiles. In addition, provisions for some cold work are in operation, using immersion in liquid nitrogen. When the cold liquids unit is in operation, flows will be simulated as well.

The presently operating facilities include three tanks: a vacuum tank for simulating the rapid changes of pressure as a missile ascends, a tank simulating the missile itself and a water receiver tank. In operation, water fills the missile tank as liquid oxygen and fuel fill the missile. In a blowdown, the helium forces liquid from the missile tank into the water receiver tank, and provisions are made for recovery and reuse of water and helium.

### Vibration, Heat Tests

Also in operation is vibration, acceleration and heat exchanger equipment capable of simulating conditions as the missile takes off and accelerates through aerodynamic heating into the cold of very high altitudes reached in flight. Facility provides for flow of helium through the test article while vibration and acceleration are in effect.

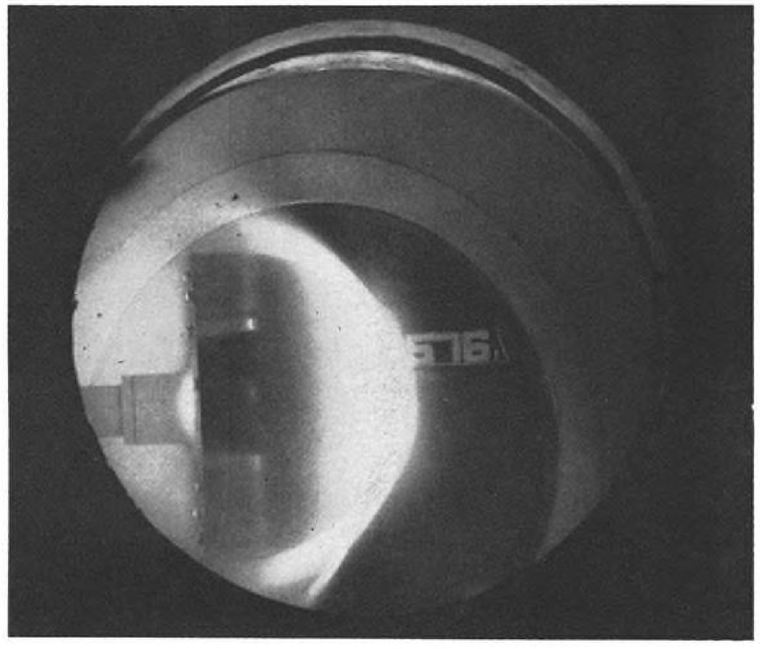
The cold flow facility tie-in with the hydro-pneumatic system is not for added versatility alone. To provide cold liquid flows as they occur in missiles, helium pressure will be used, eliminating mechanical pumps and their requirement for lubricants, a fire hazard with liquid oxygen. In initial stages, liquid nitrogen will be used in cold liquid flow facility for easier handling and reduced cost, will later be supplanted by liquid oxygen.

Cold flow unit will use tanks consisting of stainless steel light gage liners in a concrete shell, less expensive than conventional large tanks for liquid gases. The pressurizing gas will be ducted underground from the hydro-pneumatic test area to the cold liquid area. Three tanks will be used, two for programmed flows, one for steady state conditions.

## USAF Interested In Turbo-Rocket System

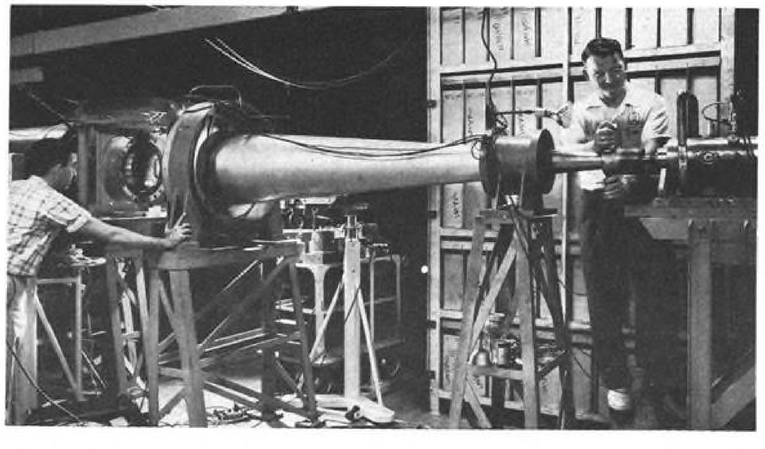
Air turbo-rocket propulsion system now under private support by Aerojet General Corp., Azusa, Calif., is being favorably looked upon by USAF, a propulsion expert familiar with advanced programs told AVIATION WEEK.

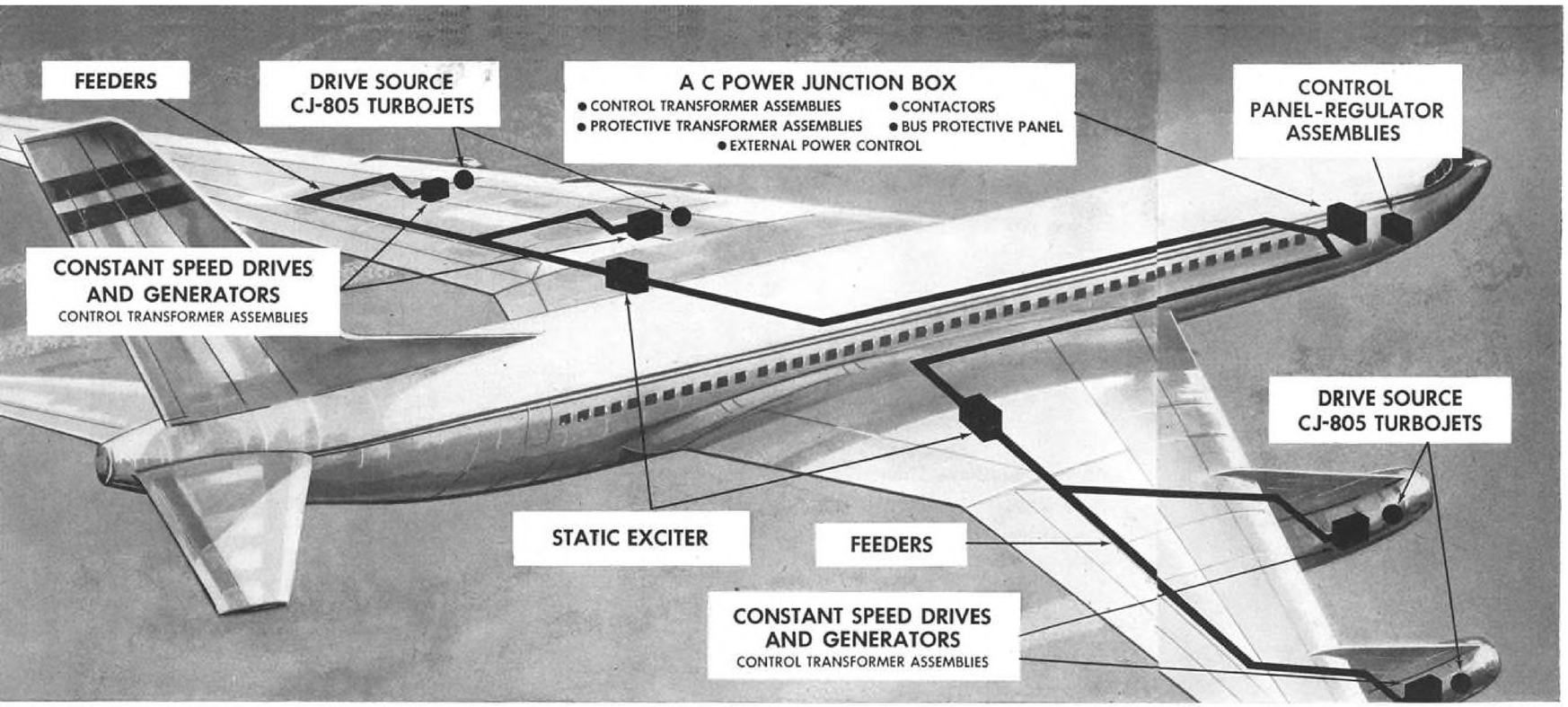
Aerojet, which has joined with Allison Div. of General Motors to obtain the advantage of that firm's large air-breathing development facilities at In-



## Nose Cone Model Glows

Nose cone model and its surrounding air are heated to incandescence during test in the hotshot tunnel at the USAF's Arnold Engineering Development Center, Tullahoma, Tenn. Mach number of this run was about 16 and stagnation temperature approximately 10,800F. The tunnel has intermittent flow and is driven by an electric arc. Test runs last about 1/25 of a second. Men below are adjusting the tunnel. Man at left is looking into the test section, one at right is by the arc.






**MAXIMUM ELECTRIC SYSTEM COMPATIBILITY, providing greater safety and reliability, will result from selection of General Electric as a one-source supplier for the Convair 880 electric system. Weight of the complete 160 KVA system is approximately 756 lbs. Of this total only 528 lbs are carried in the four engine accessory compartments.**

# Convair Simplifies 880 Component Integration by Selecting Complete General Electric 160 KVA System

By obtaining the complete system from prime mover to the bus from General Electric, Convair will greatly simplify the integration of 880 electric system components. Throughout all stages of development and testing, problems involving more than one item of equipment will be more readily resolved, allowing incorporation of the latest safety and reliability advances into a completely compatible electric system.

Even in the early design stage, advantages of the package electric system approach has paid dividends in time and cost savings. For example, a complete design study was made involving the characteristics of engine acceleration, tachometer output, constant-speed drive, generator and electrical controls to obtain proper engine starting time with a minimum of installation changes.

Another example of co-ordinated development is the designing of the automatic paralleling of the generators. In this instance, ready availability of constant-speed drive data allowed the design of paralleling circuits in the electric system which will minimize weight, in addition to simplifying the system—all without creating excessive electrical disturbances. This and similar co-ordinated development tasks are accomplished within General Electric, prior to final recommendation to Convair.

In addition to the advantages of co-ordinated development, Convair's selection of General Electric aircraft electric system equipment simplifies incorporation of the latest component developments. Tailored to the new requirements of the advanced jetliner these proven techniques will contribute to:

**GREATER SAFETY**—Damaging overvoltages to any phase of the equipment are prevented by application of the highest phase takeover sensing principle in both the voltage regulator and overvoltage relay.

Another safety feature is the permanent magnet generator incorporated in each of the system's four statically excited generators. This generator furnishes control power completely independent of the main power system. Also, since the permanent magnet generator is used as a source of initial build-up, the generator when de-energized has less than one volt residual to feed a feeder fault.

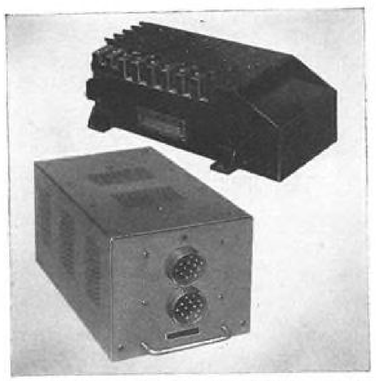
Control relay, generator line, and bus-tie contactors are all magnetically-held-type spring locked to the "off" position. This guards against loss of protection due to loss of power. In addition to the completely automatic protective system, the pilot is provided with a manual shut off to de-energize the electric system under emergency conditions. Here again reliability is not dependent on any source of electric power.

Added safety devices to be built into the hydraulic constant-speed drive include a malfunction detector, input disconnect, overspeed and underspeed devices, and an overrunning clutch.

**HIGHER RELIABILITY**—Use of the statically excited generator simplifies cooling of the rotor and windings and replaces the rotating exciter with an inherently more reliable static exciter mounted in the aircraft wheel well. The permanent magnet generator provides initial build-up, eliminating delays due to loss of residual magnetism.

Magnetic amplifier control circuits eliminate critical adjustments of sensitive relays, decreasing the possibility of nuisance tripping. Only standard hermetically sealed relays, independent of environment and contamination, will be used.

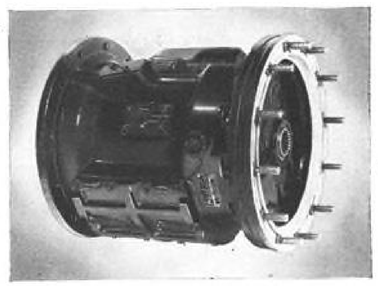
Simplicity of design, obtained by use of ball pistons, increases reliability of the General Electric hydraulic constant-speed drive. The design has a minimum of working parts with the majority of the stress limited to the five major transmission parts. The unit housing serves only to align the working parts and provide support for the generator.



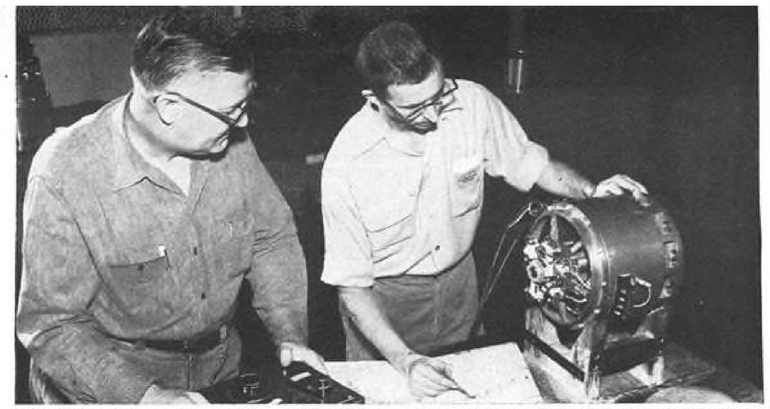
**HIGHEST PHASE TAKEOVER SENSING—will be incorporated into 880 control panels for greater aircraft safety. The automatic protective system is independent of any power sources.**

**IMPROVED PERFORMANCE**—Improved voltage control with static excitation produces better performance of load equipment, particularly sensitive electronic gear. Time for return to normal voltage after application or removal of load is reduced as much as 40 per cent based on comparative tests of the same machine with rotating and static exciters. System stability is excellent and normal voltage is attained with little or no overshoot or undershoot. Fast build-up of current on application of faults reduces clearing time for load circuit breakers.

Measuring only 11 in. in diameter, 22¾ in. in length, and weighing just 132 lbs, the compact, lightweight combination of hydraulic constant-speed drive and statically excited generator saves engine accessory section space and reduces engine pad weight. This helps reduce aircraft nacelle weight and drag penalties.



**INHERENTLY SIMPLE AND RELIABLE, ball piston, hydraulic constant-speed drive for the Convair 880 has an input speed range of 4300 to 7760 rpm and an output speed of 6000 rpm.**



**2000 HR bearing and brush life is offered by statically excited generators like this 40 KVA model. 880 generator and control life will be 5000 hrs—maintenance at 2000 hr intervals.**

**LOWER MAINTENANCE AND OVERHAUL COSTS**—The compact generator and constant-speed drive are easy to install and remove. The control panel includes all system control and protective functions, allowing "go-no-go" checkout and replacement of just one package during maintenance operations. No external adjustments are necessary.

Elimination of the rotating exciter in the generator does away with commutator undercutting and inductive neutral brush settings at time of overhaul. Static exciter parts should not need attention between major overhauls. All panel wiring is accessible for replacement and inspection before the final covers are secured.

Similarly, the constant-speed drive is designed for rapid tear-down and re-assembly. All parts are built to dimension, eliminating hand fitting or lapping-in of parts during overhaul.

For more information on General Electric aircraft electric systems, components and development capabilities, contact your General Electric Aviation and Defense Industries Sales Office or write for the descriptive brochures offered in the coupon below. General Electric Company, Schenectady 5, New York.

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General Electric Company
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- ☐ GEA-6015 Statically Excited Aircraft Generators
- ☐ GEA-6274 Hydraulic Constant-Speed Drives
- ☐ GET-2480 Theory of Constant-Speed Drive Operation

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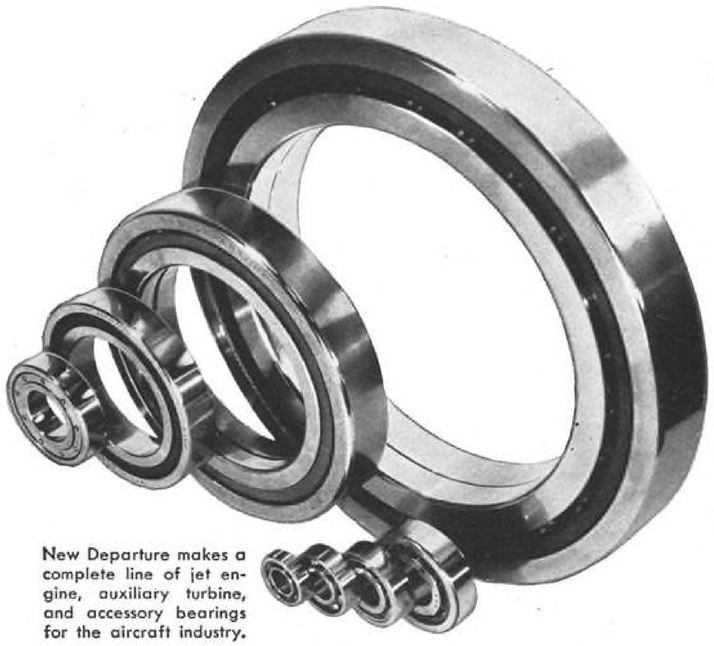
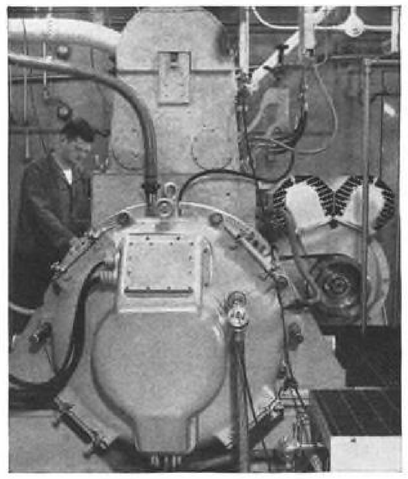
# ND FACTS

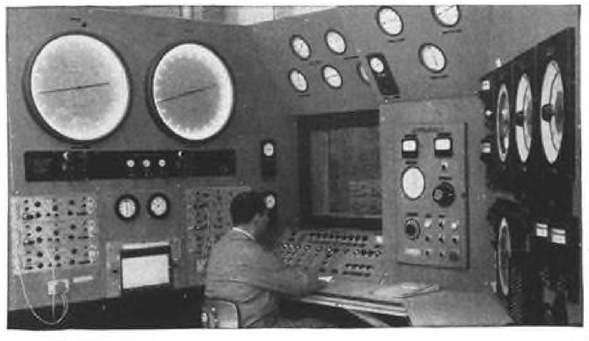


New Departure makes a complete line of jet engine, auxiliary turbine, and accessory bearings for the aircraft industry.



Test stand for running jet engine ball bearings at high speeds, high temperatures under heavily loaded conditions.

## RESEARCH NEVER STOPS!



Instrumentation and control console for test stand shown above, for testing full-scale mainshaft ball bearings.

Tomorrow's needs are today's concern at the aircraft ball bearing research facilities at New Departure. For, the future development of the ball bearing will be closely identified with future engine design trends. This means New Departure spares no effort in developing bearings to operate at higher speeds, heavier loads, and under higher temperatures with good bearing-life predictability.

As always, New Departure keeps pace with changing conditions in the industry. For New Departure's design and fabrication processes for current high-speed, high-temperature, heavily loaded ball bearings are major factors in the successful operation of today's jet engines, as well as auxiliary turbines and accessories.

*For aircraft and accessory bearings, send for* **CATALOG ABC.**

*For data on research progress for jet engine bearings, send for* **REPRINT JEB.**

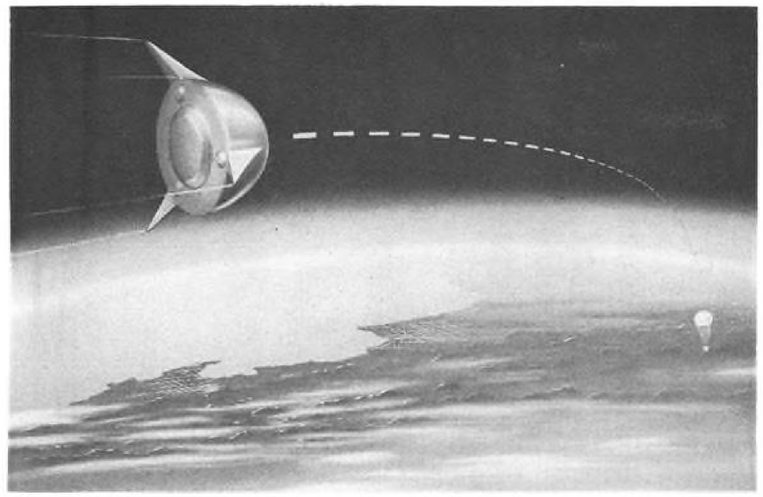
1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL



**Satellite Recovery Proposal**

One proposal for bringing a satellite back to earth was made by A. J. Eggers of the NACA. Hemispherical, finned vehicle would encounter deceleration and heating within human capacity if re-entry was made at a small angle with the horizontal.

dianapolis, Ind., has been working on the hybrid concept for three years, originally with some USAF support. Acrojet has had a breadboard of one form of the turbo-rocket running for two years.

The advantage of the turbo-rocket is that it combines the lower fuel consumption of an air breathing engine with the high altitude ability of a rocket. Besides the tactical advantage of sustained flight at very high altitudes (in the order of 100,000 ft.) a plane equipped with turbo-rocket propulsion would be able to fly at higher speeds (in the order of Mach 5) since there is less frictional heating from rare air at high altitudes.

The engine layout, which has been described in some rocket textbooks, consists of a compressor driven by a turbine, as in a turbojet. But unlike a turbojet, the main airflow bypasses the turbine, which is driven instead by the exhaust from a series of rocket nozzles.

The turbine-driving rockets can use a monopropellant fuel like acetylene which burns fairly cool (about 2,000F) to drive the turbine buckets. Then the fuel-rich rocket exhaust mixes with the bypass air to form a combustible mixture for the engine's afterburner but, in the case of acetylene, it produces an objectionable amount of carbon deposits.

A Pentagon source in USAF's advanced powerplant section refused to comment on the future of the Aerojet-Allison project except to say that to his knowledge there has been no loosening of funds despite the "historic Fourth of October."

## Missile Firms Forced To Dismiss Engineers

Two firms which have recently been forced to dismiss rocket engineering talent, despite the apparent nationwide interest in missile programs and continuing talk of the engineering shortage, are Bell Aircraft Corp., Niagara Falls, N. Y., and Arde Associates, Newark, N. J.

Nine engineers were separated from Bell's rocket engine department and 30 were given notice at Arde. Members of both firms contacted by AVIATION WEEK felt that there was irony in the situation, especially as they feel their firms are on the verge of new contracts, expected after the first of the year.

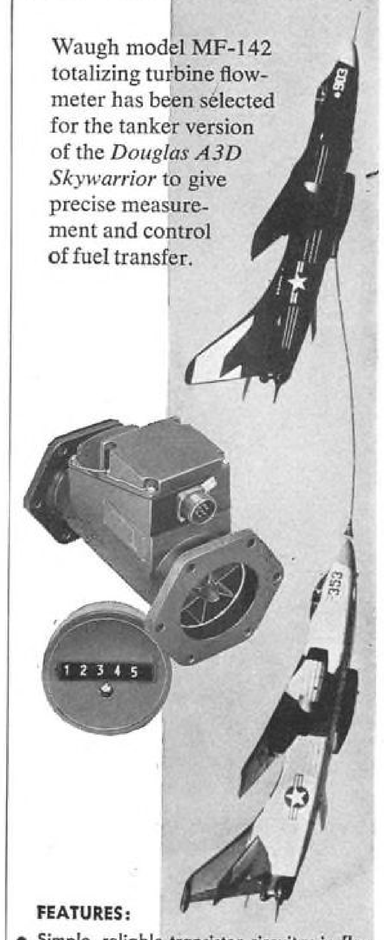
Bell's layoff was related to Rascal missile cutbacks. Its hope for the future was tied to its advanced "new horizons" missile project. Arde related its situation to the condition of the prime contractors which it serves and the drastic reduction in the number of study proposals emanating from USAF and other branches of the services. Not only has the number of these small $25,000-$100,000 research contracts been cut down from the usual dozen or so to one during the last six months, but Arde now finds it is competing with many larger firms who would ordinarily not touch this "little stuff."

