

August 17, 1959

Aviation Week

Including Space Technology

**Simulators Train
Pilots to Control
Mercury Capsule**

**PanAm 707 Jet, Aeroflot
Tu-114 Meet at Idlewild**

75 Cents

A McGraw-Hill Publication



Reaching for the Moon, Mr Designer?

Here's a tip... Millions of Kaylock® nuts ago, a new aircraft fastener made its bow... the Kaylock H20, first lightweight, high tensile, all-metal, self-locking nut.

Its significant improvement over then-existing fasteners—lighter weight, greater strength, smaller envelope—won immediate acceptance by airframe weight engineers and designers.

Today, with a premium on weight and space savings in aero-space vehicles and engines, design engineers depend more than ever on Kaylock nuts. So here's a tip...

If you're reaching for the moon, Mr. Designer, reach for your up-to-the-minute Kaylock catalogs first. Chances are, your "brainchild" will get there sooner.

Fastener with a past—that's the Kaylock H20. A favorite callout of design engineers for the past 3 years, the H20 was the first high tensile, all-metal nut using the elliptical self-locking principle for which Kaylock nuts are famous. "Vital statistics" include:



Service Temperature: 550°F
Tensile Strength: 180,000PSI
Material: Alloy Steel

Ready to Help—Here are a few of the Kaylock external wrenching nuts built to meet rigid requirements in weight and space reduction.



H14

Service Temperature: 550°F
Tensile Strength: 160,000PSI
Material: Carbon Steel



H23

Service Temperature: 550°F
Tensile Strength: 180,000PSI
Material: Alloy Steel



H24

Service Temperature: 550°F
Tensile Strength: 220,000PSI
Material: Alloy Steel



H41

Service Temperature: 900°F
Tensile Strength: 125,000PSI
Material: A286 CRES



H33

Service Temperature: 1200°F
Tensile Strength: 160,000PSI
Material: A286 CRES



H19083

Service Temperature: 1400°F
Tensile Strength: 160,000PSI
Material: M252 CRES



H10

Service Temperature: 550°F
Tensile Strength: 125,000PSI
Material: Carbon Steel

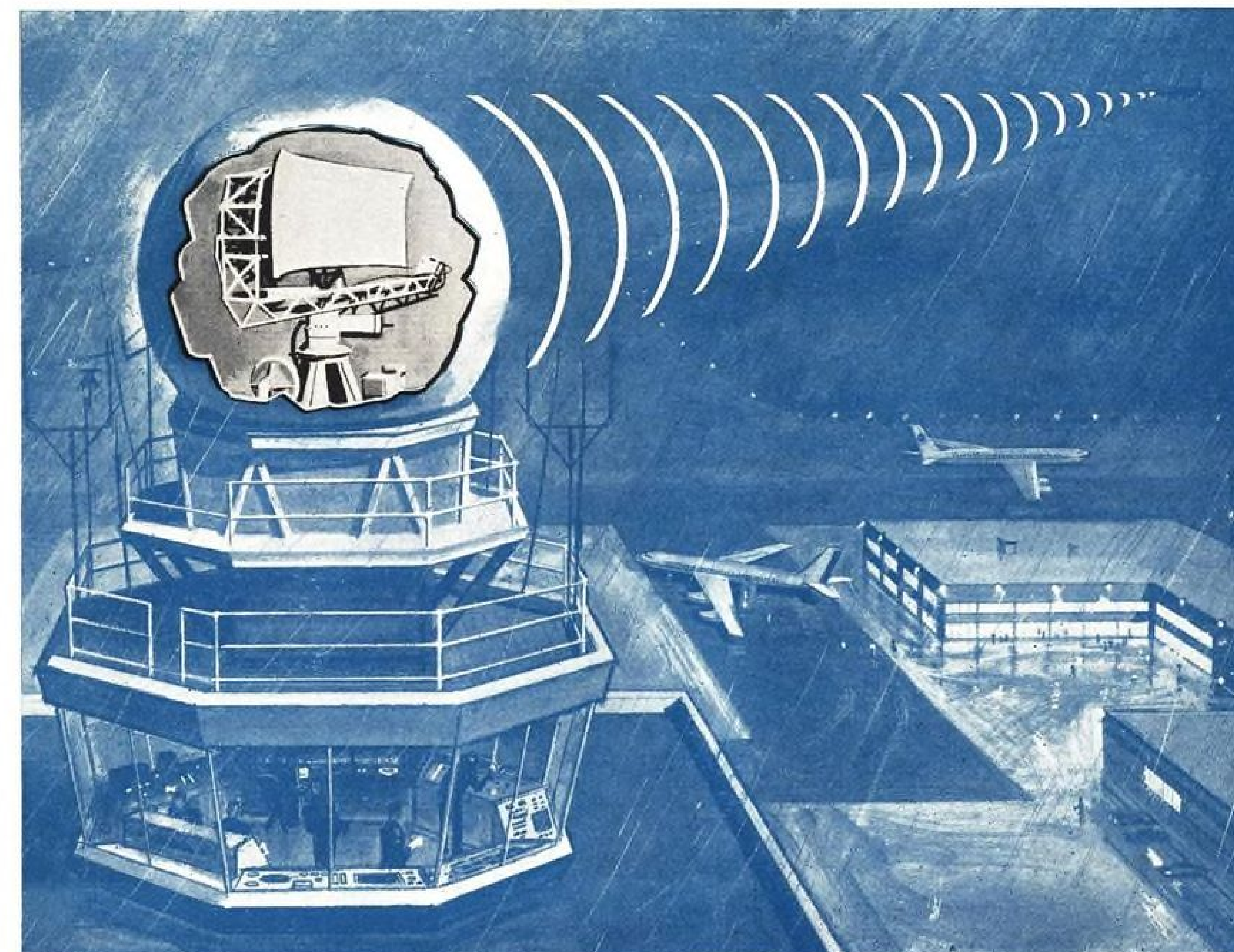


H31

Service Temperature: 900°F
Tensile Strength: 125,000PSI
Material: A286 CRES



Kaylock
ALL METAL SELF-LOCKING NUTS



HOW TO KEEP AN EYE ON RUNWAYS EVEN WHEN THERE'S "NO VISIBILITY"!

In recent years, the job of the airport traffic controller has become increasingly difficult. Runways are longer. Flights are more frequent. And planes are landing with one-mile visibility—often less!

Now—an Electronic "Eye" has been perfected that gives the controller a *visual report* of ground traffic even when there is "no visibility." Developed by the Airborne Instruments Laboratory—a division of Cutler-Hammer, Inc.—this Airport Surface Detection Equipment (ASDE) provides a high resolution radar picture of all aircraft, ground vehicles, and hangars up to a 4 mile range of the control tower. This equipment is so precise that two men—standing at arm's length from each other 1500 feet from the tower—will

appear as two clearly defined objects on the ASDE scope.

Because of long and varied experience in radar engineering and radome design, Goodyear Aircraft is supplying the 4 x 12 foot double curved reflector dish, the pedestal, and most of the major mechanical parts of the antenna system.

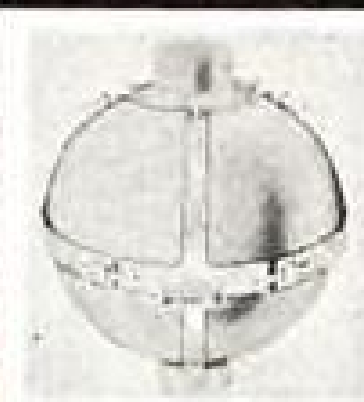
The unprecedented accuracy of this equipment is enhanced by the dependability of the antenna structure and rotating equipment developed by Goodyear Aircraft. This invaluable background of experience is available to you now—ready to assume full responsibility for the most advanced radar systems of the future. Write Goodyear Aircraft Corporation, Dept. 916FH, Akron 15, Ohio.

RADAR STRUCTURES AND RADOMES
— A PRIME CAPABILITY OF

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona

the time
has come for
a new approach...



AWICA DIVISION—Clamps, seals and couplings for positive fastening of fluid and electronic systems. Produces this air starting bottle support for aircraft.



TURBO PRODUCTS DIVISION—High alloy metals components and assemblies for jet, missile and rocket propulsion systems. Produces turbine blades, nozzle vanes for this type turbo jet engine.



POLY INDUSTRIES



U. S. PROPELLERS INC.—Propellers, fans and rotor systems for aircraft, drones, wind tunnels, and vertical flight aircraft. Supplied this Flying Platform's propellers.



FABRICEL DIVISION—Forming, contouring and fabricating aluminum, fiberglass and metal for aircraft, missiles, electronics, and ground support equipment. Completed rocket, shown with trailer.



LEFCO PRODUCTS INC.—Specialized plastics manufacturing of fluorocarbon plastic Teflon—also kel-f, nylon and polyvinyl—standard and custom sizes and shapes.



ADOR CORPORATION—Prefabricated construction units to shelter ground support personnel and equipment. Complete prefabricated walls, doors, and windows.

AMERICA'S NEWEST COMBINATION OF EXPERIENCED INDUSTRIES

Poly Industries combines six experienced divisions and subsidiaries to offer a new range of products and services... for the present and future.

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Capabilities Brochure...



POLY INDUSTRIES, INC.
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Exceptional employment opportunities for qualified engineers experienced in fluid dynamics and power components.