Arde's hope lies in the present accent on solid propellant rockets. The firm, which has been reduced from 50 to a spartan 20 employes (not counting 25 left in its outside jobbing division)


Waugh

AERIAL REFUELING FLOWMETER

Waugh model MF-142 totalizing turbine flowmeter has been selected for the tanker version of the *Douglas A3D Skywarrior* to give precise measurement and control of fuel transfer.



FEATURES:

- Simple, reliable transistor circuitry in flow sensor actuates counter and signal light—no intermediate devices
- Signal light to indicate transfer of fuel is actuated directly from flow sensor
- Slowly rotating turbine rotor is the only moving part—no relays or mechanical contacts

Write for complete data: Bulletin 105/AW

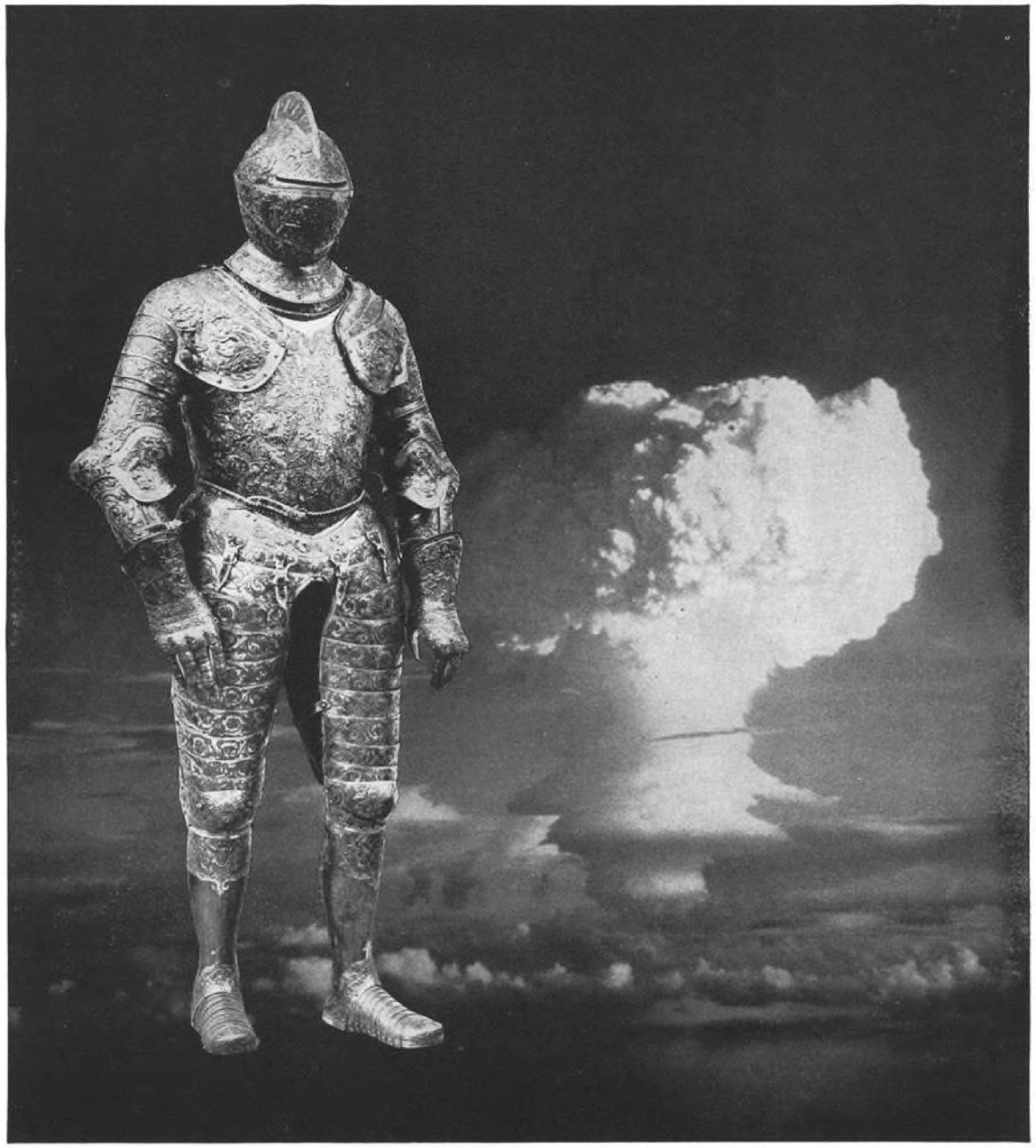
Also available: Flow Rate Indicators and Recorders, Frequency-to-voltage Converters, general-purpose Flow Sensors.

Waugh ENGINEERING COMPANY

STanley 3-1055

FLOW MEASUREMENT AND CONTROL

7842 BURNET AVENUE, VAN NUYS, CALIFORNIA



## THE SOLDIER

Much more than the H-Bomb is needed to insure our total security.

For the threat of massive retaliation is not a complete deterrent to aggression. Border incidents and "brush fire" wars cannot be handled by nuclear weapons alone.

What kind of military program, then, do we need? The consensus of top military strategists answers it this way:

We must have forces capable of meeting every aggressive threat, adaptable to the strength and skill of the aggressor and to the terrain, climate and geographical factors in the military problem involved.

This means the mobile, lightning-fast soldier of the new Pentomic Army...the man on foot with a gun in his hand, artillery behind him, and the full might of our entire arsenal readied for his support. For this man is the military policeman upon whom the keeping of the peace must always heavily depend.

*Martin is a prime contractor to all branches of the military. Among the most advanced weapon systems currently being produced for the soldier is LACROSSE. As the prototype of a new family of artillery guided missiles, this important weapon is one of the basic developments of the Army's advanced Pentomic concept.*

MARTIN

BALTIMORE·DENVER·ORLANDO


said that it is now waiting for a certain prime contractor to get a go-ahead from the government.

Both firms emphasized that the engineers which they were forced to let go were not "dead wood" but high grade engineering manpower. Some of the Bell men had been with the firm four to seven years. It was a matter of "tossing a coin" to see who was next.

The dismissed men are expected to have trouble in finding positions which would use their special talents unless they are willing to relocate. Both companies hope to be able to rehire them.

## Services-Industry Meeting On Missile Training Devices

An inter-service and industry symposium on guided missile training equipment is scheduled for March 18-19 at the Naval Ordnance Laboratory, White Oak, Silver Spring, Md., to provide an opportunity for an exchange of information relating to this specialized field.

Symposium will review the state of the art of missile training devices including philosophy, design, cost and utilization and discuss role of such equipment in measuring proficiency of service personnel.

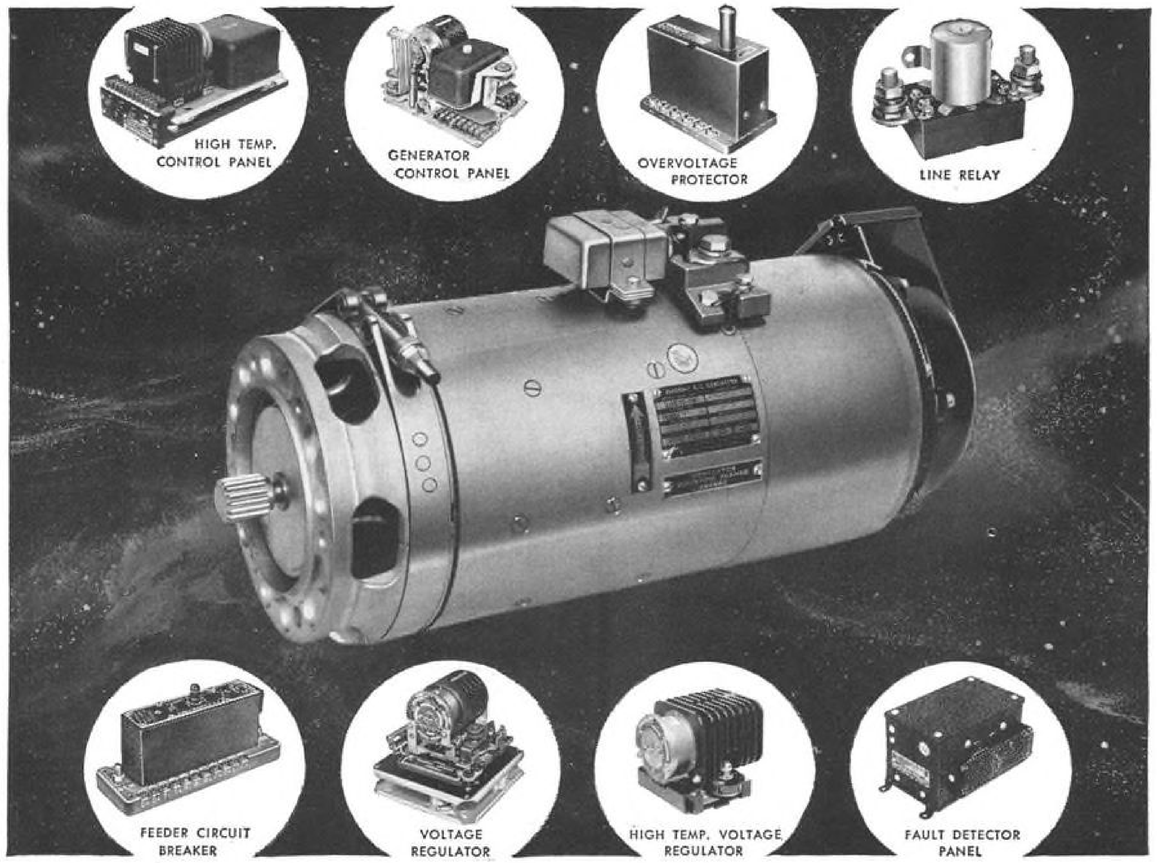
Sponsored by Guided Missiles Division of the Office of the Chief of Naval Operations, attendance will be limited to those with Secret clearance. Those desiring to attend may write: Mr. J. G. Vaeth, Head of the New Weapons and Systems Division, U. S. Naval Training Device Center, Port Washington, N. Y.

## Drafting Standardization Sought by U. S., British

American, British and Canadian delegates have presented recommendations for altering each country's drafting practices so that any engineering drawing produced in any one of the countries can be easily used by factories in any of the other countries, according to Lt. Col. A. N. Huddleston, chairman for an overall standardization committee which met recently in Toronto, Canada.

This country will incorporate changes in the American Standards Association's Y14.1-6 document, Britain in the British Standard B. S. 308 document and Canada in the Canadian Standards Association's B78.1.

Standardization has been some 12 years in the works, according to Vice Admiral G. F. Hussey, Jr., of the American Standards Association. Obvious result is that in the future difficulties which U. S. licensees of British engines have had "Americanizing" British designs and, even more pertinent at this time, future difficulties which British missile firms might have adapting U. S. missile designs, will be eliminated.




# YOU CAN EXPECT MORE FROM BENDIX RED BANK DC GENERATOR SYSTEMS

**AIRCRAFT ENGINE-DRIVEN D. C. GENERATORS FOR 30-VOLT SYSTEMS**

| Type No. | Nominal Rating Amps. | Speed Range RPM | Altitude Feet | Approx. Wt.—Lbs. | Des'd to Gov't Spec. |
|---|---|---|---|---|---|
| 30E01 | 50 | 2200–4500 | 20,000 | 24 | M–2, M–3 |
| 30E22 | 50 | 4000–8500 | 50,000 | 16 | — |
| 30B24 | 50 | 4000–8500 | 50,000 | 14 | — |
| 30E16 | 100 | 2500–4500 | 50,000 | 40 | 52B6588 |
| 30B33* | 100 | 4700–8000 | 35,000 | 28 | MIL–S–9181 |
| 30E07 | 200 | 3350–8000 | 50,000 | 45 | AN–3632 |
| 30E20 | 200—Class C 300—Class A | 4000–8000 | 65,000 | 45 | MA–1 |
| 30E02 | 300 | 3450–8500 | 25,000† | 64 | — |
| 30B37 | 300—Class C 400—Class A | 4000–8000 | 65,000 | 53 | — |
| 30E10 | 400 | 3100–8000 | 60,000 | 67 | AN–3624 |
| 30B34 | 400 | 3100–8000 | 60,000 | 67 | — |
| 30B26 | 400—Class C 500—Class A | 4000–8000 | 65,000 | 69 | MA–11 |
| 30B35* | 400—Class C 500—Class A | 3500–8000 | 65,000 | 75 | — |

*These units are Starter-Generators. †Models also available for operation at 50,000 ft.

## New models for high-altitude, high-performance aircraft

Bendix Red Bank now makes available an extremely wide range of DC generators, including more models than ever before for high-altitude, high-performance requirements. Add to these a complete line of precision protective and control equipment, and you have the reason why Bendix Red Bank offers the most efficient answer to your DC system needs. All units feature maximum reliability, minimum size and weight, and maximum installation and servicing ease. For full details, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

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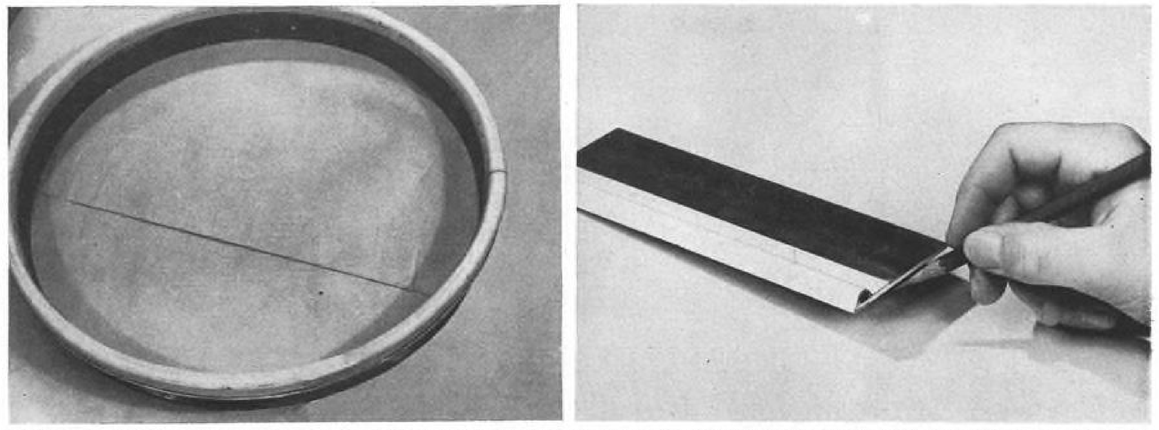
*A thousand products— a million ideas*





**TWO** parts containing silicone used on the B-58 are engine inlet duct seal (left) and teflon covered P-gasket mounted on an aluminum strip (right). The P-gasket goes between the fin and rudder.

# Silicones in B-58 Resist Mach 2 Heat

Silicones, some of the most temperature-resistant plastics, are now substituting for other plastics on Mach 2 aircraft and are being investigated for intercontinental ballistic missile type nose cones.

Silicones in the B-58 Hustler bomber enable non-metallic parts to withstand temperatures which begin to be critical for some metals.

Tests on Jupiter type ballistic missile nose cones where 7-10 layers of silicone-glass laminate covered a titanium framework have been reported to show that although four or five layers would be burned off the blunted tip, the nose cone would survive re-entry.

### B-58 Applications

Data on nose cone tests are limited, but Convair engineer A. C. Porter of the materials and processes group, Fort Worth, Tex., and representatives of Dow Corning Corp., Midland, Mich., have been able to present details on the extensive use of silicone and silicone rubbers in the B-58.

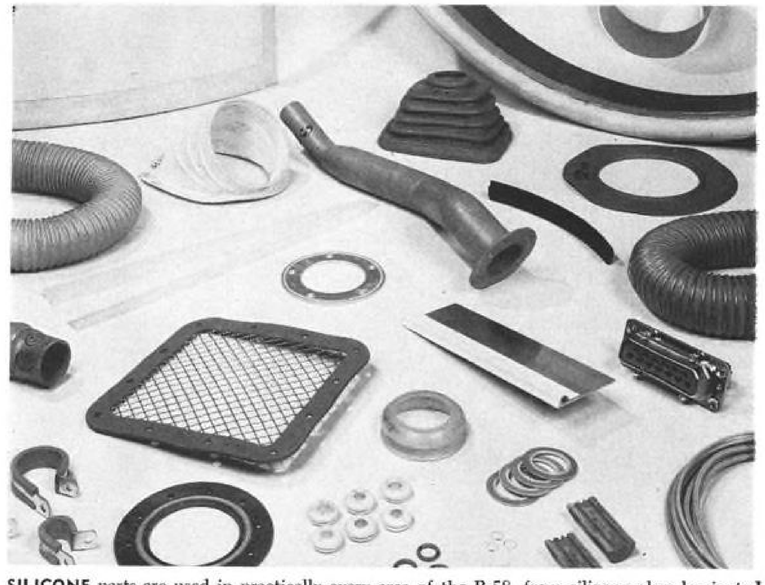
The B-58, which is potentially capable of sustained flight in the Mach 2 or better region, has been said to be Mach-limited by the temperature rise its leading surface, engine nacelle and underside parts receive respectively from aerodynamic skin friction, engine operation and engine exhaust. Since the skin temperatures on leading surfaces may be over 200F and the engine nacelle and engine exhaust temperatures can go higher, specifications call for −65 to 260F. The non-metallic parts of the aircraft are required to go beyond the usual limits of plastics—not much above the boiling point of water.

This is particularly true of parts in the previously mentioned critical areas such as the pilot's windshield, the engine inlet duct air leakage seals, flexible fairing around the underbelly payload, underside of elevons and other parts in the engine exhaust blast.

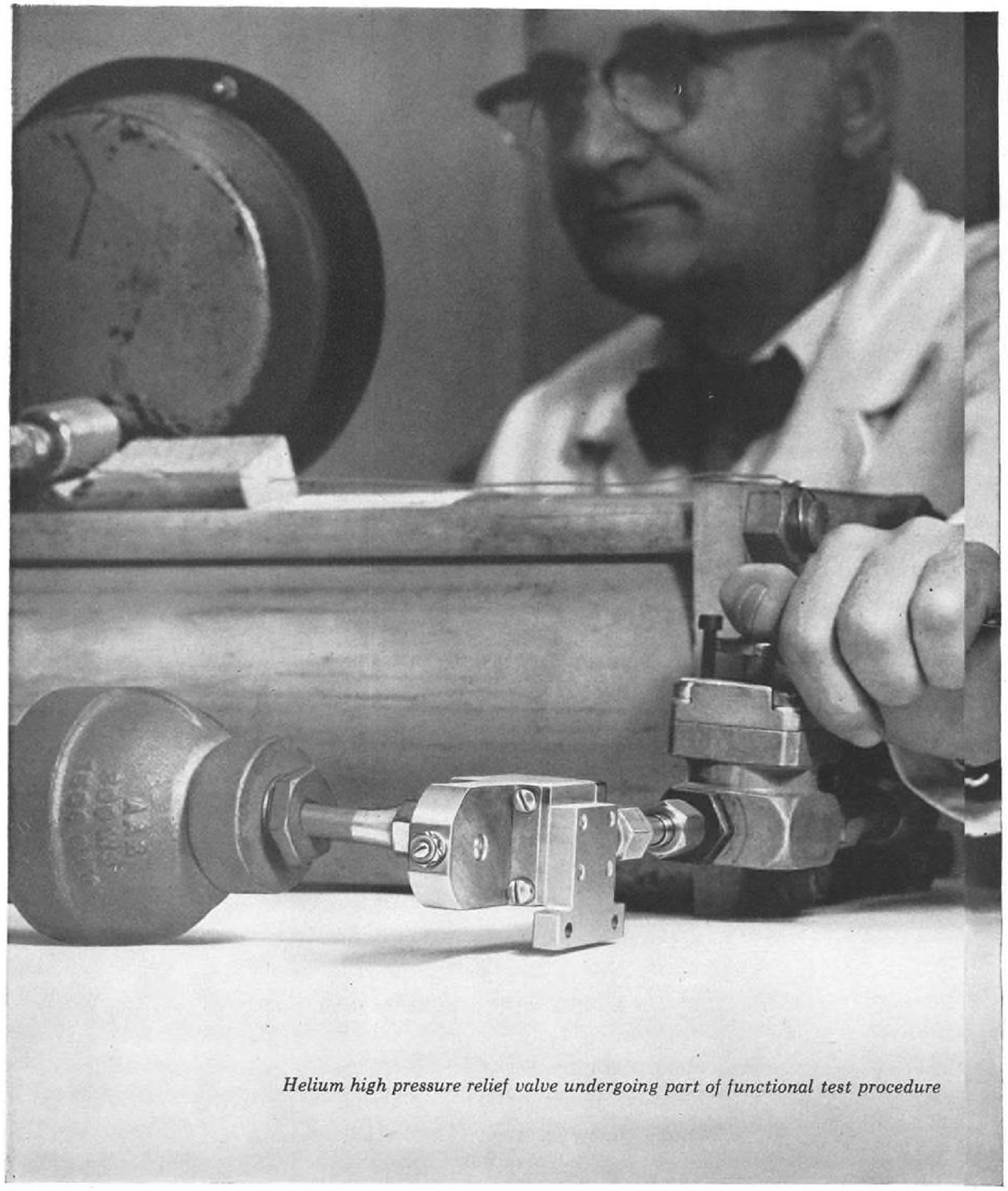
The windshield is one of the best examples. The plastics inter-layer of conventional safety glass would actually melt, making the panels not only difficult to see through but also destroying their safety properties. If the B-58 flew at top speed into gently falling rain, the windshield might shatter instantly.

### Transparent Rubber

Instead, the B-58 windshield employs a high temperature silicone rubber interlayer. It is made especially for this purpose by Dow Corning Corp. Indentified as Silastic Type K, Dow said it is



**SILICONE** parts are used in practically every area of the B-58, from silicone glass laminated radar window (upper left) to wiring insulation (lower right).

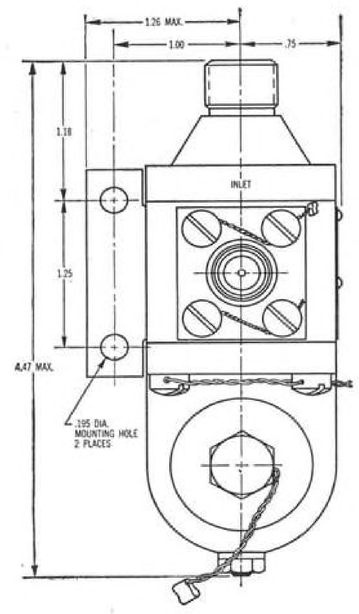


*Helium high pressure relief valve undergoing part of functional test procedure*

An important feature of this assembly is its zero external leakage – while the maximum internal leakage is as low as 100 cc per minute at slightly below reseat pressure. The unit is applicable to all types of helium and other pneumatic systems.

*From Whittaker's Pneumatic Division:*

# High pressure relief valve for –320°F helium service




Here is another outstanding contribution by Whittaker's engineers in the field of missiles!

Specifications demanded a unit with a high degree of reliability and consistency . . . resistance to vibration and acceleration . . . and very short range between crack and reseat pressures!

This lightweight valve – with all its basic components made entirely of stainless steel – meets all these critical requirements of a missile application.