AVIATION CALENDAR

- Aug. 24-26—Gas Dynamic Symposium, American Rocket Society, Northwestern University, Evanston, Ill.
- Aug. 24-26—Institute of the Aeronautical Sciences' National Specialists Meeting, a symposium on anti-submarine warfare, (classified), San Diego, Calif.
- Aug. 24-27—Fourth Symposium on Ballistic Missiles and Space Technology, Los Angeles, Calif. Sponsors: USAF's BMD; Space Technology Laboratories, Inc.
- Aug. 27-28—International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England.
- Aug. 31-Sept. 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex.
- Aug. 31-Sept. 3—Conference on Stratospheric Meteorology, American Meteorological Society, Curtis Hotel, Minneapolis, Minn.
- Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.
- Sept. 1-2—Conference on physical chemistry in aerodynamic and space flight, University of Pennsylvania, Philadelphia, Pa. Sponsors: Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Dept.
- Sept. 2-4—1959 Cryogenic Engineering Conference, University of California, Berkeley, Calif.
- Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.
- Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.
- Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences; Office of Naval Research; National Science Foundation.

(Continued on page 6)

AVIATION WEEK Including Space Technology

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AVIATION WEEK, August 17, 1959



Ingenuity Engineered

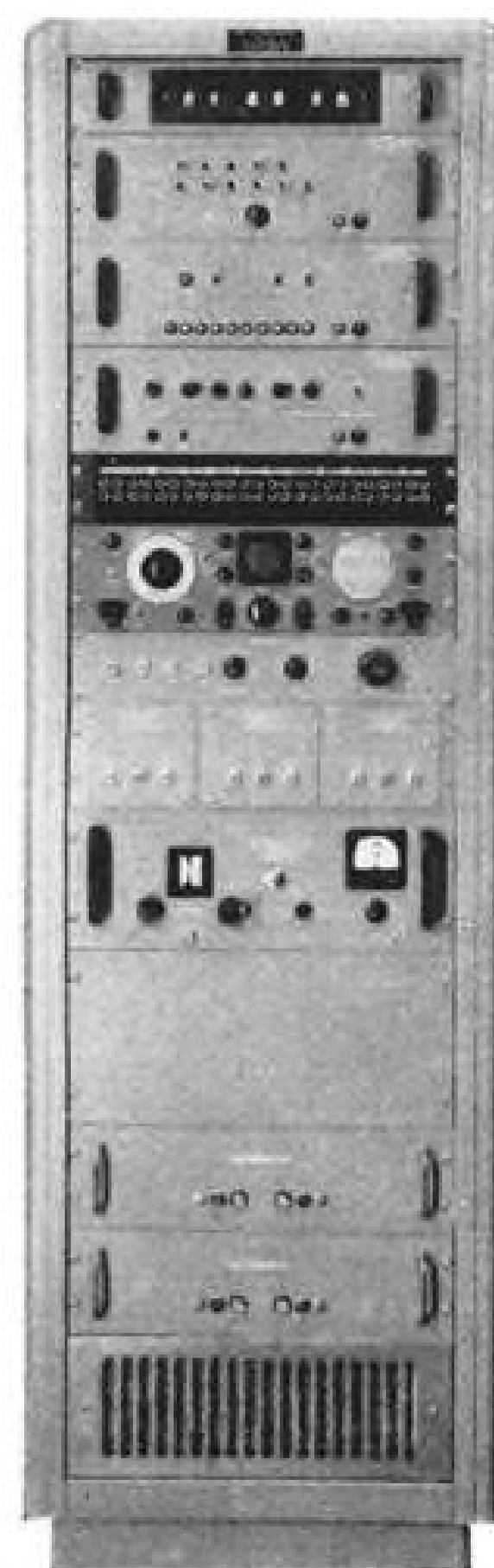


Let's not kid ourselves — *nothing* is perfect. But we think you'll agree that the x-band radar antenna shown is about as close as you'll ever get. For example, reliability has been *Ingeneered* into the scanner of this knee-high package simply by keeping the number of moving parts to a minimum: *one*.

That isn't the whole story, of course. We could talk about things like modular packages for az-el drives, how the feed exhibits circular symmetry to r-f, how we get high-speed nutation by rotation and on and on... But we figure your requirements are probably different than the next fellow's anyway, so why don't you write us if you want all the specs? 15330 Oxnard St., Van Nuys.