In design and production particular emphasis was given to consistency, so that there is no variation in performance between one valve and another.

The tube size of this unit can be varied to suit customer requirements. Furthermore, the unit size does not increase in proportion to tube size.

This is only one of the many kinds of missile problems that Whittaker has solved. This wide experience is available to you now.

## PERFORMANCE

SERVICE. Helium gas
FLOW. 6 pounds per min. at low temperature
TEMPERATURE.
Ambient, –320°F to +300°F
Fluid, –320°F to +300°F
PRESSURE. 3250 psi Operating Pressure
WEIGHT. 1.5 lbs.
TUBE SIZE. ⅜"

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Check one: ☐ Reference information ☐ Project information

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Luxury air travel at thrift fares is offered by Continental Airlines' Club Coach DC-7B's. They fly fast schedules between Chicago, Kansas City, Denver, and Los Angeles.

**Says** William A. Weeks, Assistant Director of Communications, Continental Airlines Inc.:

## "Electronic equipment in Continental's Club Coach planes is extra-dependable because of G-E 5-Star Tubes!"

"Everything about our new Club Coach DC-7B's is superior. That includes communication facilities, and radar and other navigation instruments. Their reliability helps us keep the fast, on-time schedules that are a part of Continental's Gold Carpet service.

"One reason—and a big one—for the dependable performance of our electronic equipment, is tubes such as the one I'm pointing to: 5-Star Tubes built by General Electric for air, military, and industrial sockets requiring highest tube reliability.

"Their failure rate is extremely low, and they outlast regular tubes by a wide margin. Continental's records prove both statements. Also—due to their trustworthiness—5-Star Tubes help keep our costs down. They cut our need to pull faulty electronic equipment and send it to our Denver shops for overhaul. This is expensive in operating dollars as well as in flight delays.

"Continental looks on General Electric 5-Star Tubes as an important part of its effort to give the public the newest and best in air travel."

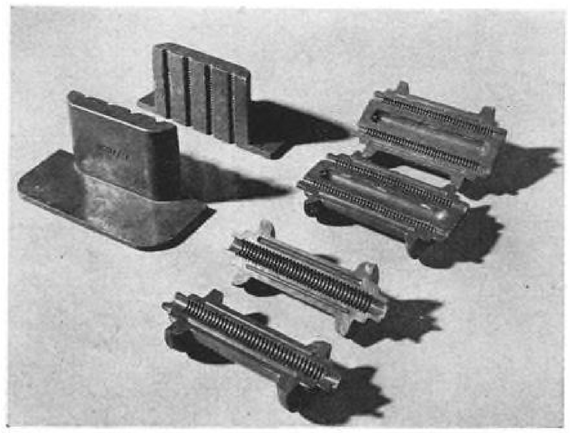
* * *

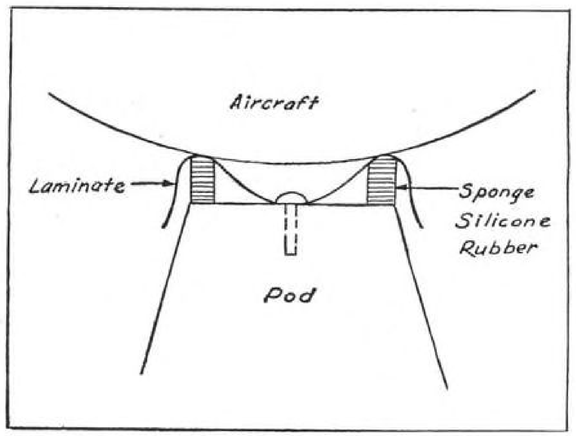
Benefit from Continental Airlines' favorable experience! Your local G-E tube distributor stocks 5-Star high-reliability tubes. Phone him! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Kentucky.*

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

161-1F4




**SILICONE** Labyrinth fairleads (left) seal control cables passing out of pressurized areas and silicone sponge rubber blocks (right) cushion M-shaped fairing laminate between B-58 and external weapon pod.

the first and only absolutely transparent rubber of any kind on the market.

Holding the safety glass "sandwich" together in a tight but resilient grip, Type K keeps the windshield clear and shatterproof at temperatures as high as 350F (roughly Mach 2.3).

Another new application calling for silicone rubber is the modified-polyester-glass take-up "spring seal" between the aircraft and the pod which is attached under the fuselage. Fabricated in an "M" shape, this plastic spring seal prevents turbulence from occurring between the two sections of the airplane. To help preserve the seal and to cushion the spring, blocks of silicone rubber sponge, 1 in. x 1 in. x 3 in., are cemented to the plastic about one foot apart down the full length of both legs of the "M."

### Pod Elevon Application

The area rule configuration of the B-58 requires that the inboard engines be located far ahead of the wing with the result that heat from their exhaust may impinge on the weapon pod ailerons and the area just ahead of the wing elevons. The pod elevons are made of solid silicone-glass laminate.

Rigid sections of silicone-glass laminate are also used as radomes on both the plane and the weapon pod, partly for heat resistance and partly because they are transparent to ultra-high-frequency wave lengths.

Another new silicone which has been widely used on the B-58, Porter said, was a glass-fiber-filled silicone molding compound, Dow Corning 301. This was used for the labyrinth-type fairleads carrying silicone-oiled steel control cables through pressure/no-pressure bulkheads. In addition to heat resistance, this material had to have impact resistance.

Following the responsibility inherent in weapon system development, Convair used military and manufacturer's specifications as guideposts—not final design criteria—according to Convair's Porter.

Materials were selected on actual performance in each specific application, and on several occasions the material was effectively pushed far beyond theoretical limits.

### Operating Temperatures

Top operating temperature for silicone rubber, for example, is considered to be in the neighborhood of 500F. But on the B-58, silicone rubber O rings in turbine bled-air line couplings are exposed to 600F for 20-30 min. at a time without evident deterioration.

On the other hand, the brittle point of silicone rubber is understood to be about 130F, but several silicone rubber NAS 522 couplings in the plane's air conditioning lines maintain complete flexibility and resistance to vibration as long as two hours at −150F.

The original B-58 design called for inflatable seals in the first cockpit, while the aft two cockpits were to have static seals. Later the aft seals were also made inflatable.

### Silicone Rubber Seals

The forward canopy seal was an inflatable seal utilizing neoprene rubber. Due to low temperatures, this type stiffened after exposure to low temperatures for relatively short periods of time. As a result, Convair switched to inflatable seals constructed of silicone rubber.

The seals are mounted in the canopies, bearing directly against the metal fuselage frame. Because the pilot's compartment canopy seal is subject to the greatest deflection, it has a raised striker bead. The others are merely serrated on the sealing edge. Backed with dacron cloth, they are tested at an inflated pressure of 18 psi. to assure their maintaining 12 psi. in service.

Other applications for silicone rubber came about through certain new developments in the B-58 weapon system itself. This aircraft for example, is believed to be the first to incorporate a rubber slip joint seal in the fuselage. An angle section of silicone rubber, ¾ in. per leg, ⅛ in. thick and about 4 ft. long, is mounted but not cemented between two center structural members so that the end of one leg is flush with the bottom of the fuselage. Said to maintain full resilience, it effects a pressure seal spanwise to the plane.

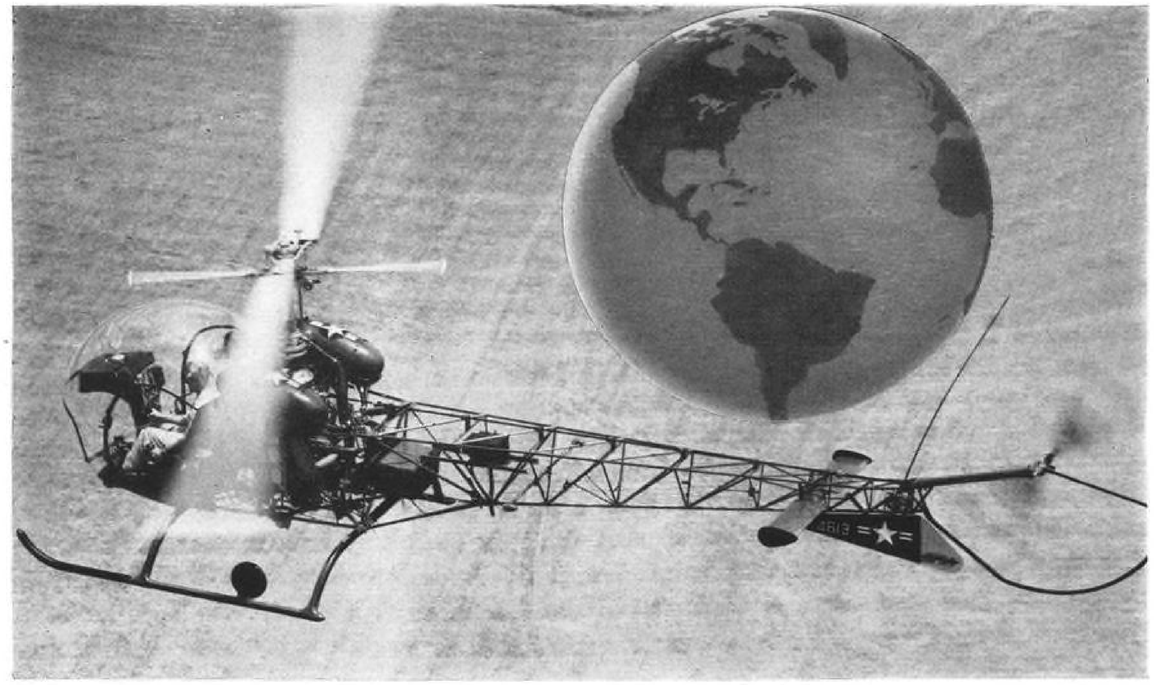
The swelling effect which jet fuel has on silicone rubber was used to make sure that the O-ring gaskets around the fuel cell bolts maintain a tight fit. In this case swelling was desirable but Dow engineers said that new fuel-resistant fluorinated silicone rubbers may prove successful for flat gaskets over larger areas where the swelling might cause undesired deflections.

### Fuel Oil Protection

In applications like the P-gaskets sealing the nose wheel and landing doors, where present silicone rubbers must be protected against fuel oil and hydraulic fluids, fluorocarbon tape with a silicone pressure-sensitive adhesive (Dow Corning XC-269) was wrapped around the gasket. Dow said that the assembled gaskets cost $.85 ft.

Silicone rubber J-seals were mounted between spars on the leading edge of the wing to seal the removable edge covers from the engine pylons. D-gaskets seal the intake air ducts from the engine tunnels inside the nacelles. These seals are subjected not only to air frictional heat but also to radiant heat from the engines.

All general purpose electrical wiring is silicone rubber covered. For the sake of consistency and subsequent easy



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2. Interchangeable metal blades.
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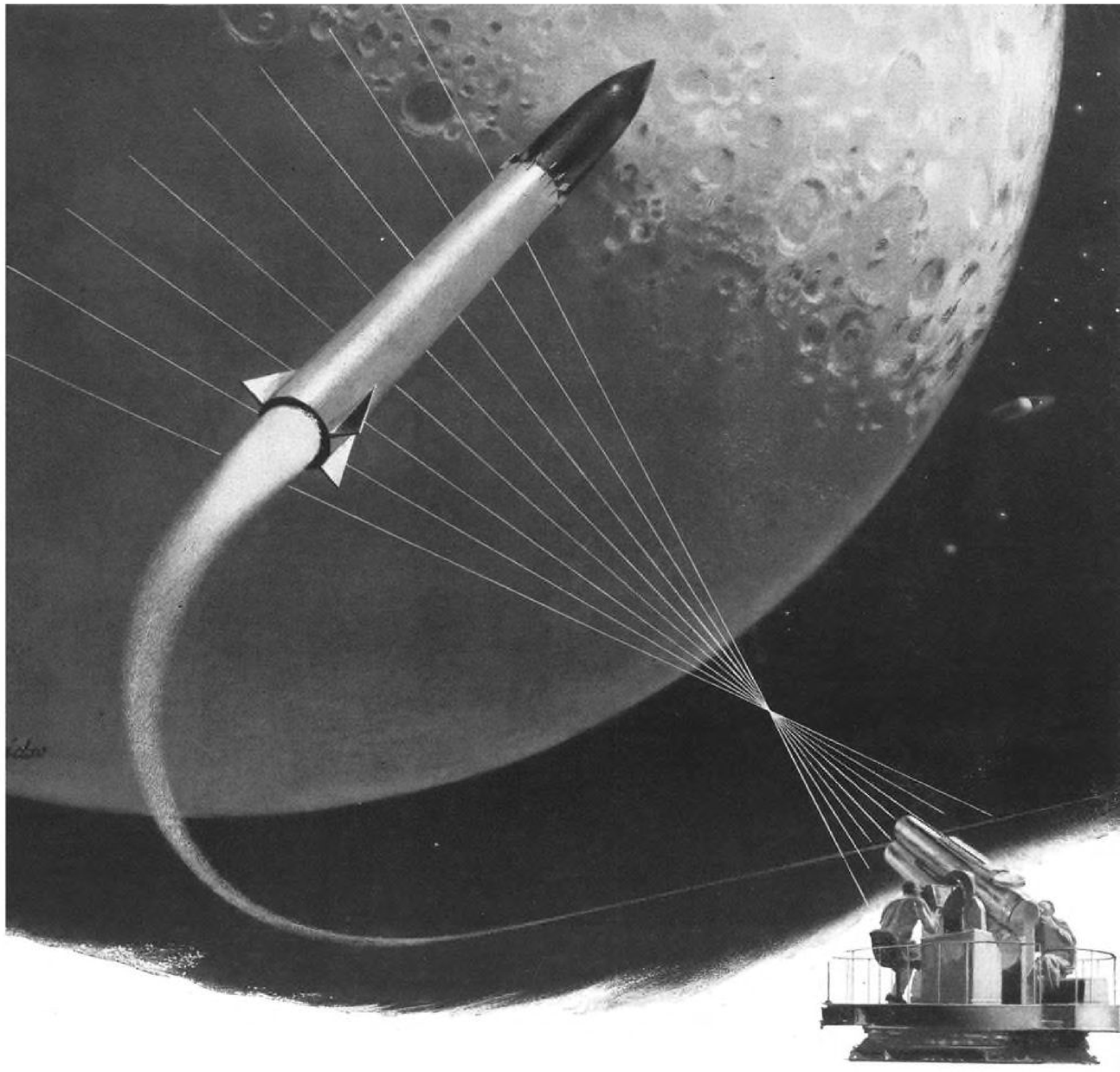

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With the launching of his first satellite man finally has pierced the thin envelope of atmosphere that separates him from outer space. He is ready for the moon.

In preparing for this next step, Perkin-Elmer has used its unique capabilities in optics, electronics and mechanics to develop many instruments essential to our conquest of space. Among these are several for guidance of missiles and satellites such as tracking telescopes, alignment theodolites and satellite cameras. Still others are for use in the U. S. satellite itself—infrared detectors, light weight optical systems. And Perkin-Elmer Vernistat® devices also play a vital role here in precision control, both ground and airborne.

Continuing information on the progress of this space instrumentation program is contained in "Optics Plus," P-E's new monthly house organ. Your name will be added to the mailing list on request. Write us at our main office in Norwalk.

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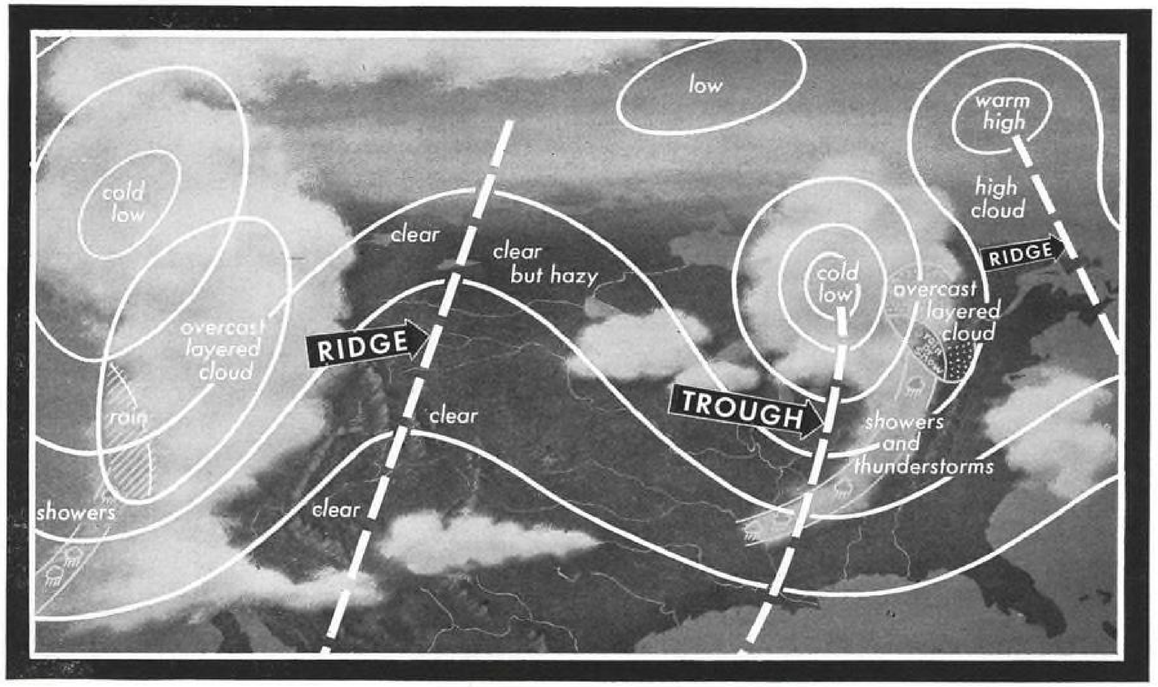
Mobil FLY WEATHER-WISE

These weather items prepared in consultation with the United States Weather Bureau




# CIRCULATION PATTERNS

Clockwise circulation of air around High Pressure areas and counter-clockwise flow around Lows in the northern hemisphere are well known to most pilots. However, there are some lesser-known features of Highs and Lows which have become apparent with the progress made in upper air analysis.

**Warm Highs**—Extend to levels above 10,000 ft. with temperatures generally warmer than Standard Atmosphere. As this type of High extends farther aloft, it often assumes an elliptical shape with major axis lying N/S to form a *Ridge*. This Ridge normally moves very slowly, blocking eastward movement of weather systems at lower levels, often causing prolonged periods of fair or rainy weather in adjacent areas. Weather in warm Highs is usually dry, fair and often hazy.

**Cold Lows**—Extend to high levels with temperatures generally colder than Standard Atmosphere. Their normal eastward movement slows until sometimes the center aloft becomes stationary or even retrogrades westward. This is called a Cold Low because of concentration of cold temperatures near the center. V-shaped elongation of these Lows toward the south is referred to as a *Trough* and marks region of wind shift and possible clear air turbulence.

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maintenance, this wiring is even used where it is not necessarily exposed to extreme temperatures.

The wiring is connected with hundreds of multi-connector plugs, all of which are filled with silicone rubber for a positive, easily joined seal. The mating faces in these plugs are also wiped with high viscosity silicone fluid to help lubricate the connector pins and for an extra margin of moisture resistance.

All terminal connections are coated with an air-drying silicone resin filled with 2% titanium dioxide. Featuring high surface resistivity and moisture resistance, the film may be parted and reapplied for easy maintenance.

All the wiring, as well as the pneumatic and hydraulic "plumbing," is held in position with literally thousands of silicone-rubber bundle clamps. The lines pass through spars and bulkheads fitted with molded silicone rubber grommets.

The pilot's in-flight feeding tube from the canopy-mounted container for liquids is also silicone rubber. Temperature stability is obviously less important in this case than the fact that of all resilient materials, only certain silicone rubbers are completely nontoxic and do not impart any taste or odor whatever to liquids.

### Still in Development

Dow said that silicone rubber is still in the early stages of development. Several new types were introduced after B-58 design and material specifications were completed. For example, in the windshield for the prototype model, the cost of specially-extruded seals for each of the irregular-shaped, compound-curved windshield panels would have been high. But with strips of silicone-rubber stock, plus a new catalytic-curing silicone adhesive (Dow Corning A-4000), Convair was able to make its own seals. An inch wide and ⅛ in. thick, the strips are cemented to the cockpit side of the panel between the interior sheet of glass, "safety glass" interlayer and metal framing. Butt joints are made at each corner and hollowed out with ¾ in. cork-boring tool. The hole was filled with silicone rubber paste, covered with cellophane and vulcanized with a tacking iron. The joint between exterior sheet of glass and metal frame is filled under pressure with a room temperature silicone rubber, Dow Corning RTV Silastic.

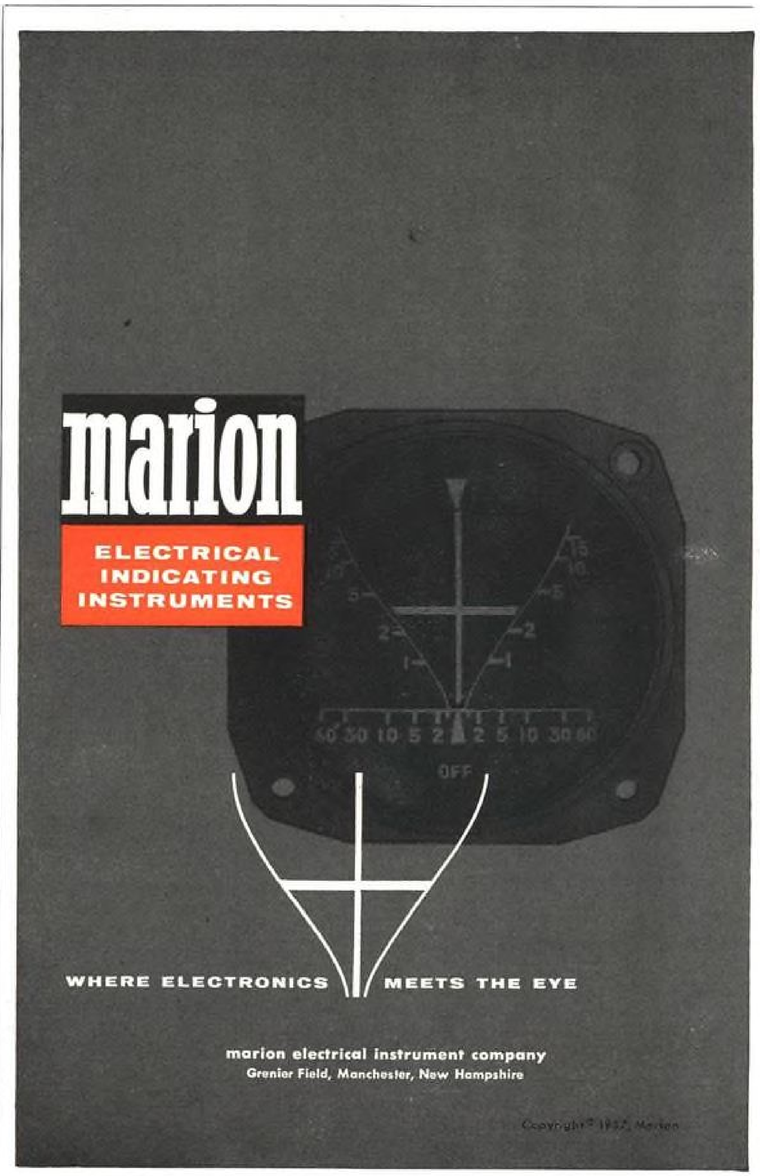
This last material proved useful in a number of sealing and filling applications, according to Porter. Easily brushed, dipped or extruded in place, it served as a seam-filler, an aerodynamic smoothing compound for bolt and screw heads, and as an adhesive for attaching other silicone parts to metals.

The nacelle/air duct seal mentioned, for example, is cemented in place with this RTV Silastic. Surface preparation was fairly simple: wipe down with low-flash solvent; apply and air-dry a silicone primer; apply the RTV. When the RTV becomes tacky, the silicone rubber part is pressed into place.

A different medium temperature curing silicone rubber, Silastic 6128, was used to fill and seal the mitered joints on the stiffening and supporting frames for each of the stainless steel sandwich panels on the wing elevons and the "islands" between them. These panels are interchangeable between top and bottom of either wing, and therefore even though the underside is subject to engine exhaust, silicone rubber was used on every panel.

Silicone rubber was applied to the mitered corners and oven cured for five minutes at 250F. Primary purpose of the seal was to prevent moisture entering during the subsequent liquid-honing process and to limit condensation during flight. After the panels were honed, they were wiped down with low-viscosity silicone fluid to prevent fingerprint-staining during assembly.

Other silicone uses on the B-58 included a silicone fluid viscosity-improver blended into the orthosilicate hydraulic fluid and paint inside engine nacelles to prevent corrosion at 700F.



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LOOK TO ARROWHEAD for advanced design—new ideas, new materials, new techniques—like this new fiberglass-silicon resin Starter Duct Support in the B-58 Supersonic Bomber. With a weight-strength ratio many times greater than steel, this high temperature resin part offers the ultimate in serviceability at extreme high and low temperatures.

Arrowhead Research and Development facilities are available to help you solve your ducting problems. Only Arrowhead has the experience, the ability and the facilities to answer *all* the problems, because only Arrowhead produces all three basic types of aircraft ducting—stainless steel, rigid plastic and flexible fabric-rubber.

Write for service or consultation on *advance design* projects. Arrowhead field engineers are located in all aircraft centers.

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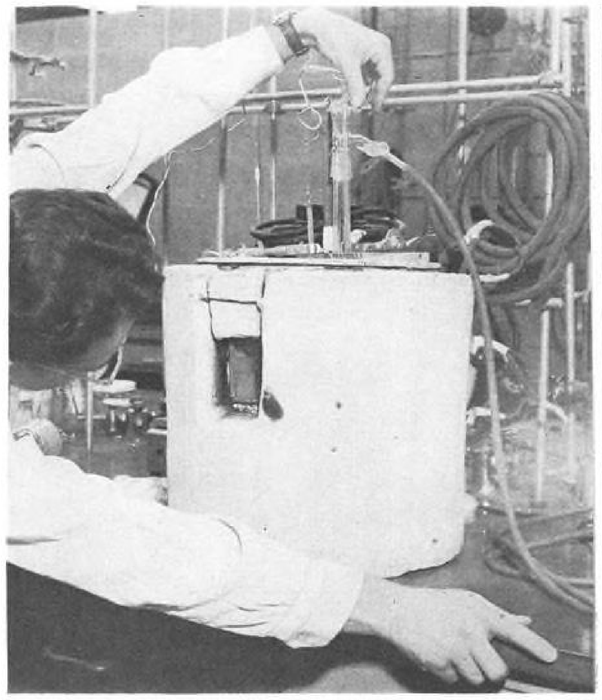

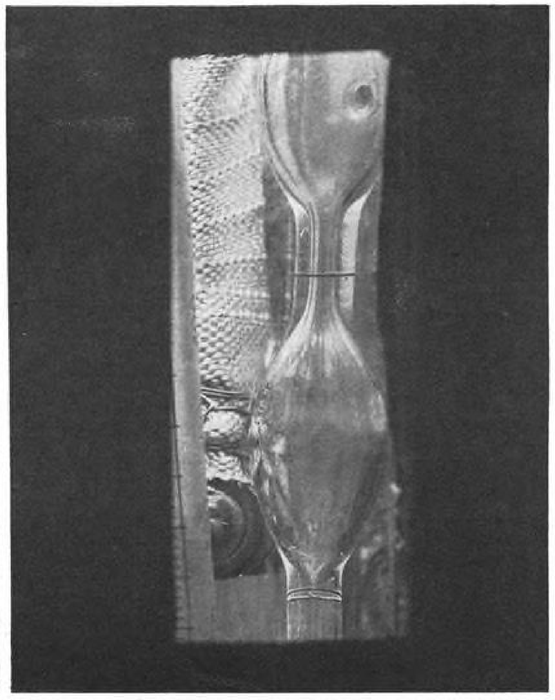

**TECHNICIAN** checks flow of Versilube fluid heated to 725F in oven at GE's Silicone Products Dept. laboratory (left). At right is close-up through observation window in oven showing fluid flowing through modified Ostwald pipette with oven temperature at 725F.

# Hydraulic Fluids Resist 700F Effects

By George L. Christian

**Waterford, N. Y.**—Two newly-introduced high temperature silicone fluids will help the airframe industry push into the region of Mach 3—about 2,000 mph.—because of their ability to operate satisfactorily at temperatures up to 700F.

One, primarily a hydraulic fluid—when integrated with high temperature hydraulic system developments as 700F prototype pumps being built by New York Air Brake Co. and 600F Viton A seals available from du Pont—promises a true breakthrough from the 350F-450F ceiling imposed on today's hydraulic systems by temperature-limited fluids, seals and components. Boeing Airplane Co., and some of its subcontractors as New York Air Brake are doing extensive work with the fluid in connection with the chemically-fueled WS-110A bomber project.

The two new fluids, developed by General Electric's Silicone Products Dept. here, possess improved lubricity and oxidative qualities respectively over an existing, lower temperature silicone fluid developed by General Electric two years ago. All three fluids are called Versilubes.

New Versilubes are:

• 81717—High lubricity fluid is intended primarily for use in hydraulic systems which will withstand prolonged use and provide good lubricity at temperatures ranging from 100F to +600F. Under certain operating conditions, fluid will give good service to 700F. Fluid was developed under an Air Force contract between the Materials Laboratory, Wright Air Development Center and General Electric.

• 81644—High oxidative stability fluid was developed for use in engines and other lubricating systems where exposure to air cannot be controlled. Fluid remains completely stable to oxidation at temperatures up to 510F, 60-80 deg. higher than was possible with previous

## Physical Properties of 81717 and 81644 Versilubes

| | | 81717 | 81644 |
|---|---|---|---|
| Viscosity-Temperature Data (approximate) | Temp. (F) | Centistrokes | Centistrokes |
| | — 65 | 3487 | 2848 |
| | — 30 | 846 | 705 |
| | 0 | 390 | 310 |
| | +100 | 71.3 | 65.6 |
| | +300 | 12.9 | 13 |
| | +450 | 5.5 | 5.2 |
| | +700 | 1.9 | 2.4 |
| Color | | Water-White to amber | Amber |
| Pour point | | Below — 100F | Below — 100F |
| Flash point | | 575F | 560F |
| Specific gravity at 68F | | 1.03 | 1.04 |
| Bulk modulus | | 150,000 psi. at 75F | 150,000 psi. at 75F |
| | | 30,000 psi. at 700F | 30,000 psi. at 700F |
| Panel coking | | 0.0 mg. at 600F after 8 hr. | 1.0 mg at 600F after 8 hr. |
| | | 950.0 mg. at 750F after 8 hr. | 3.0 mg. at 750F after 8 hr. |

**WHO** is America's largest producer of jet engine roller bearings?

**HYATT** of course!

**WHY?**

**1** FLEXIBILITY. HYATT is always happy to cooperate with aircraft engineers seeking new ways to break "bearing barriers" of higher speeds and temperatures. *We're glad to explore unorthodox designs.*

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**HYATT** HY-ROLL BEARINGS FOR AIRCRAFT INDUSTRY




### 1,000F Hydraulic Systems

General Electric engineers, in discussing very hot hydraulic systems—1,000F or more—suggested that these developments may be necessary to make them practical: ceramic bearings for pumps; liquid metal fluids, such as NAK 77 (AW Nov. 11, p. 69); all-metal seals or lap fits to eliminate seals.

silicone and other high temperature lubricants. General Electric says that 81644 is also a somewhat better lubricant than standard lubricating silicone fluids. It will also operate at 700F under certain conditions.

Both 81717 and 81644 are based on General Electric's first high temperature chlorphenyl fluid, Versilube F-50, which possesses the best thermal stability of the family of three Versilubes. It is also the only one of the three that contains no additives.

General Electric says that, prior to F-50, while silicone fluids were known for their viscosity stability over a wide range of temperatures, their lubricating qualities were poor. F-50 fluid gives good lubricity.

#### Broadened Horizons

With the existence of these three fluids, systems designers will broaden the design horizons and provide greater flexibility in the development of hydraulic and engine lubrication systems for aircraft and missiles, and will simplify or eliminate the necessity for cooling hydraulic or engine oils. As General Electric technicians point out, the trio of fluids allows systems designers to choose a fluid for its lubricity, resistance to oxidation or for its thermal stability, depending on the particular design requirements.

All three fluids will burn at very high temperatures. Their auto ignition point is over 900F. Fire point where they burn if exposed to an ignition source ranges from 620F for 81717 and 81644 to 650F for F-50.

At 700F, the two new Versilubes have a breakdown rate of 2% an hour. Breakdown starts at 600F, varies directly with temperature and remains constant at a constant temperature.

Both exhibit excellent gear lubricating properties.

#### Safe Handling

No special precautions are required to handle any of the Versilubes.

However, the high temperature (350F) silicate ester base hydraulic fluid currently used in the B-58 Hustler—Oronite 8515 (AW Nov. 11, p. 69)—requires that several precautions be taken with a hydraulic system using it. Among them are:

• Atmospheric air sealed out to avoid




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. . . 3 . . . 2 . . . 1 . . . 0
scratch one raider!

ELGIN *safety and arming systems and fuzes make sure the "count down" is safe . . . yet deadly*

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Elgin offers its complete background of experience, its production and research facilities in Elgin, Illinois . . . Lincoln, Nebraska . . . and Chatsworth (Los Angeles), California . . . to all manufacturers requiring precision timing. Elgin engineered fuzes, safety and arming mechanisms are now used in NIKE, SPARROW and SIDEWINDER. Contact the Micronics Division of Elgin for your design and manufacturing requirements.

*Elgin's rapidly expanding technical staff now offers a broad scope of opportunities for qualified engineers and technicians.*

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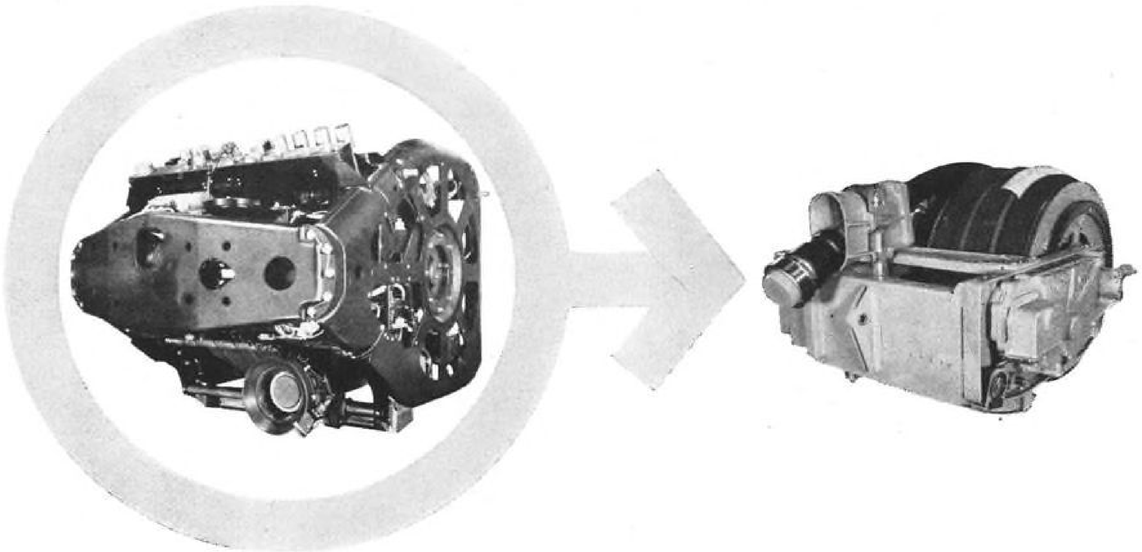
# SAME SYSTEM



## SMALLER, MORE EFFICIENT UNITS

**Research on airborne hose reel units of the reliable Probe and Drogue aerial refueling** system has, in the space of only three years reduced both the size and weight of the tanker units, and provided significantly greater fuel flows at higher operating altitudes and speeds.

Latest in the long line of refueling equipment, designed and produced by Flight Refueling Inc., is the efficient, hydraulically powered reel unit A-29 for Navy's FJ-4 "Buddy" tanker (above, right). The magnitude of engineering refinements incorporated in this latest design is evident when the picture of the new reel is compared with that of its larger predecessor, the A-12-B (left), for Air Force's KB-50, multipoint tanker, which was produced first about three years earlier. Not only does the A-29 come in a smaller package, it has more efficient controls, faster response approximately equal fuel flow, a wider range of refueling altitudes and speeds, and is much more accessible for maintenance.

Applied research at Flight Refueling, Inc., is directed toward solving the complex fuel transfer requirements of military weapons including missiles and rockets as well as manned aircraft, ships and other mobile equipment.

If you have a perplexing fuel handling problem, Flight Refueling's engineers will be pleased to discuss it with you, and suggest practical methods of solving it.

***ATTENTION*** **Engineers**

Unusual career opportunities for engineering personnel are available in new projects for developing new refueling systems.

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**Flight Refueling, Inc.**

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**REPRESENTATIVES:** *West Coast: William E. Davis, Box 642, Inglewood, Calif. Dayton: Fred J. Kendall, Box 622, Far Hills Sta., Dayton 9, O.*



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# PORTABLE HEATING and VENTILATING

Serves the Defense Establishment Everywhere

**On Land** Speed and maneuverability are two of the advantages offered by Herman Nelson portable heaters. For time-saving truck engine warmup, BT400 unit slides out fast, starts up in seconds, delivers volumes of heated air for quick truck starting.

**On Sea** When the Marines land, these BT400-3 portable heaters are floated in with them! Such versatility is but another feature of these efficient units—stemming from Herman Nelson's 16 years of experience and leadership in the portable heating and ventilating field.

**In the Air** Dependability, too, is of utmost importance to the Defense Establishment. That's why Herman Nelson portable heaters will be found around the globe furnishing efficient, fast heat for airplane pre-flight maintenance. Let Herman Nelson's experience go to work on your next portable heating or ventilating problem.

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DEFENSE PRODUCTS DIVISION

moisture and hydrolysis. Fluid is driven into system from storage containers by pressurized nitrogen.

• **Nitrogen** atmosphere maintained in ground test equipment.

• **Oronite 8515** kept from contamination with any other fluids.

None of these precautions need be observed with the Versilubes. They can be handled just as standard petroleum-based fluids are.

Exposure to air has no effect on the fluids, and they can be contaminated with water to some degree without harm. Nitrogen atmosphere is never required.

Oronite 8515 has somewhat better lubricity characteristics at temperatures up to 400F above which 81717 surpasses it, according to General Electric engineers.

Although 81717 was developed by General Electric under contract with Wright Air Development Center, 81644 and F-50 fluids are a product of General Electric's independent research in the field of silicones.

To investigate the entire range of fluid properties at temperatures ranging from 100F to 700F required considerable original thinking, improvising specialized test equipment and developing entirely new yardsticks of fluid property measurements.

### Laboratory Developments

Here are some of the laboratory developments accomplished in the company's temperature silicone fluid research:

• **Determination** of a new method of measuring fluid viscosity since the standard fluids viscosity yardstick VI, or viscosity index, has no meaning for silicone fluids. General Electric derived a new, meaningful measure called VTC—viscosity temperature coefficient.

• **Modification of** four-ball lubricity tester to eliminate mercury contacts which would prove hazardous when heated close to 700F. Strain gage was added to the tester to measure torque produced by the rotating spindle.

• **Development of methods** of discriminating whether fluid breakdown is due to oxidation or heat and establishment of methods which assure that fluid's breakdown is due entirely to one cause or the other.

• **Design and building** of specialized test equipment and development methods to handle fluids safely at the temperature extremes of 100F to over (plus) 700F.

Characteristics of Versilube fluids include:

• **Fluids** are ordinarily non-corrosive to metals. Since they do not contain rust preventatives, exposed metal surfaces may corrode due to water or other vapors.

• **Versilubes** are completely chemically stable under lengthy storage conditions. F-50 has been stored for over four years without any detectable change.

• **Toxilogical** studies on the fluids are not complete.

• **Fluids are not** irradiation resistant. Large doses of irradiation attack the chlorine atoms and gellation of the fluid occurs. Therefore Versilubes cannot be recommended for applications where high irradiation concentrations are present.

Spontaneous ignition temperature for all three fluids is about 910F. This temperature remains the same regardless of whether the fluid is under pressure, is jetting or is in a vaporized state.

All three Versilubes are being tested in various applications on a variety of existing and up-coming missiles.

**TEST** rig firepower pack uses surplus flap actuator to raise, lower pack. Unit weighs 200 lb.

# Helicopter Weapons Pack Readied

First model of General Electric Co's lightweight gun-and-rocket firepower pack for Army helicopters (AW May 20, p. 32) is scheduled to go to the Army Aviation Board at Ft. Rucker, Ala., for tests.

Reconnaissance and utility helicopters can carry two packs each for suppression of ground fire. Pack carries two 23-lb. M-60 ground guns, which have 300-900 yd. range, and eight 3.5 in. fixed fin, armor piercing rockets. Rocket tubes can be adapted for 2.75 folding fin rockets by insertion of sleeves. Guns are quickly demountable.

Pack is made of magnesium and weighs just over 200 lb. It is manufactured by Brooks and Perkins, Inc. Pack is bolted to an "H" frame which in turn is bolted to the helicopter's undercarriage. Tests on a National Guard Bell 47 type, which has the least ground clearance of the smaller helicopters, indicate pack will clear ground sufficiently and withstand rough landings.

Guns are held in pack by three PIP pins. Ammunition can, carrying 300 rounds per gun, is held in by folding door at side of pack.

Maintenance and logistics problems are kept to a minimum by use of standard parts and ordnance. Pack system includes no electronics—man completes the computer loop. Intervalometer in cockpit programs rocket firing sequence.

See-saw switch on pilot's cyclic control stick keeps him from firing gun and rockets at the same time.

Rockets can be fired singly, in pairs or in volleys up to 16. Selection of firing pattern can be made on the ground or in flight. For large volleys, rockets are automatically fired 20 milliseconds apart.

Test rig uses a surplus flap actuator (see picture) to raise and lower pack, giving pilot control over elevation of guns and rockets. In later models elevation control would be buried in the pack itself. Packs can be mounted or removed in five minutes.

Guns can be charged in the air by means of a cable. Rockets are armed in flight with a master switch on a panel. Guns are fired by means of a solenoid used to pull the trigger, and rockets are fired electrically. Gun's bolts are locked for landing.

General Electric has fired some 6,000 standard 7.62 mm. NATO rounds from the guns but has not fired rockets from the air. General Electric and Brooks and Perkins have developed the pack with their own funds. Estimated production cost is $1,000 per pack.

*Announcing a specialized*

MISSILE SUPPORT SERVICE

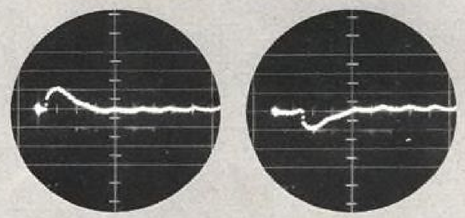
You worry about the missile... let Packard Bell Electronics take care of ground support! Proven performance in this field has resulted in a separate missile equipment section devoted exclusively to ground test and launching equipment. Here, in a 21,500 sq. ft. facility geared for short run production, experienced management shoulders complete responsibility. Here the most radical design changes are absorbed during the process of development. Here direct assembly supervision by production engineers eliminates costly and time-consuming delays. A reliable source, any way you look at it. And a reliable way to rid yourself of a major headache!

ENGINEERING BEYOND THE EXPECTED

DESIGN—When time dictates, available equipment can be adapted to your specifications. But you receive custom design, *beyond the expected*, when you need it. For example, the transistorized MAGAMP power supply (right). This unit provides a faster response time... a lower overshoot and undershoot... and remote regulation at longer distances than has ever been achieved before with this type of power supply.

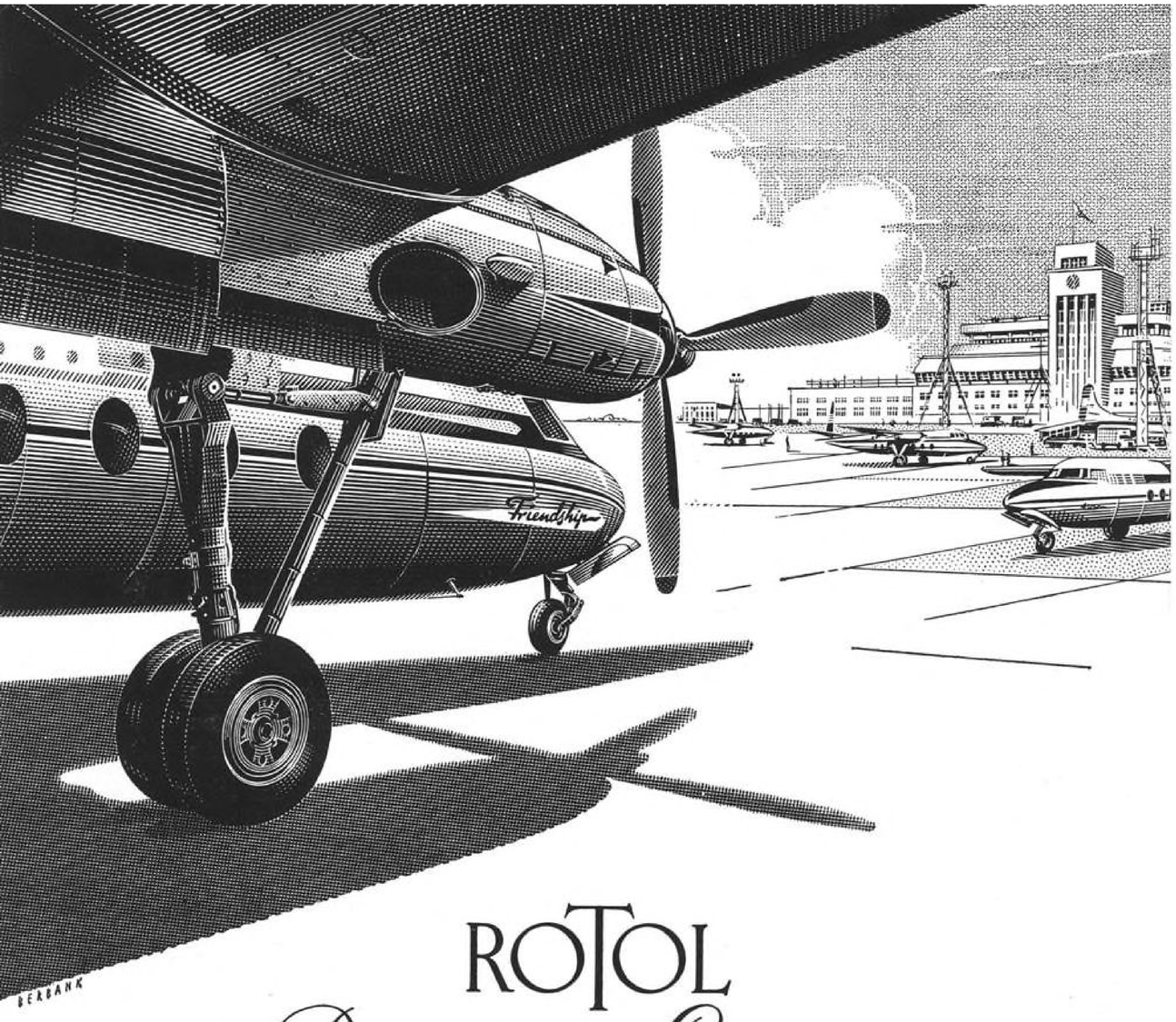
DELIVERY—A contract from Douglas Aircraft for "Thor" test equipment was awarded in March 1956. A total of 100 units, comprising 30 different units, was delivered before deadline in November. On-time delivery at its best... delivery *beyond the expected*.