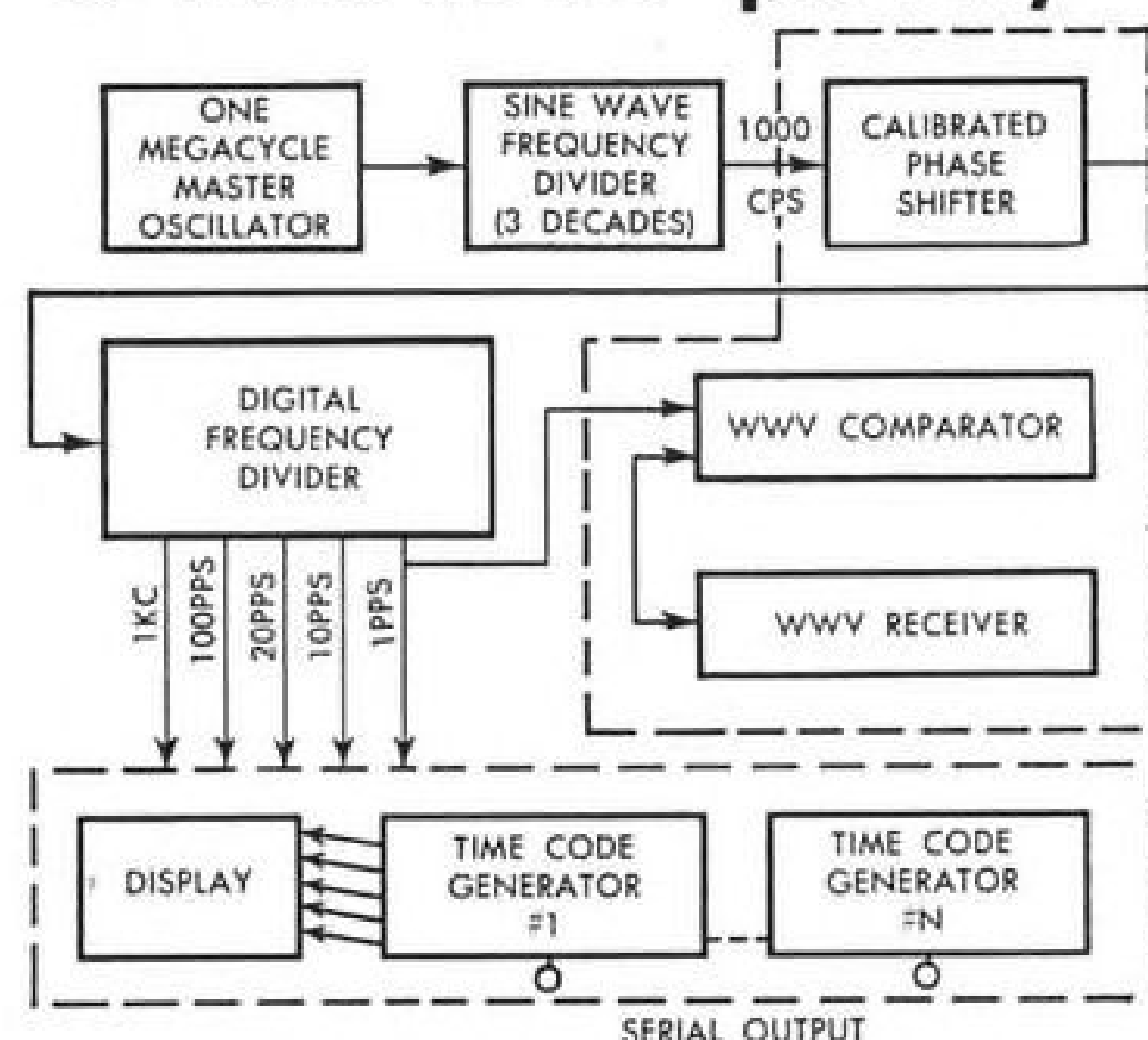


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Hermes Range Time Generator
Model 207

Missile Range TIMING SYSTEM with Stability of 5 Parts in 10^{10} per Day



This System is composed of a Precision Frequency Time Base Oscillator with a stability better than 5 parts in 10^{10} per day; a WWV Receiver with appropriate circuitry for synchronizing the System with WWV; Digital Timing Generators providing timing signals that can be recorded on magnetic tape, oscillographs, plotting boards, phototheodolites, etc.; and line driving equipments for time distribution.

The Hermes System is at present being used for range time generation at some of the country's major missile test ranges.

Write for Range Timing Bulletin PTS

FEATURES

- **TIME BASE FREQUENCY STABILITY** 5 parts in 10^{10} per day (max. drift of 22 μ sec.)
- **SYNCHRONIZATION** to WWV with transmission propagation compensation
- **TIME CODE FORMAT** Choice of any of the major time codes such as AFMTC, AFFTC, NOMTC, and others
- **OUTPUTS PROVIDED** for recording time on tape recorders, oscillographs, plotting boards, phototheodolites, etc.
- **TIME** is displayed in hours, minutes, and seconds through use of horizontally mounted Arabic indicators.
- **SINE WAVE FREQUENCIES** available at 1000 Kc, 100 Kc, 10 Kc, and 1 Kc, and pulse rates of 1000 pps, 100 pps, 10 pps, 1 pps, and 1 pp 15 sec.