This transistorized MAGAMP power supply delivers a 27V to 42V output at 0 to 300 amperes, *regulated at a load up to several hundred feet away.*



The MAGAMP has a surge capacity of 400% overload for 2 seconds. Regulation at the load is 1% or better. Recovery time is less than 50 milliseconds. Overshoot and undershoot are less than 25%, with a 30% change in load. (Scale in above photos: 5V/CM and 10MS/CM.)

PACKARD BELL ELECTRONICS
Missile Equipment Section
Technical Products Division
12333 W. Olympic Blvd.
Los Angeles 64, Calif. · BRadshaw 2-2171

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# Mockups Aid Douglas Jet Noise Studies

**New York**—Top priority tests of three basic methods of sound suppression for DC-8 jet engines are producing encouraging results, according to Douglas Aircraft Co.

To date, more than 3,000 tests have been conducted to measure the effect of combinations and modifications of the three fundamental sound suppression methods.

Thrust reverser development is associated with the noise suppressor program since both are on the propulsive jet exhaust at the same end of a gas turbine engine.

### Full-Scale Mockups

While much of the test program has been done with 10% and 20% scale models, a number of full-scale mockups are now under test to develop and prove required endurance and reliability of operation.

Jet engine noise is caused by the shear along the surface of fast-traveling exhaust gases—up to 2,000 ft./sec.—boring through quiescent ambient air (AW Sept. 3, 1956, p. 50).

Mixing the jet exhaust with the ambient air will result in a reduction of the noise.

Three basic methods of accomplishing this mixing are being investigated by Douglas:

- **Replacing** single, large nozzle with group of smaller ones.
- **Interrupting** uniformity of exhaust stream by revising nozzle shape.
- **Adding** an ejector tube around nozzle so that exhaust itself will become core of rapidly moving cold air stream. (Bypass jet engines are inherently less noisey than other types because bypass air reduces velocity gradient across shear plane between engine exhaust and ambient air).

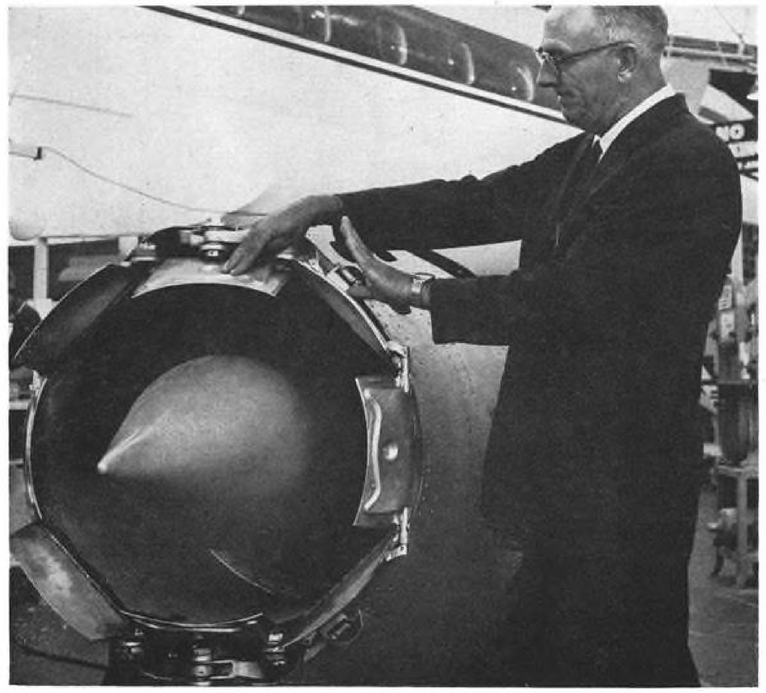
Douglas engineers say they have achieved significant gains by combining elements of all three methods of noise suppression.

### Jet Nozzle Flaps

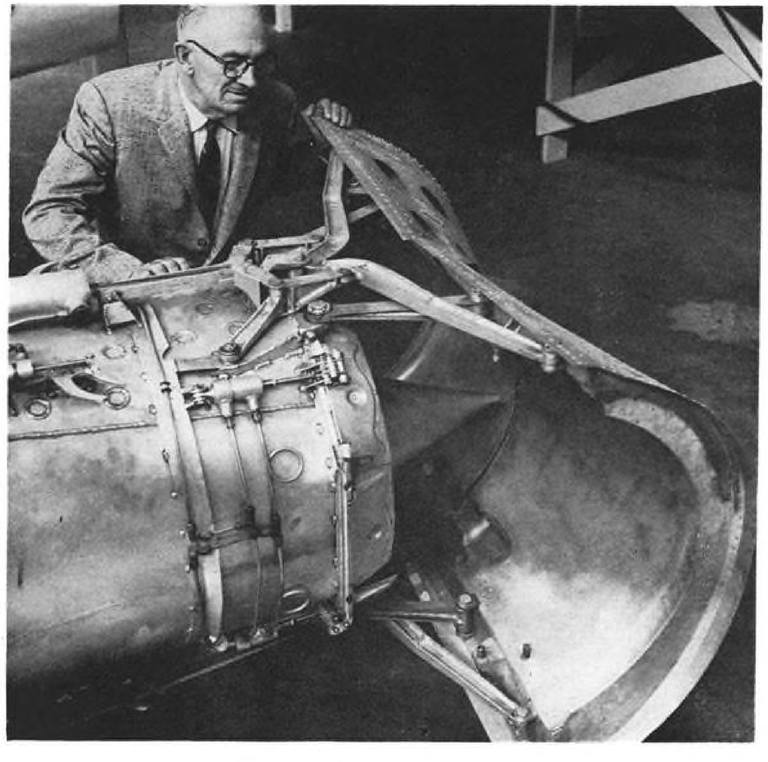
One of the Douglas designs uses flaps around the jet nozzle to diminish noise at take off. A clamshell thrust reversing device is included on the same mock-up.

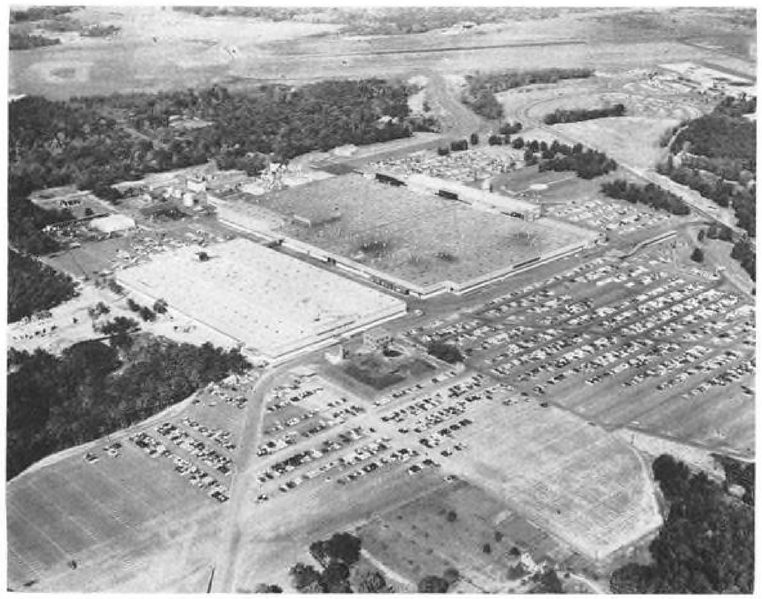
Douglas says that test data indicate that jet engine noise can be controlled and thrust reversal accomplished with minimum penalties in weight and performance.

Company says that ". . . the encouraging results obtained to date may well be surpassed by the continuing intensive program of research and development which will insure effective and efficient devices for the DC-8."

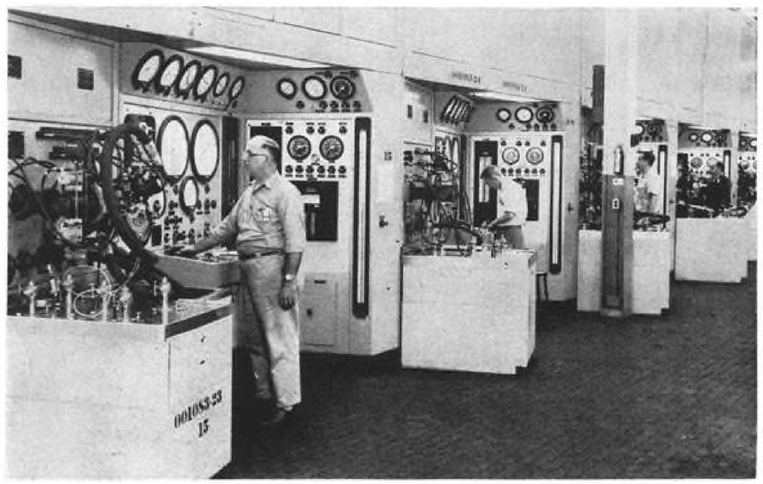


**EIGHT** sound suppression flaps surround DC-8 jet engine exhaust mock-up (above). Pneumatic flap actuator and thrust reverser clam shell doors, fully extended, are shown below.





**NEW,** 410,000 sq. ft. Fuel Control Building is in foreground. Behind is 1-million sq. ft. main plant. Concrete circle is helicopter landing pad. Bradley Field is in background.



**BATTERY** of five fuel control test stations already in operation in Hamilton Standard's new Fuel Control Building. Tests check such conditions as unit's fuel metering accuracy.

# Fuel Controls Facility Dedicated

New 410,000-sq.-ft. building housing equipment for the development and production of fuel controls for turbine, rocket and atomic engines was recently dedicated by Hamilton Standard Division of United Aircraft Corp. at Windsor Locks, Conn.

Production lines in the new building, which will house 2,500 employes, are already moving.

Separate research facility, included in the dedication, is equipped to test company products with all types of engine fuels at very high or low temperatures.

New buildings will boost floor space in the division's Connecticut plants to a total of 1,750,000 sq. ft.

Hamilton Standard Division is also producing aircraft air conditioning systems, gas turbine engine starters, hydraulic pumps and other accessories for the turbine and missile fields (AW Oct. 21, p. 102).

## German Airport Installs Hydrant Fueling System

**Bonn**—Hydrant fueling system to be installed at Frankfurt Airport will be fed by 10 underground tanks each with a 26,418 U. S. gal. capacity. Provision is being made for 10 fueling stations with one hydrant each for piston-engine planes and four additional positions with two hydrants each for jet aircraft. With the dual hydrant outlet, jet planes can be fueled at a rate of 1,320 gpm. which means that aircraft with capacities of 18,500-21,500 gal. can be fueled in approximately 15 min.

Hydrant fueling system is being built jointly by Flughafen-Aktiengesellschaft Frankfurt (the airport administration) and Esso, A.G., Hamburg, a subsidiary of Standard Oil Co., N. J.

## OFF THE LINE

**Reaction Motors, Inc.** reports that 86% of its payments to vendors and subcontractors under defense contracts were made to 1,400 small business concerns during the period from Jan. 1 through Oct. 31. Small business received $8,678,000 out of a total of $10,017,000. Small businesses are those with 5,000 or less employes.

**Profits** of Resistoflex Corp. for the company's first fiscal quarter, which ended Sept. 30, were 3.5% higher than for the same period last year. Quarter sales totaled $2,283,128 and profits after taxes were $154,903, an increase of 1.7% over the corresponding period of 1956. Stretch-out in delivery schedules required management economies, including the lay-off of 125 employes. Earnings per share of common stock were 30 cents for the first quarters of both 1956 and 1957.

**Passenger seats** for Lockheed's newly rolled out Electra prop jet airliner will be supplied by Aerotherm Corp., the same company which will supply all the seats for Pan American World Airways' Boeing 707 jet transports. Electra seats are a result of a three-year joint development program by Lockheed, Henry Dreyfuss industrial designers and the Aerotherm Corp.

**New high energy** boron fuel, HiCal, will be exhibited to the public for the first time during the 26th Chemical Industries Exposition in New York, Dec. 2-6. Fuel was developed for the Navy by Callery Chemical Co. Other Callery products on display will be decaborane, diborane, amine boranes, potassium borohydride and the alkyl boric acid group.

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Here's an *entirely new* chair concept to meet current need for ultra high density seating. Its clean sculptured lines impart a feeling of spaciousness, yet design simplicity permits substantial savings in weight, space, and ease of maintenance without sacrificing passenger comfort. The Starest reflects Hardman's years of design-manufacture experience. It sets new high density passenger comfort standards for any airliner.

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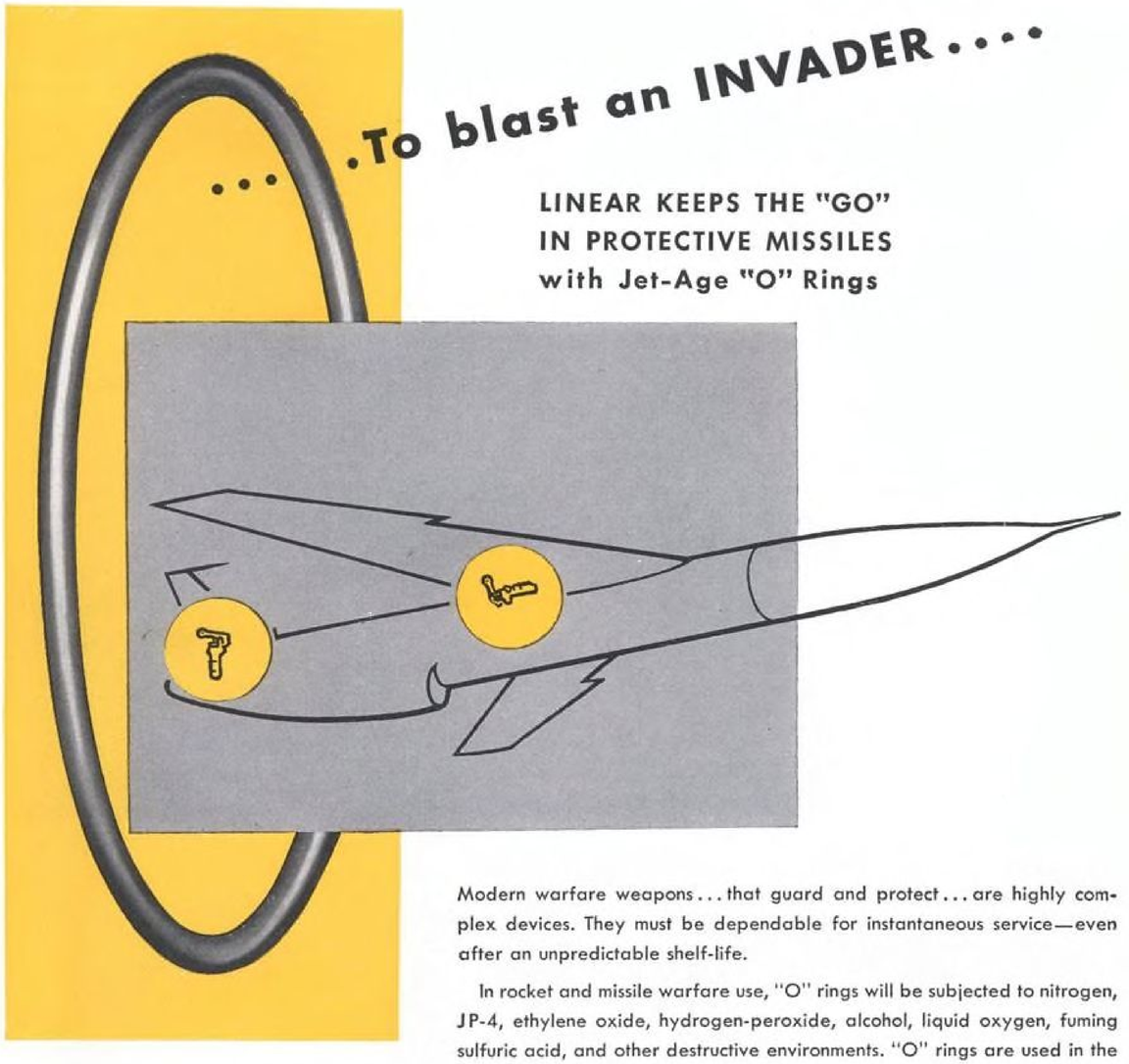


Modern warfare weapons . . . that guard and protect . . . are highly complex devices. They must be dependable for instantaneous service—even after an unpredictable shelf-life.

In rocket and missile warfare use, "O" rings will be subjected to nitrogen, JP-4, ethylene oxide, hydrogen-peroxide, alcohol, liquid oxygen, fuming sulfuric acid, and other destructive environments. "O" rings are used in the servo-systems for flight control of guided missiles, and must withstand extremes in temperatures and the destructive actions of synthetic fluids.

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When it's a sealing problem, call on LINEAR or one of its agents for engineering assistance . . .

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# NEW AVIATION PRODUCTS

### Etchant for Magnesium

Magnesium etchant 1066A is a granular product that chemically mills magnesium alloys, including magthorium alloys, at 1 to 1.3 mils/min. Etch rate decreases with increasing temperature. Material comes in drums containing 400 lb.

Aircraft Dept., Wyandotte Chemicals Corp., Wyandotte, Mich.

### Water-Cooled Torches

Welds comparable in strength with spot welds made by conventional resistance welding processes—relative to gage thickness and size—are possible, using new Tec Spot water-cooled tungsten inert gas welding gun, the manufacturer reports.

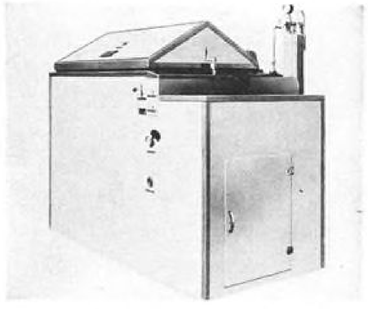
Tec Visuweld torch has transparent nozzle to facilitate viewing weld in process. Work can be done at three or 350 amp. without need to change torches, maker states. An additional timing unit permits operator with a selection of weld depth penetration of any two joint applications without having to make adjustments at the power source.

Tech Torch Co., Inc., 300 Paterson Ave., Carlstadt, N. J.

### Salt Spray Fog Unit

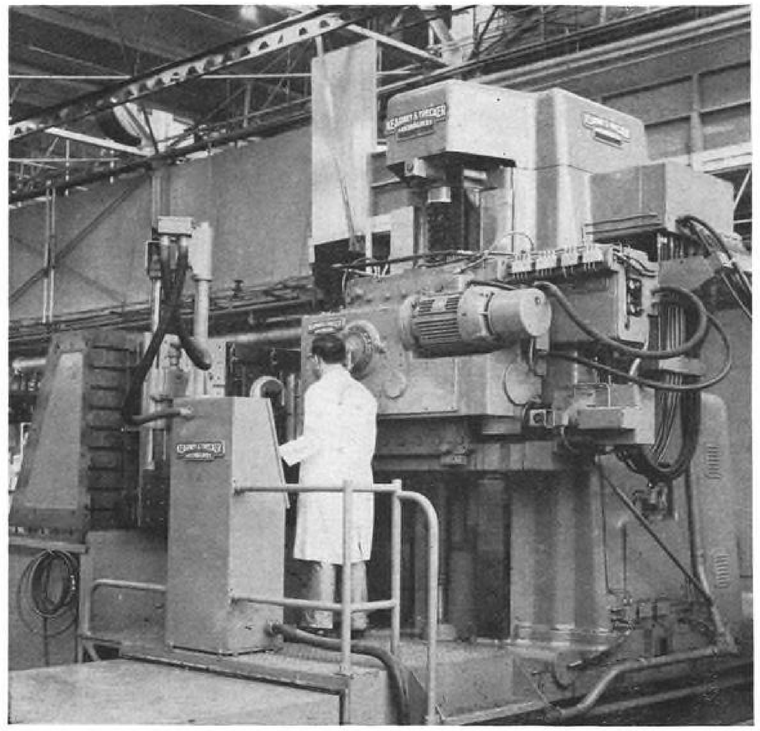
Salt spray fog test cabinets, ranging from 10 ft. x 10 ft. x 10 ft. walk-in. room type to 2 ft. x 2 ft. x 2 ft. size, are designed to meet military specifications for equipment testing. A thermostatically controlled radiant heating blanket is used for temperature control and to maintain control to one-half degree.

Chambers feature hydraulic cover-



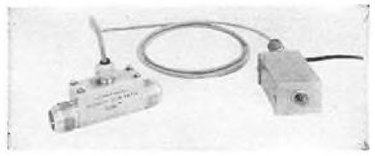
lifters, automatic level control of humidifying tower and air pressure regulation as standard equipment. Optional equipment includes pass-throughs, windows, pH meters and electrical and hydraulic connections.

Development Engineering Co., 9 Cross St., Norwalk, Conn.



## Northrop Installs Tape-Controlled Machines

Three of these 54-ton numerically controlled Kearney & Trecker profile milling machines will be installed in Northrop Aircraft, Inc., facilities by the end of this year. Machines will be used for work on the SM-62 Snark missile, T-38 supersonic trainer and subcontract work on other missiles and aircraft.



### One-Inch Flow Unit

Flow sensitive device in one-inch size will detect flows of one-quarter to one-half gal. per minute and activate a switch for indication or control in systems.

Explosion-proof one-inch airborne unit weighs 12 oz.; 1¼-in. unit 16 oz. and two-inch version, 20 oz. One-inch unit will indicate flows down to 0.1 gal./min. if, after a valve has been closed, there is seepage into the line, according to the maker. Company also points out that equipment will operate in any attitude in liquid or gas and can be completely submerged. Normal operating temperature range is −85F to 550F.

Potter Aeronautical Corp., Route 22, Union, N. J.

### Chamber Provides Humidity

Relative humidity from 20% to 95% can be automatically maintained or varied in accordance with military specifications, temperatures of 0 to 200F can also be provided in environmental chamber TH-PB-27-HL. Unit

occupies work space of 35 in. x 35 in. x 38 in.

Circular chart cam programming controllers are used to handle both wet and dry temperatures.

Leatherman Co., 13259 Sherman Way, N. Hollywood, Calif.

# Westinghouse metal miracles boost jet engine performance 15%

Turbojet "hot end" parts, made from clad molybdenum, are increasing jet engine efficiency up to 15% by permitting higher turbojet operating temperatures. Developed by Westinghouse research scientists, this new method of coating molybdenum to prevent high-temperature oxidation has proved successful during extended engine testing of "clad-moly" parts at temperatures above 2000°F.

Development of this protective coating—which remains intact and effective after molybdenum alloy sheets or shapes are formed into parts of complex shapes—is part of the advanced metals research program at Westinghouse. The Aviation Gas Turbine Division is helping to keep America strong by applying this coating and other new research developments to create better and better jet engines for the defense of America.

Take advantage of Westinghouse's ability to engineer, develop and produce equipment for America's defense. Contact your Westinghouse Defense Products sales engineer, or write: Westinghouse Electric Corporation, Aviation Gas Turbine Division, P. O. Box 288, Kansas City, Missouri.

J-91057

The first stage turbine nozzle vanes (outlined in red) were chosen for initial testing as they are subjected to the highest temperatures and are most susceptible to thermal shock.

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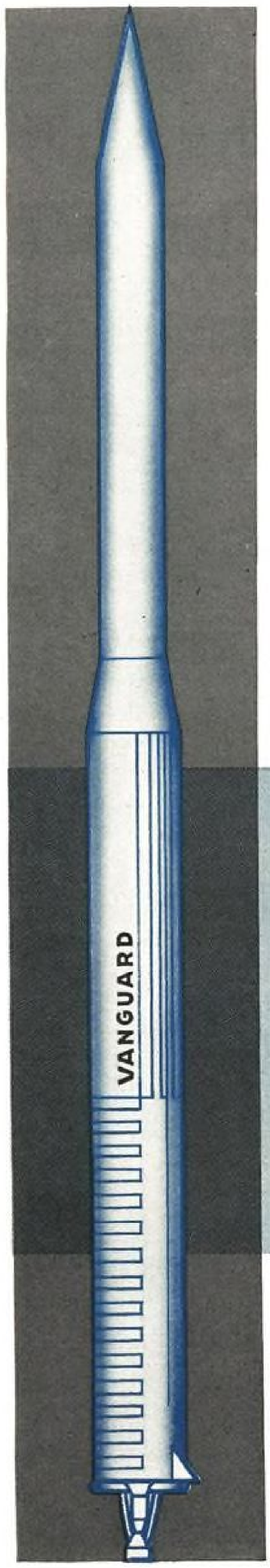


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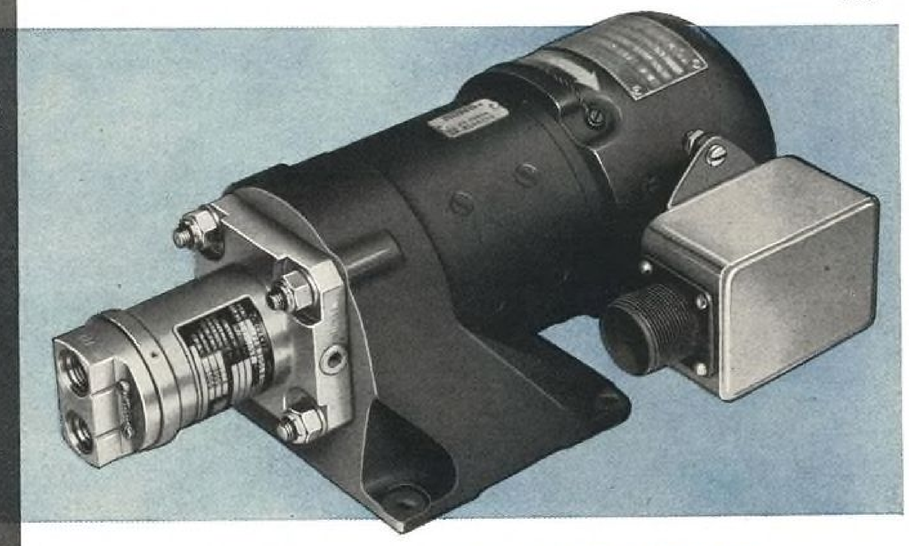
Numerous Vickers miniaturized hydraulic airborne components have been successfully developed for missile use without sacrifice of their inherent high efficiency and reliability. Representative of the "packaged" approach to dependable missile hydraulic power is the PFM-3906 constant displacement piston type pump shown here mounted on an electric motor. The pump has a theoretical delivery of 0.84 gpm at 7400 rpm and 1000 psi with a volumetric efficiency of 95%. The explosion proof motor has 6.0 in.-lb. torque from 6900 to 9000 rpm. The complete package weighs 8 lb. . . . 1 lb. for the hydraulic pump and 7 lb. for the electric motor. **The overall length is less than 10 inches.** For further information about Vickers miniaturized hydraulic components and complete packages, ask for Bulletin A-5216.

7886



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# Medical Group Reports on Pilot Fitness

By Richard Sweeney

**Los Angeles**—Progress in understanding the human factors of flight in higher and faster spectra was outlined at the Third Annual Aviation Medicine Symposium here recently, sponsored by The University of California at Los Angeles Medical School and Medical Extension. Those attending the symposium heard reports on:

- **Civil Aeronautics Administration** plan to obtain more realistic physical fitness standards for civil pilots by gathering data under provisions of reworded Part 29 of Civil Air Regulations, by Dr. James Britton, M. D., CAA.
- **Operational human factors** problems with the F8U, by Capt. Ashton Graybiel, MC., USN.
- **Project Man High,** biodynamics, weightlessness, by Col. John Stapp, MC, USAF, Holloman Air Development Center, N. M.
- **Army-Navy Instrumentation** program, Al Mayo, Douglas Aircraft Co., El Segundo Division.

Also given were papers on medical aspects of Litton's high vacuum laboratory (AW Oct. 14, p. 62); Convair's thermal stress, radiation and dynamic vertebral column loading programs; work on sound by the research center of the Subcommittee on Noise in Industry.

With the rewording of Part 29 of Civil Air Regulations which took effect last August, CAA intends to start a program aimed at updating physical standards regulations on a realistic basis commensurate with the philosophy that every U. S. citizen so qualified has the right to fly an airplane, Dr. Britton told the symposium.

He pointed out that whereas the military consider it a privilege to fly and apply physical standards on that basis, testimony to the CAA philosophy is the fact that six deaf mutes and a paraplegic currently are certificated in the U. S.

### Stringent Restrictions

Citing the fact that today's Part 29 requirements first were written into regulations in 1926 and stemmed originally from 1912 Army standards, Dr. Britton said CAA feels that certain conditions which now block issuance of medical certificates are actually not disabling, and that persons suffering from these could safely operate aircraft. He mentioned diabetes controllable by diet and certain coronary conditions as areas where restrictions now apply, but wherein substantial quantitative data might show that the conditions do not jeopardize safe flights.

Under the reworded regulation, regional medical examiners will pass along to a specific group in CAA's Washington medical section those cases which are applicable and the Washington unit will decide if a medical certificate for a strictly limited period of time can be issued, or one calling for certain examinations at stated intervals by qualified medical examiners. Close check possible under time limits and over a five year period, Dr. Britton said, should yield excellent data for rewriting of that part of the regulations on a more realistic basis.

Indications also are that visual qualifications rules leave something to be desired, Dr. Britton said, both in the rules themselves and in the methods of determining the qualifications. Examples, he said, are the color discrimination test, the depth perception test, the determination of other visual conditions.

One real necessity for a realistic physical standards regulation, Dr. Britton declared, is the writing of a pilot's job description, covering what he does, what he must be able to do under what conditions, and what physical capabilities he actually needs.

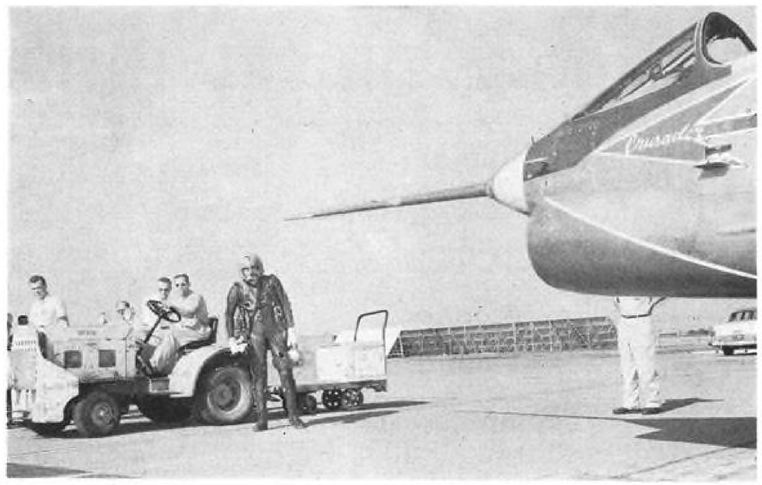
Overall physical fitness, Dr. Britton said, is a combination of many factors, some not even touched on in regulations, notably emotional and mental stability. An examiner who knows a person is physically qualified under regulations but is mentally or emotionally disturbed to the extent that he might be dangerous in the air, usually must grant a certificate. Even if he denies a certificate, the person can appeal to the Civil Aeronautics Board. Proving a borderline condition can be difficult, the doctor said.

### Physical Standards

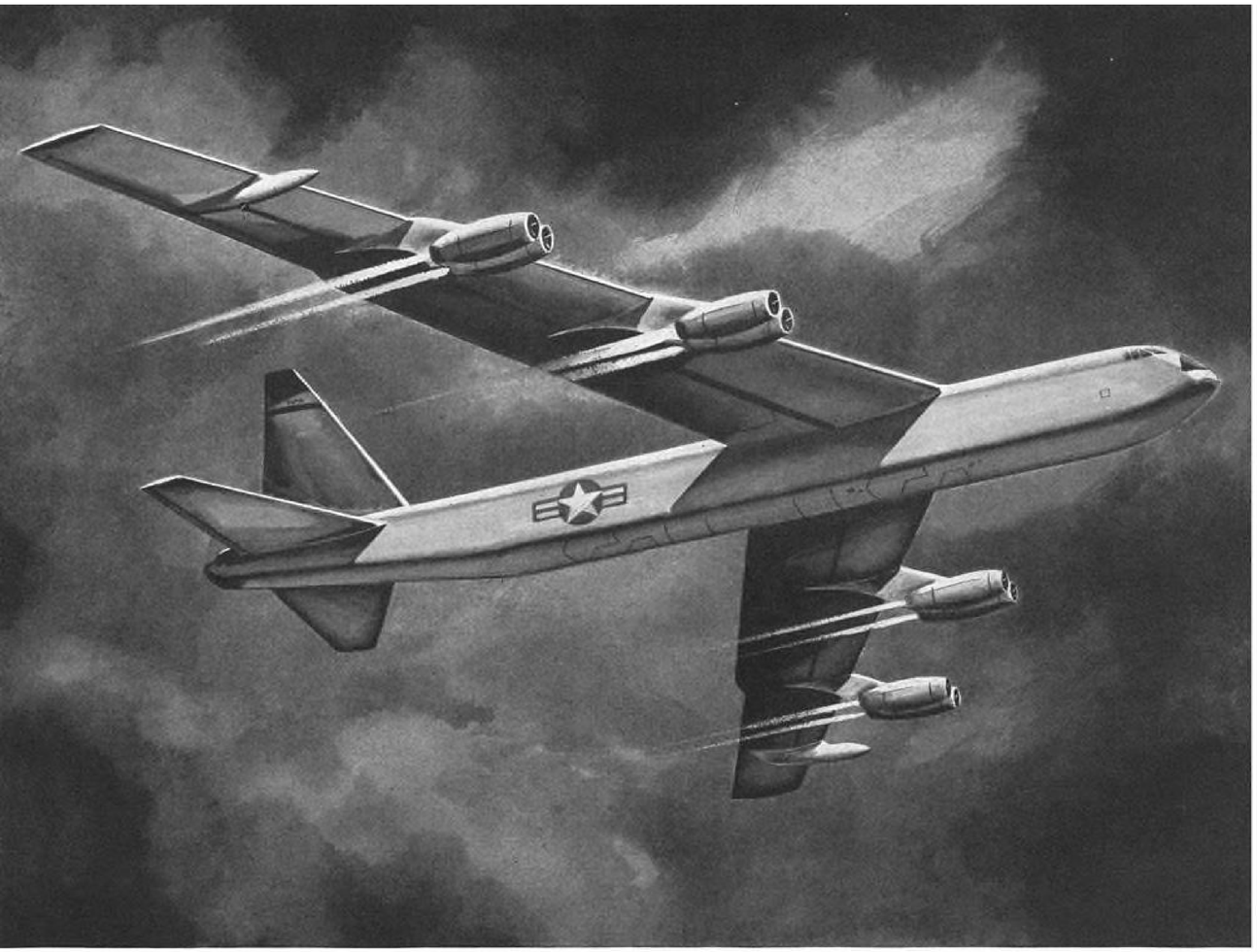
Concerning physical standards for jet transport pilots, Britton said new criteria may be inaugurated. He pointed out that in the past, increased demands were matched by experience in older pilots, but with the introduction of jets, older pilots will have limited or no experience to compensate, and hence may face difficulties.

In addition, he stated, he expects the requirement for yearly electrocardiograms for transport pilots over 40 to become a C. S. regulation, possibly within a year.

Regarding decompression problems for jet transport passengers, Britton said indications are that oxygen drills may be accomplished by airlines, with a view toward making it a routine pro-



**HIGH ALTITUDE** flight preparation is uncomfortable for a pilot until the plane's air conditioning begins to work. Test Pilot Robert Rostine, Chance Vought, Inc., dressed in partial pressure suit, carries oxygen cylinder that serves him from time he completes 30-min. "indoctrination" in oxygen tanks at flight tower until he plugs into XF8U-1 oxygen supply. Cart spares him a long walk in hot sun at Dallas plant. Aluminum canopy that shields cockpit from sun has been rolled back. Flight was 400th for the experimental aircraft.



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Flyweight Jockey for a High-flying Boom...

The Boeing KC-135 jet tanker is the USAF's first production plane capable of in-flight refueling of supersonic bombers and fighters at jet speeds and altitudes.

To maneuver the mighty tanker's refueling boom with pin-point accuracy, Boeing development engineers designed a lightweight, pivoting "Ruddevator"... a 30 x 60 inch honeycomb sandwich control surface.

A critical problem in the design of the uniquely efficient sandwich structure was the selection of a structural adhesive to splice the several sections of internal core as well as to bond the skins to the core. Obviously, the adhesive would have to withstand enormous operational punishment including severe sonic buffeting.

The adhesive selected for this crucial task: Narmtape® 102... formulated specifically with non-brittle elastomeric constituents to provide unmatched fatigue resistance under highest stress and vibration. The KC-135 Ruddevators' more than 200 hours of trouble-free service life are further testimonial to the ability of Narmco adhesives to perform under rugged operational requirements.

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cedure which will not alarm customers but will accustom them to possible hazards in a manner which will not discourage their traveling by air.

### F8U Program

Biggest problem with operational use of F8U, Capt. Graybiel said, was disorientation of the pilot, and investigation was undertaken with a view toward trying to establish a pattern or syndrome which could be accurately reproduced under laboratory conditions.

Program involved 23 run-of-the-mill operations pilots, 23 to 33 years old, most in their late 20s.

Two questions were asked concerning transition to the Crusader, whether the pilot had more trouble transitioning from propeller airplanes to jets, or from subsonic jets to high performance airplanes. Answers were about even concerning transition into the Crusader, some saying it was easier than the prop-to-jet change, some the same, others harder. However, it was indicated that transition from one subsonic type to another was easier than transfer from a subsonic jet to a high performance type.

Pilot criticism was directed at roll instability of the Crusader compared to types previously flown, there was concern about the structure which lifts the wing at landing and takeoff, and pilots were bothered to an extent by different handling characteristics at low and high altitude.

There was no indication that pilots felt their problems related to speed per se, since speed was mostly a figure on a dial unless there were clouds nearby or some other reference frame to establish the rate of passage.

### Time Factor Stresses

Pilot reaction varied about the time factor involved in F8U flight. Some said they constantly felt pressed for time flying the airplane, while others indicated adequate preflight planning gave ample time for all activities, including emergencies encountered in carrier landing pattern.

High altitude flight itself gave some pilots problems such as the space void sight problem, clear air distance judgment, and the problem of maintaining level altitude with little reference. Some pilots, Graybiel said, told of constantly being on instruments at high altitude regardless of weather conditions, to maintain proper flight attitude due to the lack of visual reference cues in the F8U. When the situation of visual cues vs. gravitational ones arose, it was found pilots split about evenly under light acceleration conditions, but when sufficient G was applied, visual cues were overridden and the acceleration cues were dominant.

While vertigo problems at high altitude in the Crusader are generally similar to those in other airplanes, two differences were found: Those of pilot-induced oscillations in pitch which were followed by roll at high altitude, and the use of afterburner at low altitude where acceleration produced a feeling that the airplane nose was higher than it actually was. A number of pilots told of lowering the nose considerably after applying afterburner, returning to a nose high condition as they noticed airspeed increasing swiftly or being much higher than it should have been.

A difference in reaction to the airplane in general was discovered during the program, one conforming to previous estimates of pilot inclinations. More experienced pilots tended to operate the airplane within known safe limits of their personal equipment even though aircraft capabilities were greater, due to caution and common sense rather than any hint of fear. Younger pilots tend to investigate the aircraft's capabilities much closer to maximum performance than older pilots, the investigation indicated.

Out of the 23 pilots investigated, two cases definitely involved fear of the airplane. Another problem arose from personal equipment, with emphasis on the current wry comment that "I can still move, must have forgotten something."

Fatigue factor was again divided, some declaring the airplane easy to fly, fine, not fatiguing at all, while others found the airplane extremely fatiguing.

An additional point brought out was the need for personal physical fitness. All pilots expressed a belief that enough off hours drinking was going on to interfere with the next day's efficiency. Same held true regarding smoking and coffee, both being used possibly more than they should, with detrimental effects. A definite reaction among the pilots was that the daily regimen should include a required period for exercise of a kind which would help relieve tension, be beneficial to flying duty.

Overall investigation showed, Graybiel said, that there is no doubt the average pilot will be able to transition into the F8U, that there is a heavy time stress situation in flying the high performance airplane, that some pilots do get into problems at high altitudes, but as a personal thing rather than as a flat airplane or human factors cause, that physical fitness is being brought home to pilots in a way that definitely shows them their personal requirements must be met.

Questioned after his talk, Capt. Graybiel said the F8U and similar configuration aircraft where the pilot has little reference for straight and level flight may incorporate rubber lines

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across windshields for pilot reference. He also indicated in answer to an inquiry that questionable rumors about a new plane which precede its introduction are usually quickly ended when the airplane appears and proper transition procedures are followed.

Experiments now in progress on biodynamics—the effects of mechanical energy on living tissue—were outlined by Col. Stapp, who also showed motion pictures of the balloon flight of Maj. David Simon and ballistic trajectory flights in a TF-102A for weightlessness experience.

### Supersonic Wind Protection

Col. Stapp's presentation covered materials not yet ready for general dissemination pending completion of three more experiments in sled runs at Holloman. However, he indicated prospects are excellent for protection of aircrews against supersonic wind effects by special clothing material in combination with the other protective devices now in use or being developed.

Work which will be done next spring at Holloman, Col. Stapp said, will include tests with rear and forward facing airplane passenger seats, oriented toward gathering data on ease of exit after airplane impact. Col. Stapp said he now feels that if seats are properly designed to stay securely fastened through crash accelerations and retain their structural integrity, that rearward facing seats will enable passengers to get free, escape the airplane in case of fire or other mishap after crash landing better than forward facing seats. He said that persons will live through high accelerations in forward facing position, but that attendant doubling over somewhat reduces their ability to quickly release a safety belt and walk to the closest exit, while rearward facing seats which absorb the design loads will leave passengers in better condition to complete their escape due to distribution of acceleration loads over greater area.

If funds permit, further flights in the gondola used by Maj. Simon will be made, Col. Stapp said. A new balloon with 5 million cu. ft. gas capacity will be available, enabling flight to greater altitudes.

The balloon used by Maj. Simon had 3 million cu. ft. capacity, carried passenger to what Col. Stapp said he is sure is at least 103,000 ft., but the true altitude will be unknown until the Bureau of Standards completes work with a sealed borograph which was aboard the gondola. New balloon should be, Col. Stapp said, capable of carrying the gondola and a 100 lb. payload to 150,000 ft. for an extended stay.

Other data determined from Maj. Simon's flight, Col. Stapp said, included a very low cosmic radiation effect. In fact, strike plates showed little above normal background radiation. Cosmic radiation, he added, will not retard manned satellite or more balloon experiments. Records of animals in 66 flights, in which one animal was 44 hr. above 90,000 ft., bear out that it would take 2,000 hr. exposure there to accumulate $\frac{1}{4}$ the present Atomic Energy Commission allowable radiation exposure during a 20 yr. career working in radiation areas.

Biggest job yet to be done concerning space flight, Col. Stapp said, is investigation of the effects of weightlessness. In the filmed record of the TF-102A flights, cigarettes were allowed to float free in the cabin, and a cat was shown to lose its ability to quickly twist about and land feet first when dropped from the feet up position, under weightless condition.

Experiments with monkeys and mice which experienced approximately 3 min. periods of weightlessness in rocket flights to 37 mi. indicated no damage to the sensory system or observable emotional effects, he said.

General outline of the Army-Navy instrumentation program was given the symposium by Al Mayo. Data presented was in line with that given at a recent meeting in Los Angeles (AW Oct. 21, p. 34).


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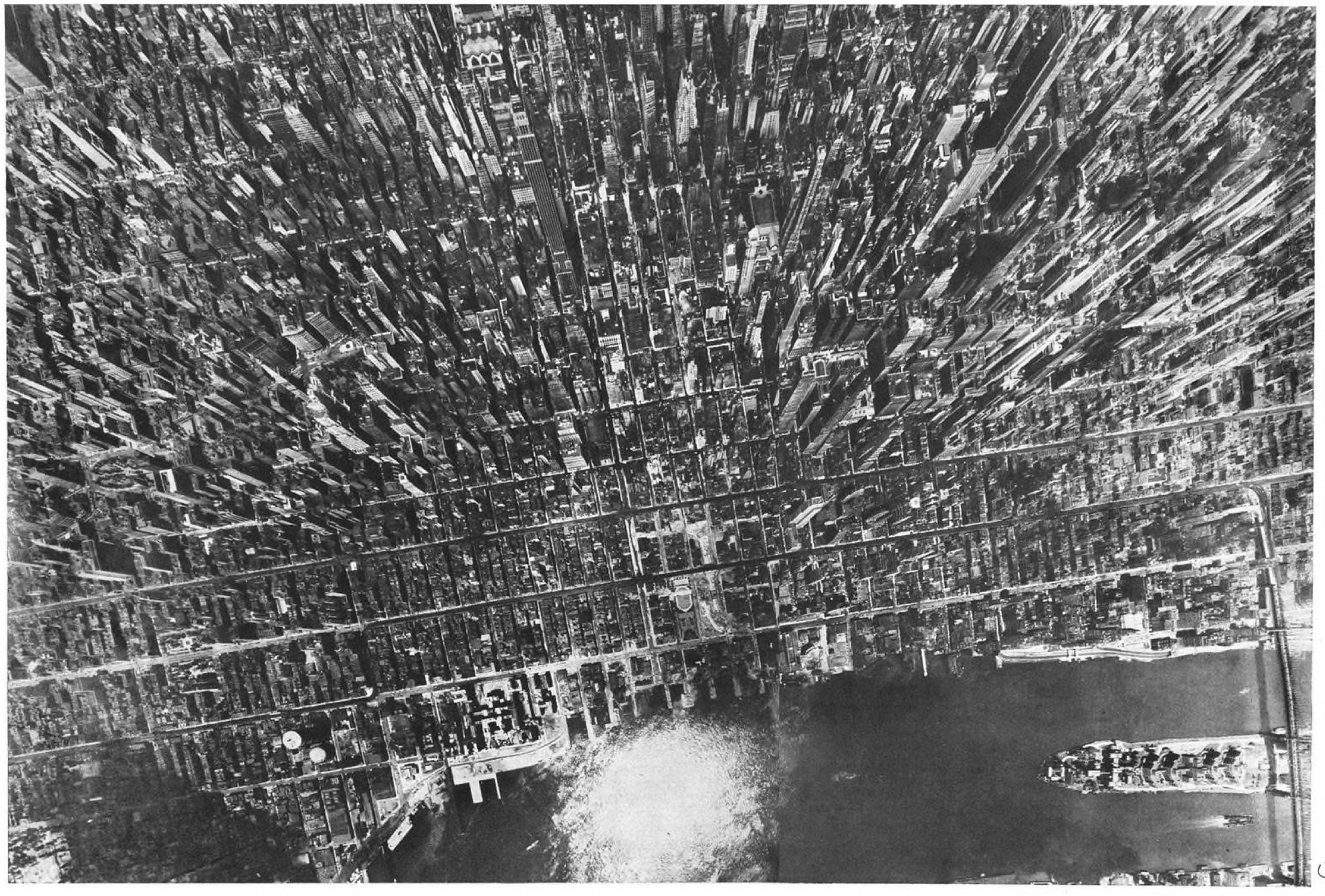

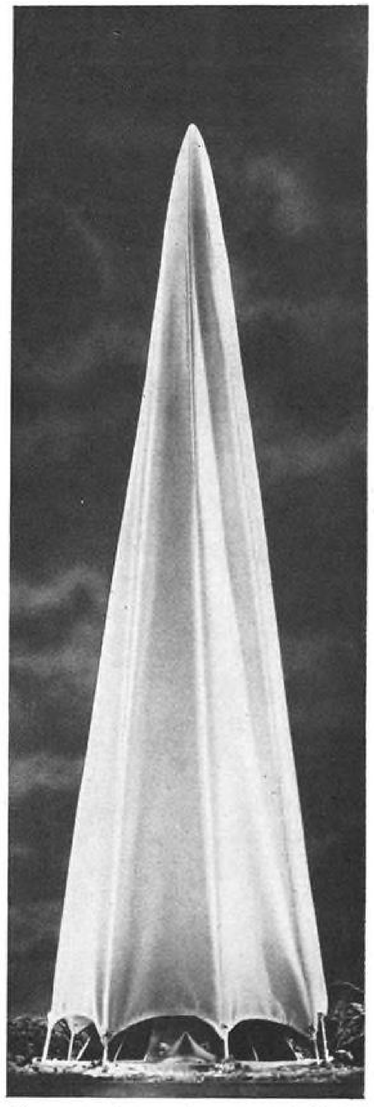

*Thor*, new intermediate range ballistic missile developed for the Air Force by the Douglas Aircraft Company is still a hush-hush project. Thor is designed to carry a thermonuclear warhead at meteoric speeds . . . when operational will supplement the manned bomber force of the Strategic Air Command. Douglas is now building three basic types of rocket and missile: air-to-air, ground-to-air, and ground-to-ground.