WESCON SHOW
Booth Nos.
2821 and 2823

The new name for HYCON EASTERN, INC. is
Hermes Electronics Co.
75 Cambridge Parkway • Dept. W • Cambridge 42, Massachusetts

AVIATION CALENDAR

(Continued from page 5)

- Sept. 14-15—Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Society of Automotive Engineers, Milwaukee Arena, Milwaukee, Wis.
- Sept. 14-16—14th Midwest Quality Control Conference, American Society for Quality Control, Sheraton Hotel, French Lick, Ind.
- Sept. 16-17—Western Regional Meeting on Frontiers of Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.
- Sept. 17-18—Conference on Effects of Nuclear Radiation on Semiconductors, Western Union Auditorium, New York, N. Y. Sponsor: Army Signal Corps.
- Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago, Amphitheater, Chicago, Ill.
- Sept. 21-22—Conference on Planning and Designing of Urban Helicopter Facilities, Institute of Aeronautical Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.
- Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.
- Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.
- Sept. 28-30—1959 National Symposium on Telemetry, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers' Professional Group on Space Electronics & Telemetry.
- Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.
- Oct. 5-7—Seventh Anglo-American Aeronautics Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y.
- Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.
- Oct. 6-8—12th Annual Meeting, National Business Aircraft Assn., Hotel Leamington, Minneapolis, Minn.
- Oct. 6-9—International Symposium on High-Temperature Technology, Asilomar Conference Grounds, Monterey Peninsula, Calif. Sponsor: Stanford Research Institute.
- Oct. 7-8—Second Advanced Propulsion Systems Symposium, New England Mutual Hall, Boston, Mass. Sponsors: Air Force Office of Scientific Research; Avco-Everett Research Laboratory.
- Oct. 7-10—Fourth Annual National Meeting, Air Traffic Control Assn., Biltmore Hotel, Oklahoma City, Okla.
- Oct. 8-10—Society of Experimental Test Pilots' Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif. Third Annual Awards Banquet, Oct. 10.
- Oct. 12-14—15th National Electronics Conference, Hotel Sherman, Chicago, Ill.
- Oct. 12-16—15th Annual General Meeting of the International Air Transport Assn., Imperial Hotel, Tokyo, Japan.
- Oct. 14-23—"William Tell II," Seventh World-Wide Interceptor Weapons Meet, Tyndall AFB, Panama City, Fla. Host: Air Defense Command.



Crosley Radar And America's defense

Soon the latest in ground radar from Crosley will stand watch along the distant approaches to the North American continent. Since 1955 Crosley's radar engineers have been at work—designing, perfecting, improving this important new radar unit.

Now the FPS-26 ground radar is ready for production, and Avco's Crosley Division has been named prime contractor by the U. S. Air Force.

The huge radar—so new that it is still classified—will be housed in a radome more than 50 feet in diameter. It will be mounted atop a reinforced concrete tower more than 70 feet high and will consist of more than 300,000 parts, including some 3500 tubes and diodes.

Handling the design and production of complex, challenging radars is "old hat" to Crosley, prime contractor of the famous MPS-16 height finder radar now widely used by the armed forces. Similarly, Crosley now is prime contractor to the Air Force for the radar-directed fire control system that puts a 50-caliber "stinger" in the tail of the B-52 bomber.

Radar is just one example of Crosley know-how in both engineering and production—*designing* the best possible performance into the product . . . *producing* it on schedule, and at a reasonable cost.

Today Crosley is recognized as a leader, not only in radar, but in communications, marine electronics, electronic ground support, infrared, fire control systems, air traffic control, ordnance and missile arming and fuzing.

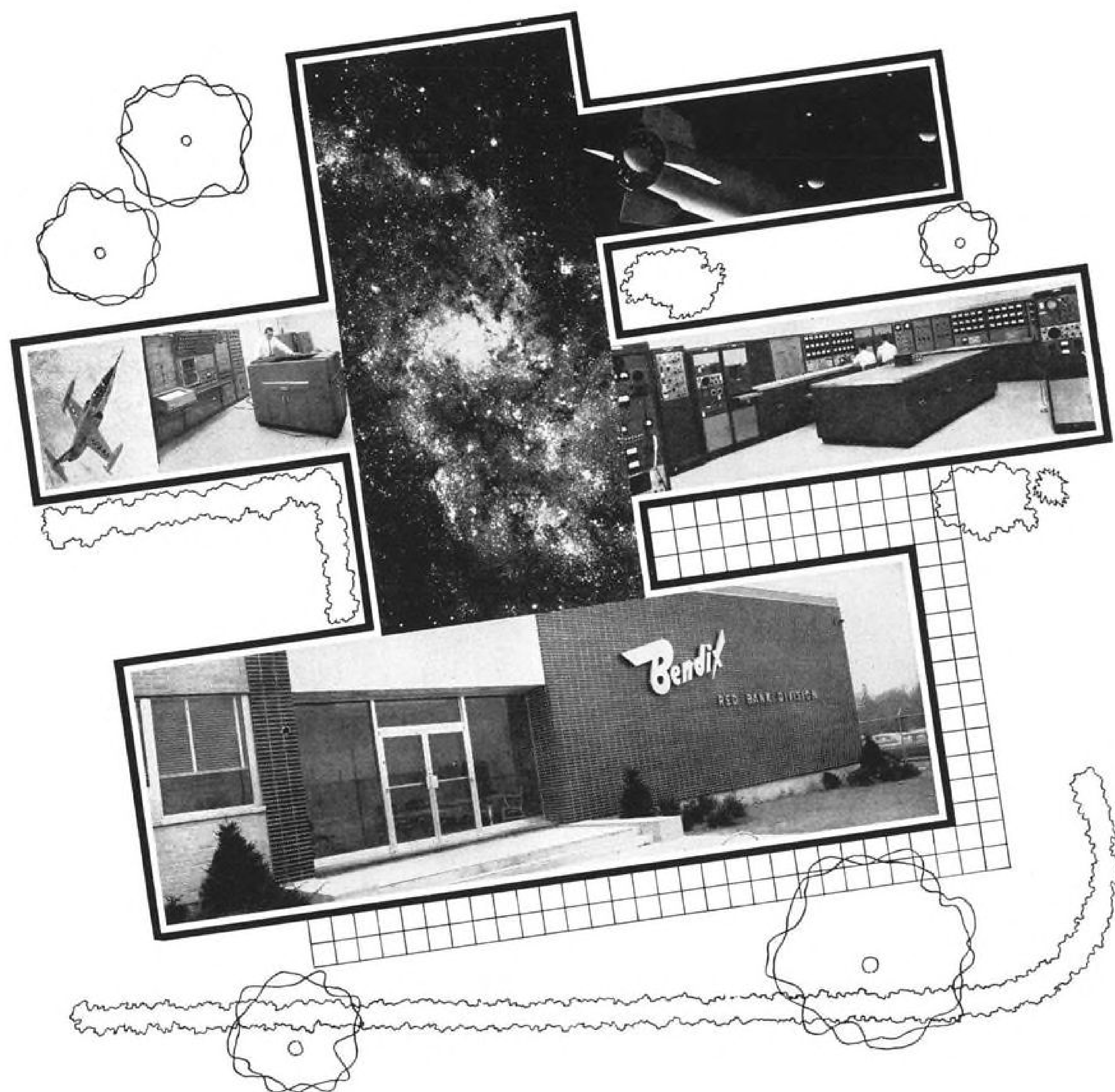
For more information, write to: Vice President, Marketing-Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

ENGINEERS:

Creative research and development engineers experienced in electronics, mechanics, weapons systems, and ordnance warheads are urged to investigate the wide range of opportunity at Crosley. Write to: Director—Technical and Scientific Personnel, Dept. W-89 E, Avco/Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco // **Crosley**





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ment conducive to imaginative, creative thinking.

Bendix Red Bank's rapid growth since 1941 from a small maker of electrical devices to its present role as producer of a multitude of complex electrical and electronic systems is your added assurance that advanced engineering is a built-in Red Bank feature.

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Ryan has built every production rocket motor for America's first operational guided missile — the Army's Corporal — for over five years.

It takes tremendous power to boost the 10-ton Corporal to Mach 3 flight speeds... to drop its atomic blast on a target 100 miles away. And this power must be controlled with pinpoint precision.

Ryan achieves this fine precision by forming, welding, and machining Corporal rocket motors to laboratory-like tolerances. Ryan has over twenty years' experience in this exacting type of work, which merges

high-temperature metallurgy with manufacturing skills.

Designed by the Cal-Tech Jet Propulsion Laboratories, the Corporal motor is built by Ryan for the Firestone Tire and Rubber Company, prime contractors for the Corporal missile.

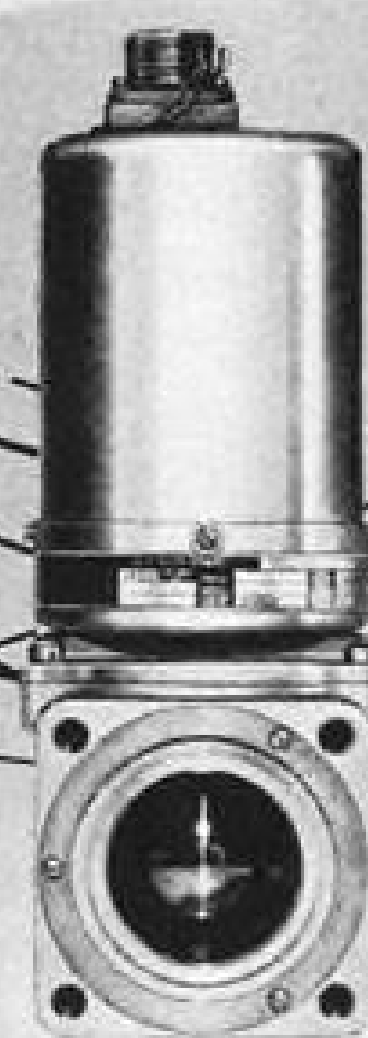
The Army relies on the Corporal's rocket motors for unerring performance—shot after shot. America's aircraft, engine, and missile manufacturers can rely on Ryan, too—for building complete propulsion systems... for building single components for rocket motors, ramjets, or turbojet engines.

RYAN BUILDS BETTER

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Ryan Aeronautical Company, San Diego, Calif.