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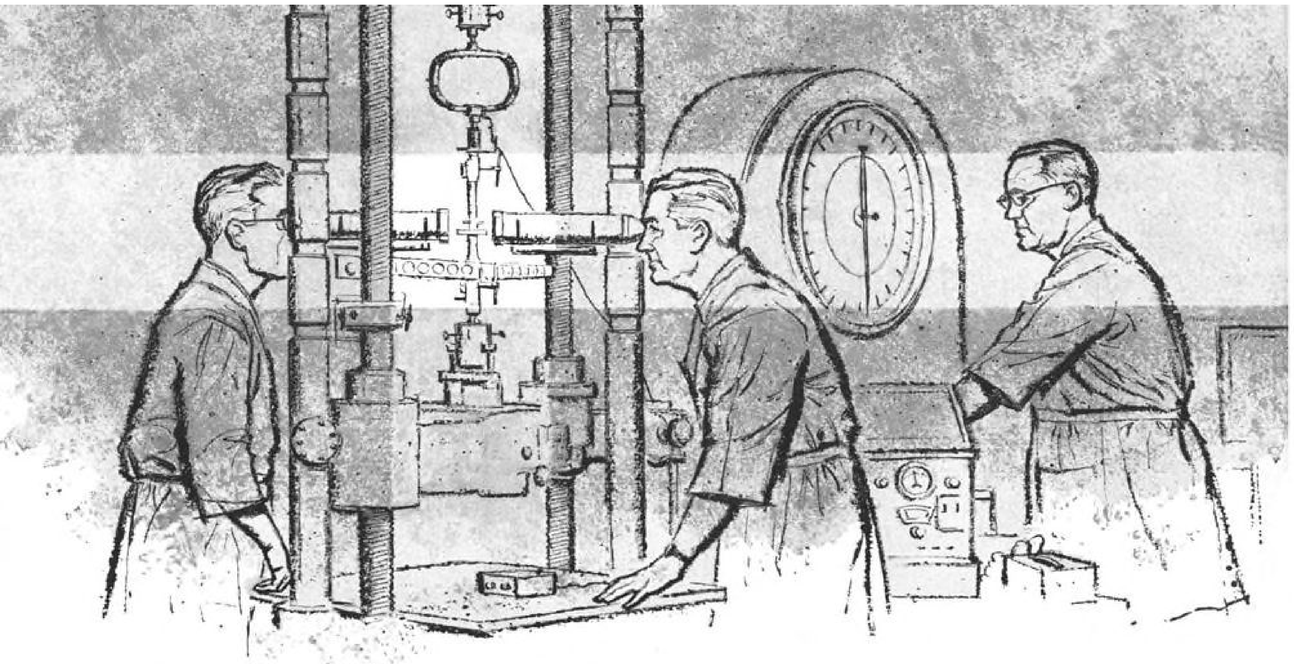

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## Stock Transactions

**Washington**—Acquisition of 216,817 Trans World Airlines common shares, including exercise of rights on 170,900 shares, by the Hughes Tool Co. for a holding of 5,169,101 has been reported by the Security and Exchange Commission.

Pierre G. Desautels, officer, acquired 127 common shares through exercise of rights, for a holding of 254, Sidney Maestre, director, acquired 166 common shares through exercise of rights, for a holding 332, and A. D. Simpson acquired 100 common shares through exercise of rights for a holding of 334. Other transactions for the period July 11 through Sept. 10 include:

**Aero Supply Manufacturing Co.** Acquisition of 200 common shares by Harold E. Christensen, director, for a holding of 400; acquisition of 1,400 common shares by Henry M. Margolis, director, for a holding of 48,261, with Henmar Investing Corp. beneficially holding 20,335 common shares.

**Aeroquip Corp.** Disposal of 100 common shares by Charles Hollerith, officer and director, for a holding of 16,112.

**Air Way Industries Inc.** Acquisition of 200 common shares by Edward Lamb, director, for a direct holding of 41,466; disposal of 555 common shares by Edward Lamb Enterprises, beneficial owner under Edward Lamb, leaving a holding of 42,907, with Dispatch Inc. beneficially holding 14,357 common shares; disposal of 5,000 common shares by Edward Lamb Enterprises, beneficial owner, leaving a holding of 386,548; acquisition of 1,500 common shares by Woodruff Inc., beneficial owner under Prudence H. Lamb, for a holding of 6,420; disposal of 1,400 common shares by Edward Lamb Enterprises, beneficial owner under Prudence H. Lamb, leaving a holding of 108,223, with Dispatch Inc. beneficially holding 5,835 common shares and Prudence H. Lamb beneficially holding 50,263 common shares; acquisition of 5,000 common shares by Frank C. Oswald, officer, for a holding of 21,275.

**Allegheny Airlines Inc.** Acquisition of 1,000 common shares by Willard F. Rockwell Jr., director, for a holding of 17,000.

**American Airlines Inc.** Acquisition of 100 common shares by Shepard Spink, officer, his entire holding.

**American Bosch Arma.** Disposal of 1,500 common shares by holding company under William S. Wasserman, director, leaving a beneficial holding of 12,400; disposal of 300 common shares by trusts under William S. Wasserman, leaving a beneficial holding of 4,669, with Wasserman direct holding of 12 common shares.

**Atlas Corp.** Disposal of 100 preferred shares by Cecelia E. Edwards, officer, leaving a holding of 100.

**AVCO Manufacturing Corp.** Disposal of 100 preferred shares by A. B. Newton, officer, his entire holding.

**Bell Aircraft Corp.** Acquisition of 4,000 common shares by Equity General Corp., a beneficial owner, for a holding of 1,324,266; acquisition of 100 common shares by Walter A. Yates, director, for a holding of 4,350.

**Braniff Airways Inc.** Acquisition of 300 common shares by R. K. Brack, officer, his entire holding.

**California Eastern Aviation, Inc.** Disposal of 8,500 common shares by William W. Brinkerhoff, officer and director, leaving a holding of 72,211; acquisition of 647 common shares by Thomas O. English, officer, for a holding of 3,920; acquisition of $10,000 6% convertible debentures by

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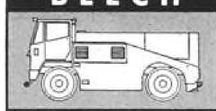
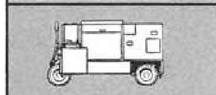
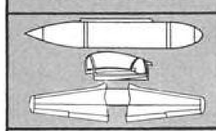
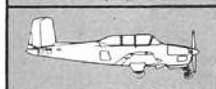
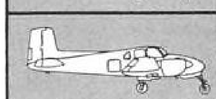
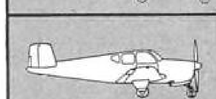
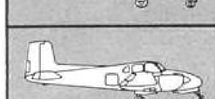
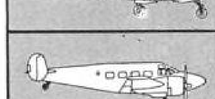
|  | MA-3 MULTI-PURPOSE VEHICLES |
|  | C-26, MD-3 POWER UNITS |
|  | TANK-WING-MAJOR SUBASSEMBLY SUBCONTRACT PRODUCTION |
|  | BEECHCRAFT T-34 TRAINERS |
|  | BEECHCRAFT L-23 TRANSPORTS |
|  | 4-PLACE BEECHCRAFT BONANZA |
|  | 6-PLACE BEECHCRAFT TWIN-BONANZA |
|  | 8-PLACE BEECHCRAFT SUPER 18 |

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Edward A. Kerbs, director, for a holding of $111,000.

**Capital Airlines Inc.** Disposal of 350 capital shares by J. H. Carmichael, officer, leaving a holding of 1,998.

**Consolidated Electrodynamics Corp.** Disposal of 100 common shares by Harold Washburn, officer and director, leaving a holding of 7,190.

**Continental Air Lines Inc.** Acquisition of 1,000 common shares by Frederick L. Ehrman, director, for a holding of 2,000.

**Continental Aviation & Engineering Corp.** Acquisition of 700 common shares by R. P. Brooks Jr., director, for a holding of 1,200.

**Curtiss-Wright Corp.** Acquisition of 1,000 common shares through exercise of option and disposal of 1,000 common shares by Jack O. Charshafian, officer, for a holding of 2,000; disposal of 1,000 common shares by Nicholas Dykstra, officer, leaving a holding of 4,000.

**Douglas Aircraft Co. Inc.** Disposal of 1,000 capital shares by Arthur E. Raymond, officer and director, leaving a holding of 10,600.

**Emerson Electric Manufacturing Co.** Acquisition of $1,000 in 5¼% convertible subdebentures through exercise of rights by Hord Hardin, director, his entire holding.

**Fairchild Engine and Airplane Corp.** Acquisition of 1,550 common shares by Richard S. Boutelle, officer and director, for a holding of 3,063; acquisition of 1,000 common shares by Mrs. Boutelle, beneficial owner through her husband, her entire holding; acquisition of 200 common shares by George F. Chapline, officer, for a holding of 725.

**General Dynamics Corp.** Acquisition of 7,500 common shares through exercise of option by Frederick de Hoffman, officer, for a holding of 7,530; disposal of 8,700 common shares by Earl D. Johnson, officer and director, leaving a holding of 21,300; disposal of 1,050 common shares by Allen D. Marshall, officer, leaving a holding of 9,700; disposal of 3,500 common shares by Robert B. Watts, officer and director, leaving a holding of 3,640.

**General Electric Co.** Acquisition of 345 common shares by F. J. Borch, officer, for a holding of 1,628; acquisition of 1,817 common shares through exercise of option by William S. Ginn, officer, for a holding of 3,167; disposal of 100 common shares by William Rogers Herod, officer, leaving a holding of 8,076; disposal of 400 common shares by Edwin H. Howell, officer, leaving a holding of 1,135; acquisition of 2,070 common shares by Clarence H. Linder, officer, for a holding of 8,440; acquisition of 2,070 common shares by Ray H. Luebbe, officer, for a holding of 8,460; acquisition of 2,025 common shares and disposal of 782 common shares by Francis K. McCune, officer, for a holding of 6,151; acquisition of 1,600 common shares through exercise of option by William V. O'Brien, officer, for a holding of 5,610; acquisition of 1,320 common shares through exercise of option and disposal of 1,000 common shares by Charles R. Pritchard, officer, for a holding of 4,754; acquisition of 450 common shares through exercise of option, by Carter L. Redd, officer, for a holding of 3,654, with Carter L. Redd Jr., beneficially holding 542 common shares; acquisition of 1,725 common shares through exercise of option by Charles K. Rieger, officer, for a holding of 3,459; acquisition of 1,668 common shares through exercise of option by Glenn B. Warren, officer, for a holding of 3,953.

**General Electric Co.** Acquisition of 2,139 common shares by W. R. G. Baker, officer, for a holding of 12,291; acquisition of 2,400 common shares through exercise of option, by Robert L. Gibson, officer, for a holding of 5,310; acquisition of 2,070 common shares through exercise of option, by Chauncey Guy Suits, officer and director, for a holding of 5,070; acquisition of 1,125 common shares by Clarence C. Walker, officer, for a holding of 4,683; acquisition of 1,695 common shares through exercise of option, by William C. Wichman, officer, for a holding of 4,872.

**W. R. Grace & Co.** Acquisition of 3,000 common shares through exercise of option and disposal of 300 common shares by Hugh S. Ferguson, director, for a holding 10,510.

**Graham-Paige Corp.** Acquisition of 500 common shares through exercise of option by Enos Curtin, director, for a holding of 1,700.

**Lockheed Aircraft Corp.** Disposal of 588 capital shares by Robert E. Gross, director, leaving a holding of 72,136.

**The Martin Co.** Acquisition of 500 common shares by John E. Parker, director, for a holding of 1,400; acquisition of 550 common shares by John L. Sullivan, director, for a holding of 9,702.

**McDonnell Aircraft.** Acquisition of 146 common shares by Kendall Perkins, officer and director, for a holding of 2,000.

**McDonnell Aircraft.** Acquisition of 100 common shares by G. C. Covington Jr., officer, for a holding of 1,336; acquisition of 1,400 common shares by James S. McDonnell, officer and director, for a holding of 243,154; acquisition of 100 common shares by T. G. Rutledge, officer, for a holding of 200.

**Minnesota Mining & Manufacturing.** Disposal of 1,000 common shares by Herbert P. Buetow, officer, leaving a holding of 19,790; acquisition of 250 common shares through exercise of option, by Cecil C. March, officer, for a holding of 2,102; acquisition of 800 common shares through exercise of option and 25 common shares as a gift by Clarence B. Sampair, officer and director, for a holding of 2,392; disposal of 300 common shares by George S. Swenson, officer, leaving a holding of 2,896.

**National Airlines Inc.** Acquisition of 400 common shares through exercise of option by Alexander G. Hardy, officer, for a holding of 1,100; acquisition of 100 common shares through exercise of option by William A. Perry, officer, for a holding of 150; acquisition of 119 common shares through exercise of option by Charles F. Sharp, officer, for a holding of 700.

**National Aviation Corp.** Disposal of 1,000 common shares by Elmer Wellin, director, leaving a holding of 1,200.

**National Aviation Corp.,** a registered closed-end investment company. Disposal of 600 common shares by Elmer Wellin, director, leaving a holding of 2,200.

**Northeast Airlines Inc.** Disposal of 1,000 common shares by Alfred A. Lane, officer, leaving a holding of 4,010.

**Pacific Northern Airlines.** Acquisition of 1,500 common shares by John A. Cunningham, officer, for a holding of 1,500; acquisition of 200 common shares by Robert A. Rowan, director, for a holding of 19,767.

**Pacific Northern Airlines.** Acquisition of 500 common shares by Harold A. Olsen, officer, for a holding of 7,900; disposal of 16,500 common shares by A. G. Woodley, officer, leaving a holding of 241,161; acquisition of 500 common shares by Robert A. Rowan, director, for a holding of 19,567.

**Pan American World Airways.** Acquisition of 3,000 common shares by Robert L. Hamill, director, for a holding of 5,000.

**Pan American World Airways.** Disposal of 300 common shares by R. G. Ferguson, officer, leaving a holding of 2,959; acquisition of 200 common shares through exercise of option by Franklyn Gledhill, officer and director, for a holding of 4,902.

**Penn-Texas Corp.** Disposal of 171 common shares by C. T. Lanham, officer and director, leaving a holding of 51; acquisition of 1,500 common shares by Uno Equities Inc., a beneficial owner, for a holding of 10,869.

**Radio Corp. of America.** Acquisition of 100 common shares by Mildred McA. Horton, director, for a holding of 400.

**Republic Aviation Corp.** Acquisition of 100 common shares by William V. Platt, director, his entire holding.

**Robertshaw-Fulton Controls Co.** Disposal of 100 common shares by W. D. Miller, officer and director, leaving a holding of 100.

**Seaboard & Western Airlines Inc.** Disposal of 200 common shares by Douglas M. Amann, director, leaving a holding of 6,800; disposal of 400 common shares by Harold Montee, officer, leaving a holding of 13,402; disposal of 500 common shares by Arthur V. Norden, officer and director, leaving a holding of 59,615; disposal of 200


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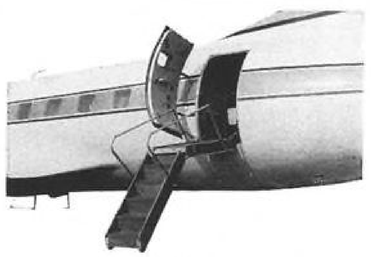

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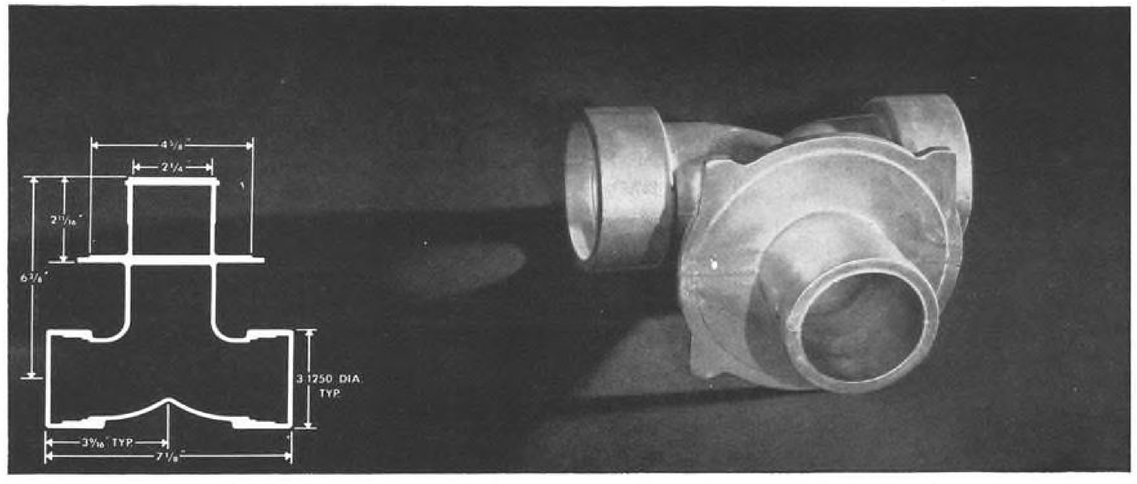
Aviation engineers have found that exterior aerodynamic requirements and internal space limitations transform today's jet aircraft fuel system into a plumber's nightmare. Necessarily large orifices and tortuous passages through and around other systems components have introduced the addition of scores of elbows and connecting fittings to supply a constant flood of fuel to the power plant. Until now, each additional fitting carried an unavoidable weight penalty.

Now, thanks to new Alcoa precision casting techniques, the finished fuel system fittings used by one major aircraft company weigh 30% less than they formerly did as sand castings. They perform better, too. Plaster cast, in alloy 356-T6, with a wall thickness of .080 in. and a tolerance of plus or minus .015 in., these parts establish a new standard in aircraft fuel line castings. Not only are they half the thickness previously considered minimum, but the tolerance itself has been halved. Although specifications still call for impregnation of these parts for fuel system service, they have thus far passed porosity tests without it. In fact, these plaster castings compare favorably with the soundness and strength of permanent-mold castings.

Savings up to 20% in time and money were realized by this company when it was discovered that the precision and concentricity inherent in the fittings made it unnecessary to prepare expensive adjustable jig and fixture setups for finish machining operations. For the complete story on how this new development in casting techniques can benefit you, call your Alcoa sales engineer. He'll be glad to work with you in developing sound, lightweight castings that can save you time and money. Aluminum Company of America, 1800-L Alcoa Building, Pittsburgh 19, Pa.

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common shares by Raymond A. Norden, officer and director, leaving a holding of 57,363.

**Seaboard & Western Airlines Inc.** Disposal of 100 common shares by Douglas P. Amann, director, leaving a holding of 7,000; disposal of 500 common shares by Wallace P. Neth, officer and director, leaving a holding of 31,813; disposal of 500 common shares by Arthur V. Norden, officer and director, leaving a holding of 60,115; disposal of 500 common shares by Raymond A. Norden, officer and director, leaving a holding of 57,653; disposal of 1,800 common shares by Warren H. Renninger, officer, leaving a holding of 8,808.

**Skiatron Electronics & Television Corp.** Disposal of 400 common shares by Frank V. Quigley, officer and director, leaving a holding of 535.

**Skiatron Electronics & Television Corp.** Disposal of 22,850 common shares by Arthur Levey, officer and director, leaving a holding of 407,431.

**Solar Aircraft Co.** Acquisition of 200 common shares by Walker G. Dollmeyer, officer and director, for a holding of 200.

**Sperry Rand Corp.** Disposal of 1,000 common shares by G. W. Banks, officer, leaving a holding of 1,000; disposal of 700 common shares by H. C. Landsiedel, officer, leaving a holding of 4,920; disposal of 6,500 common shares by trusts under Harry Landsiedel, officer, leaving a beneficial holding of 12,460, with Landsiedel directly holding 13,904; disposal of 5,000 common shares by Bernard O. Reuther, officer, leaving a holding of 20,000; disposal of 9,000 common shares by John Sanderson, officer and director, leaving a holding of 1,149; disposal of 3,000 common shares by J. A. W. Simson, officer, leaving a holding of 7,232.

**Temco Aircraft Corp.** Acquisition of 600 common shares by D. H. Byrd, director and beneficial owner, for a holding of 144,558; acquisition of $26,000 worth of 5¼% convertible debentures by D. H. Byrd, director and beneficial owner, his entire holding with trusts under Byrd beneficially holding $10,000 worth; acquisition of $10,000 worth of 5¼% convertible debentures by W. L. Leeds, officer, for a holding of $10,000.

**Temco Aircraft Corp.** Acquisition of $5,000 worth of 5¼% debentures by D. H. Byrd, director and beneficial owner, for a holding of $31,000; acquisition of 1,000 common shares by D. H. Byrd, director and beneficial owner, for a holding of 145,558 with trusts holding 100,474.

**Tung-Sol Electric Inc.** Acquisition of 200 5% Cum. preferred shares by Roy F. Duke, director, his entire holding.

**United Aircraft Products.** Acquisition of 1,400 common shares by Aaron S. Saphier, director, for a holding of 5,125.

**United Aircraft Corp.** Disposal of 2,800 common shares by Leonard S. Hobbs, officer and director, leaving a holding of 3,000.