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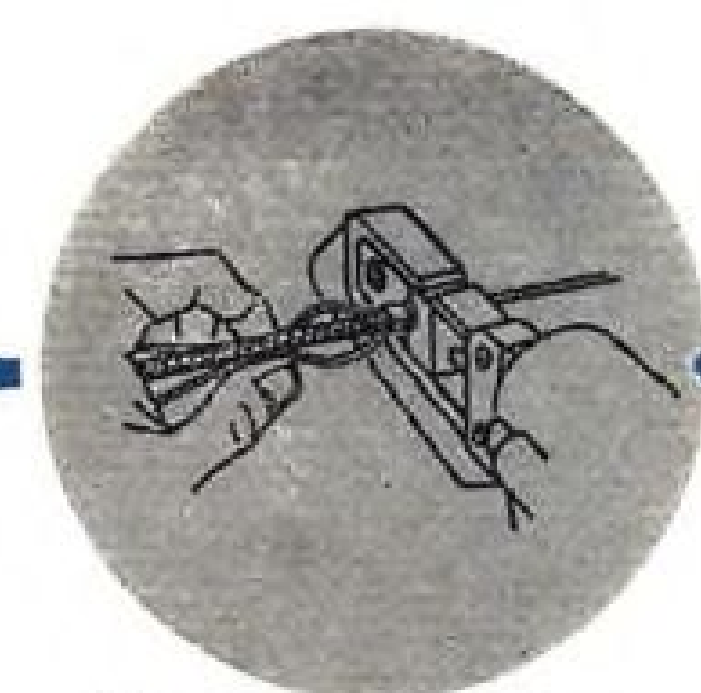
WHEN IT COMES TO SHIELDED WIRE



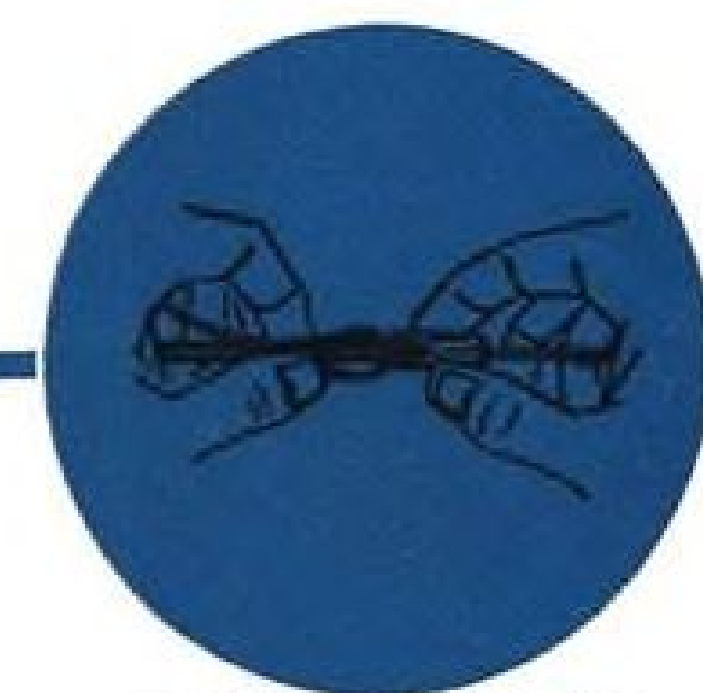
SLIDE
on the ferrule



SLIP
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SNAP
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PRESTO!

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How's that for speed! And the post-insulation of the Termashield Shielded Wire Ferrule is easily and quickly accomplished . . . you eliminate close tolerance cable stripping required by other techniques . . . you eliminate blind probing of taps into other type ferrules . . . you eliminate solder and burnt cable . . . you eliminate lost time . . . you eliminate doubt.

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Prints are so inexpensive that engineers are urged to discard them rather than re-file them. Costs are cut dramatically, and savings from \$20,000 to \$100,000 a year are being reported.

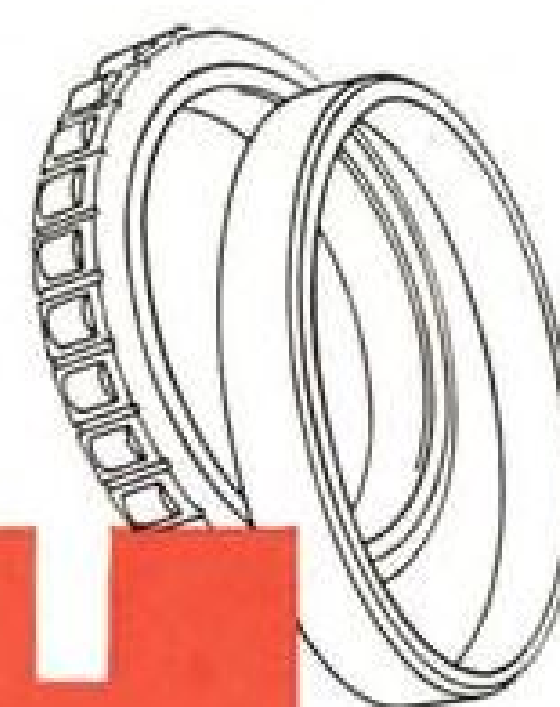
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REAL TIME..
UNIVERSAL BASIS FOR
DATA CORRELATION