**United Air Lines.** Acquisition of 800 common shares by Vernon Stouffer, director, for a holding of 1,000.

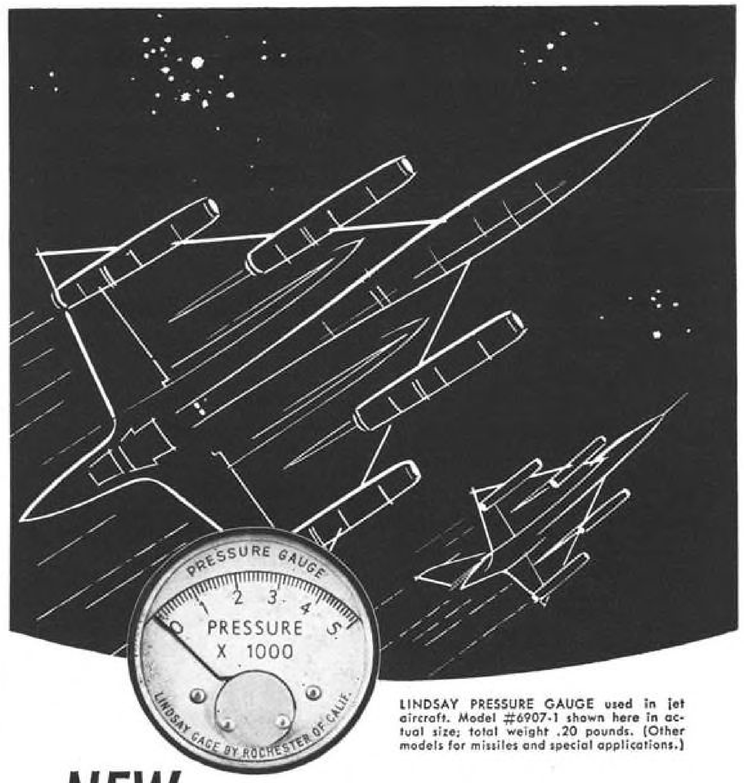
**United Air Lines Inc.** Disposal of 500 common shares by Paul A. Bissinger, director, leaving a holding of 540.

**Western Air Lines Inc.** Acquisition of 2,000 common shares by Dudley Swim, director, for a holding of 3,297; acquisition of $8,000 worth of 4¼% convertible subdebentures by Dudley Swim, director, for a holding of $339,000.

**Western Air Lines Inc.** Acquisition of 250 common shares by G. G. Brooder, officer, for a holding of 1,484; acquisition of 2,900 common shares by W. H. Gonyea, director, his entire holding.

**Westinghouse Electric.** Acquisition of 300 common shares through exercise of option, by Chris H. Bartlett, officer, for a holding of 1,075; acquisition of 200 common shares by Bruce D. Henderson, officer, for a holding of 900; acquisition of 300 common shares by Leslie E. Lynde, officer, for a holding of 1,075; acquisition of 200 common shares through exercise of option, by Tom Turner, officer, for a holding of 1,925.

**Westinghouse Electric.** Acquisition of 500 common shares by Tomlinson Fort, officer, for a holding of 1,557; acquisition of 300 common shares by John F. Myers, officer, for a holding of 1,019.


LINDSAY PRESSURE GAUGE used in jet aircraft. Model #6907-1 shown here in actual size; total weight .20 pounds. (Other models for missiles and special applications.)

## NEW LINDSAY GAUGE designed for jet pressure systems

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The RMC-Lindsay Gauge is a bourdon tube type, using a multiple coil, helical bourdon tube with the pointer attached directly to the end of the coil. The life of the Lindsay helical bourdon coil, as compared to the traditional "C" spring bourdon gauge, is more than 10 times greater and its proof pressure limits are increased by a factor of 3 or 4. The helical bourdon tube also eliminates the use of linkages and pivots, improving the gauge's shock resistance by a factor of 5 or 10.

The helical bourdon element is, of course, not a new development. However, the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications *are* new—and exclusive with RMC.

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# BASIC RESEARCH . . .

## *More Practical Than You Think*

**This editorial, one of a special series on the importance of research to the American economy, deals with an aspect of our research program that may have serious consequences in future years — the lag in basic research.**

An earlier editorial in this series noted: "The keen interest of U. S. business firms in scientific research points the way to a new kind of prosperity for our economy — a prosperity based on deliberate creativeness." As a result of the dramatic increase in industry's research expenditures, more new products will be introduced in the years 1957-1960 than in any previous four-year period.

A steady stream of new products and new processes means better values for consumers and lower costs for business. And thus it promises to sustain a high level of general prosperity that defies the old laws of boom and bust. **But, as we look further ahead, there is a danger that the stream of research discoveries may run dry because of our neglect of basic research.**

This danger was described by John Jay Hopkins, late founder and chairman of the General Dynamics Corporation: "Unless there is a revolutionary development in America of pure, not applied, science, there will come a day when there is no use in trading in your old car; because the new one is no better. The only difference between this year's television set and next year's will be the appearance of the cabinet! Scientific progress will be replaced by scientific stagnation."

### What Basic Research Is

Basic (or pure) research has been characterized as the pursuit of knowledge for its own sake rather than to fulfill some practical objective. It is generally carried out in an environment which allows the investigator the freedom to follow the lead of his curiosity. The scientist in basic research, in the words of Glenn T. Seaborg of the University of California, is not concerned with "utilitarian goals, but a search for deeper understanding of the universe and the living and inorganic phenomena within it."

**Impractical as basic research may seem in its initial purpose, it is an essential prerequisite to applied research and product development.** A few examples will show how some of the greatest technical advances of recent years have come from basic research projects that had no immediate practical objective:

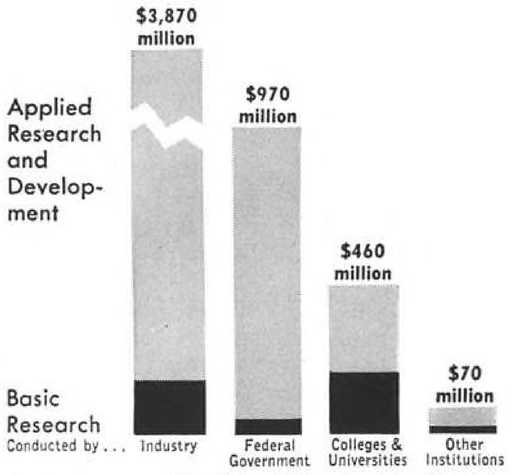
- **Radar** — an important military development of World War II with broadening commercial applications — was the outgrowth of a basic research project whose purpose was to obtain information about the height of the ionosphere, the layer of air that lies some 25 miles above the earth's surface.

- **Transistors** — the miniature devices which are already vital components of hearing aids, pocket radios and a wide variety of industrial equipment — were invented at Bell Laboratories (research subsidiary of the American Telegraph and Telephone Company) following university investigations into the electrical behavior of solids.

- **Neoprene** — a synthetic rubber — was developed by duPont with the help of basic information provided by Father Nieuwland of Notre Dame, who discovered he could control the polymerization (the linking together of molecules) of a certain class of organic compounds.

- **Nylon** — the first of the noncellulosic synthetic fibers that have revolutionized the textile industry — grew out of fundamental research by Dr. Wallace Carothers on long-chain polymers.

**Only 8% of All Research and Development in the U. S. is Devoted to Basic Research**




Data: National Science Foundation, "Funds for Basic Research in the United States, 1953"

## Industry's Stake in Basic Research

Industry traditionally has relied upon colleges and universities and other nonprofit institutions for basic research; and the U. S. has long benefited from the greater emphasis placed on basic research in Europe. It is conventional to think that business cannot, and should not, do much about "ivory tower" projects which do not have immediate practical application.

However, there is not so much in this idea as is supposed. The examples above illustrate what Caryl Haskins, president of the Carnegie Institution, has called "the widespread paradox that the most important practical consequences are commonly the least sought after." Furthermore, it is certain that, without adequate basic research, industry's efforts to produce new and better products will become progressively more difficult. And our national defense, in an age of breathtaking military applications of science, will become increasingly precarious.

In the past, our economic growth came largely through expansion into new lands or through discovery and development of rich deposits of natural resources. Such opportunities are relatively limited today. The great opportunities now lie in discovering new materials and new properties of the materials we already have. **This is the job of basic research, and industry has a vital stake in it.**

The chart indicates the tiny share of research efforts in the U.S. that is devoted to basic research. **Only 4% of all research by industry, and only 8% of all research in the U.S., during the year 1953** (the latest for which information is available) **represented fundamental research to add to overall scientific knowledge.** Even in colleges and universities less than half the research performed is basic research. At least one Nobel Prize winner has expressed the belief that we need and should work toward a doubling of the proportion of our total research effort that is devoted to basic research as soon as possible.

## What Business Can Do

Without anything like a staggering increase in the total cost of its research programs, industry could do much to expand our basic research effort. Companies with big research programs should, as a matter of successful survival, be devoting a share of the effort in their own laboratories to basic research. Significantly, companies that are already doing a notable job of basic research have also made an outstanding record of translating such research into new products for industry and the consumer.

Smaller companies may rightly regard the conduct of research projects with uncertain prospects of reward as a luxury. Some basic research, indeed, never results in any tangible payoff. But, with modest contributions, small companies can still have a part in the advance of basic research. They can join together with other companies on cooperative projects. They can support basic research through trade associations and technical societies. They can help research centers in universities and other nonprofit institutions. Arrangements are available in some instances whereby business firms can pay a fee to have access to work done by university researchers.

**One way or another, it is up to private business firms to see that basic research moves forward. By doing so they will be laying the groundwork for the development of the new products and technology on which their growth, and the growth of the economy, depend.**

*This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.*

Donald C. McGraw
PRESIDENT

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NEW

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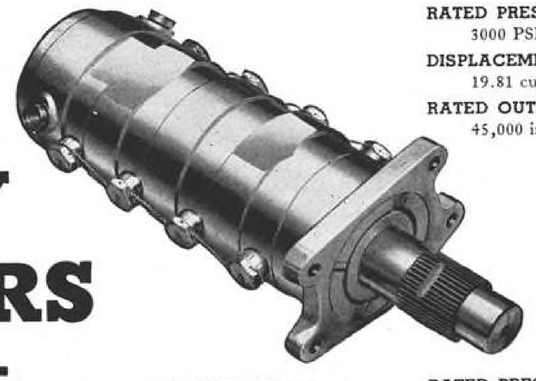
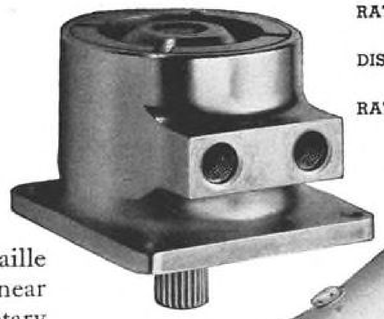
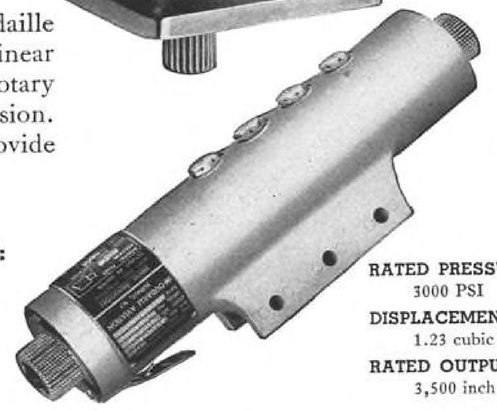


RATED PRESSURE: 3000 PSI
DISPLACEMENT: 19.81 cubic inches/radian
RATED OUTPUT TORQUE: 45,000 inch pounds



RATED PRESSURE: 3000 PSI
DISPLACEMENT: 8 cubic inches/radian
RATED OUTPUT TORQUE: 2,000 inch pounds



RATED PRESSURE: 3000 PSI
DISPLACEMENT: 1.23 cubic inches/radian
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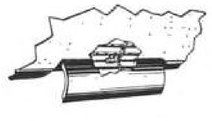

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Here's a good example of what imagination and enterprise can do—given the opportunity that's offered bright young engineers at Goodyear Aircraft.

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For further information on your career opportunities at Goodyear Aircraft, write: Mr. C. G. Jones, Personnel Dept., Goodyear Aircraft Corporation, Akron 15, Ohio.

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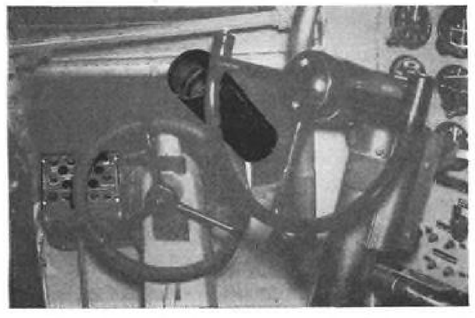
SELECTS

# EDO LORAN

Pan American World Airways has ordered Edo Loran units for installation in its fleet of Boeing and Douglas jet transports. Selection of the new Edo long-range navigation equipment followed testing in both Atlantic and Pacific service. Edo Loran drew praise from pilots and technical personnel alike for its simplicity of operation, accuracy and reliability. Edo's lightweight (29 pounds), compact design for cockpit installation, simple operation and directly-read data for pilot use, combined with the accuracy and proven reliability of the Loran system, were factors in Pan Am's choice of Edo Loran as the basic long-range navigation system for its upcoming fleet of jet aircraft.



Installation of Edo Loran in Pan American Boeing Stratocruiser shows compact design and convenient mounting for pilot operation. ¾ ATR receiver unit is remotely installed.

*Brochure available on request.*

**Edo Corporation**

College Point, Long Island, New York

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# LETTERS

## Barcelona Incident

May I congratulate you upon the splendid coverage of the Eighth Congress of the International Astronautical Federation at Barcelona a few weeks ago. Dave Anderton did a fine job of interpreting events in the hectic and emotionally charged week following the launching of Sputnik.

One impression, however, was in error. It was reported (AW Oct. 21, p. 31) that American delegates spontaneously applauded Russian Academician L. I. Sedov at the dance festival. What actually occurred was that Sedov upon arrival had been urged by news photographers into posing and taking a few steps with the costumed dancers. When the photos had been taken and he turned to join the rest of the group there was applause—adulatory, but in appreciation and approval of his good humor and sportsmanship in permitting the photos. I know that this was the case as I took part in it. Dave Anderton in all probability did not witness the preamble to the applause and draw an erroneous conclusion.

Aside from this mistaken impression, I thought the coverage was excellent. The Russian delegates could have been arrogant and self-satisfied, but they were not. They took no advantage of the opportunity to be smug and in my opinion showed remarkable restraint and good grace.

F. C. Durant, III
Chairman, International Affairs Committee,
International Astronautical Federation
Everett, Mass.

## Moon Question . . .

The photograph on the cover of your Oct. 28 issue of Aviation Week strikes us not only as a fascinating demonstration of the merits of the Roti Mk. II camera but also as a classic demonstration of a basic psychophysical phenomenon: if a picture which is rendered primarily in highlights and shadows is inverted, the picture will reverse the perceiver's sense of convexity and concavity. In other words, it seems to us that your cover photograph has been printed upside down—unless, of course, the Roti Mk. II camera has revealed that the moon, rather than being pock-marked with craters, is, instead, a mass of blisters.

As human engineers and systems analysts, we are intrigued both with the perceptual phenomenon and the questions implicit in the sequence by which this spectacular photograph ended upside down on the cover of your most commendable magazine.

Donald N. Michael
Senior Research Associate
Dunlap and Associates, Inc.
Stamford, Conn.

I wonder how many of your readers noticed that your cover photo of the moon on the Oct. 28 issue was upside down? Or was it?

For those who missed the craters, and saw instead a pool of bubbling lava, I suggest turning the cover around and waiting five or ten seconds. It takes that long for the bubbles to settle and for the crater walls to rise.

Tom Bergin

***Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 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.***

## . . . Moon Explanation

*(Aviation Week asked the Perkin-Elmer Corp. which took the photograph of the moon which appeared on the Oct. 28 cover, to explain how the photograph was made. The following letter is in reply to our inquiry.—Ed.)*

We've asked one of the engineers in our Engineering and Optical Division, John Gregory, to give us an explanation of the Roti moon photo and just how to look at it. John is an active amateur astronomer and was the one who took the photo of Sputnik's rocket in your Oct. 21 issue (p. 29). This is John's explanation:

"Actually, when looking through a telescope the moon would appear with the dark portion on the left and astronomical journals always reproduce it so. However, this particular photograph is of a three-quarter moon, and if you stood facing East before sunrise and viewed the moon with the naked eye as it was rising, the dark portion would appear toward the top as reproduced on the AW cover."

While John was doing this, I asked him to recalculate how close this photograph brought one to the moon. If you take an 8x10 print, such as you used, and hold it ten inches away from your eyes, the moon appears as it would if you were about 535 mi. away from it. Using a 16x20 blow-up (on which we based our original computation) it appears as it would if you were about 260 mi. away.

Charles C. Dayton
Public Relations Manager
The Perkin-Elmer Corp.
Norwalk, Conn.

## More on Infrared

Your article "Infrared Simulates Aerodynamic Heating" (AW Sept. 30, p. 81) is interesting and educational, but there are additional facts in which you might be interested.

The prototype USAF facility utilized 40-75 kva General Electric controllers, and we worked with Wright Air Development Center on some of its stability and response problems. WADC has passed the point of interest in ignitron controllers. We are currently making a complete 20,000 kw facility for WADC, including power distribution equipment, ignitron controllers, and heat rate computers.

Also, National Advisory Committee for Aeronautics, Langley Field, was probably the first (1948) to start work on this type of facility. In fact, it was NACA's instigation that brought about G. E.'s development of the T3 infrared lamp which is universally used. We are now building power equipment, including ignitron controllers, rated 10,000 kw for Langley Field.

General Electric has spent considerable effort on High Temperature Structure Test Facilities in the past several years, and is continuing to do so. We have sold integrated systems as well as components and hope to sell more in the future.

D. E. Steeper
Systems Application Engineering Section
General Electric Co.
Schenectady, N. Y.

## $R_X$ for Abbr.

Mr. C. R. Englebry, in his letter published in Aviation Week of Oct. 28 (p. 150), took the words right out of our mouth. The situation he described is acute, but there is relief in sight.

The enclosed booklet (entitled "Aviation Alphabet Scoop") may not check the abbreviation malignancy but it should at least help to bring it under control. We will be glad to send it to any of your readers who are having difficulty with the new language of Aviation Acronym.

Norman Warren
Vice President & Director
Advertising & Public Relations
Lear, Inc.
Santa Monica, Calif.

## Engineering Dignity

As a student in engineering and about to graduate, I am somewhat amazed by the child-like letters that must clutter the desk of the editor of this fine periodical. I am referring to three letters in the letters column (AW Sept. 2, p. 118; Sept. 23, p. 150; Oct. 7, p. 174), containing nonsensical ravings of each other's pride and joy (B-58, F-86). The letters were written by supposedly clear-thinking, level headed engineers who normally would shun such ridiculous phases as being beneath their dignity. The question arises, are there more like these in industry or has Aviation Week just had a bad month. I would venture to say that these utterances would be indicative of us student engineers, and I include my humble self.

Sandy A. Insana
Pittsburgh, Pa.

## Equipment Location

On p. 109 of your issue of Oct. 21 ("Navy T2V-2 Report for Carrier Duty"), you state that the pitot tube and dual purpose UHF and Tacan antenna of the Lockheed T2V-1 "SeaStar" are contained in the arresting hook. The items in question are actually contained in the barrier guard.

Dan K. Disher
Production Test Pilot
Lockheed Aircraft Corp.
Palmdale, Calif.

All-weather flight for Helicopters

Sperry Announces Advanced Developments in Controls

To increase the all-weather capability of helicopter flight has been a continuous research and development program at Sperry. The newest development is a Stabilizing Control System adaptable to all types of rotary wing aircraft.

This new miniaturized electronic system is designed for partial or fully automatic control to achieve stability during take-off, in flight, hovering and landing – in varying conditions of wind and weather. Use of transistors, redundant amplification and rugged miniaturized components, engineered with traditional Sperry precision, give the new system great accuracy and reliability—all within small space and light weight for either the minimum or fully automatic system.

CHIEF BENEFITS OF THE NEW SYSTEM ARE:

**Reduction of pilot fatigue.** Constant stick handling is eliminated.

**Accurate navigation.** Precise flight is achieved even under conditions of poor visibility and over unfamiliar terrain.

**All-weather flight.** Automatic system provides hands-off stability needed under all flight conditions.

**Control stick steering.** The pilot generates command signals by moving stick in conventional manner.

Other Sperry developments for helicopters include a new Sperry All-Weather Integrated Instrument System. Providing simplified display of all data for manual control, it includes Flight Director Computer, Horizon Flight Director Indicator, Navigation Computer, Compass Pictorial Displacement Indicator, Altitude Vertical Rate Indicator and RPM Control System (also available individually). If you have a requirement in helicopter controls and instrumentation, write our Aeronautical Equipment Division.

AERONAUTICAL EQUIPMENT DIVISION

SPERRY GYROSCOPE COMPANY
Great Neck, New York

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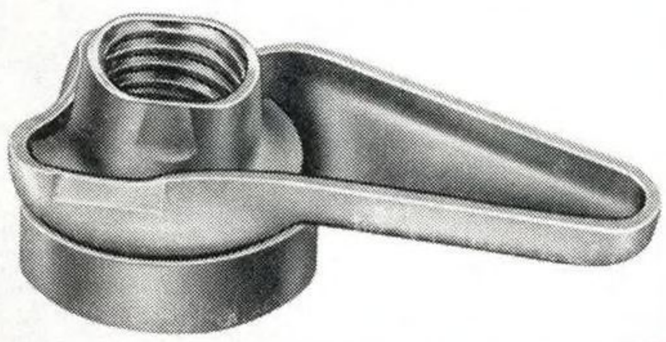
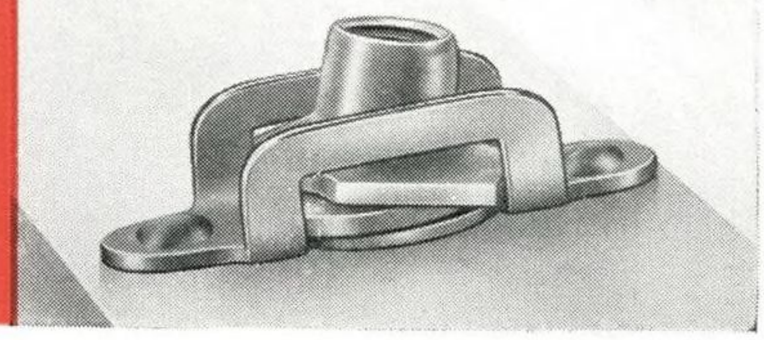
Self-aligning Hex Nut
Type LH2935 • 10-32, 1/4-28, 5/16-24



Self-aligning Self-wrenching Nut
Type LH2956 • 1/4-28, 5/16-24



Self-aligning Anchor Nut
Type LHA3022 • 10-32, 1/4-28

# WHERE CAN YOU USE ONE OF THESE NEW SELF-ALIGNING STOP NUTS?

Got a problem in bolting non-parallel surfaces? Still use a costly compromise like hand-selecting tapered shims? Must you resort to time-consuming, unwieldy, multiple spot-facing operations?

For a cost-saving, weight-saving, time-saving solution try the new ESNA self-aligning fasteners. To meet specific application installation problems four different designs are offered: a hex nut to standard dimensions; a double hex, high tensile fastener which develops 180,000 psi in the bolt; a floating anchor nut; and a self-wrenching type. All of these parts automatically correct for angular misalignment up to 8° in any direction from the center line.

- **The self-aligning anchor nut serves as a "fixed" fastener for use where the bolt is removable but the fastener remains riveted to the structure.**
- **The self-aligning hex is designed for applications where a wrenchable nut can be used.**
- **The 12-point double hex design provides 180,000 psi high strength performance and requires a minimum of wrenching area.**
- **The self-wrenching design is suggested for locations where tightening with a wrench is impractical. The lug anchors itself against an adjacent surface for easy wrenching.**

Each self-aligning fastener consists of a nut body with curved base and mating washer surface which act together on the ball-joint principle. Made of carbon steel for use at temperatures up to 550°F., these fasteners meet Specification AN-N-10 performance requirements and also the torque, tensile, twist-out and push-out requirements of MIL-N-25027 (ASG).

Like to know more about this line of lightweight self-aligning fasteners? Mail the coupon today.

**Dept. N38-1125, Elastic Stop Nut Corporation of America**
**2330 Vauxhall Road, Union, New Jersey**

Please send me the following free fastening information:

☐ Standard drawings of four new ESNA self-aligning fasteners.

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

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