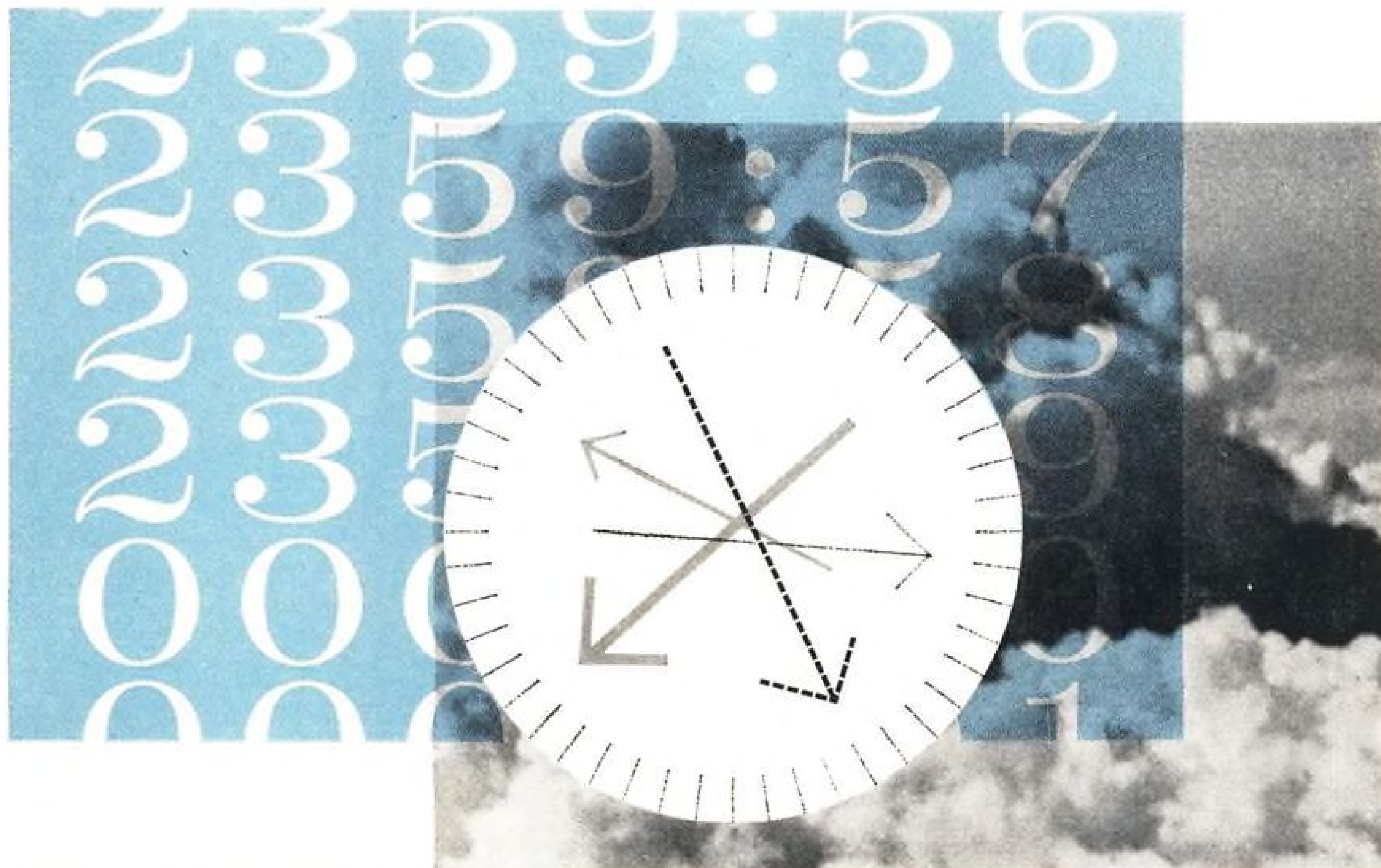
DIGITAL TIMING SYSTEM

Temco's Digital Timing System is a compact, accurate, airborne device capable of generating real time information for visual display at up to 21 remote indicators, for magnetic tape and graphic recordings, and as a source of coded digital time for master time transmission.

The system will automatically synchronize to a transmitted master time signal and correct for propagation delay time, insuring exact time event relationship of all remote systems. The additional capability to decode a recorded or transmitted signal makes the system complete in itself.

One of Temco's many proprietary products, the Model G-1033 Digital Timing System was developed and manufactured by Temco's Overhaul and Aerosystems Division assisted by Temco Electronics and is now in use on classified military programs.

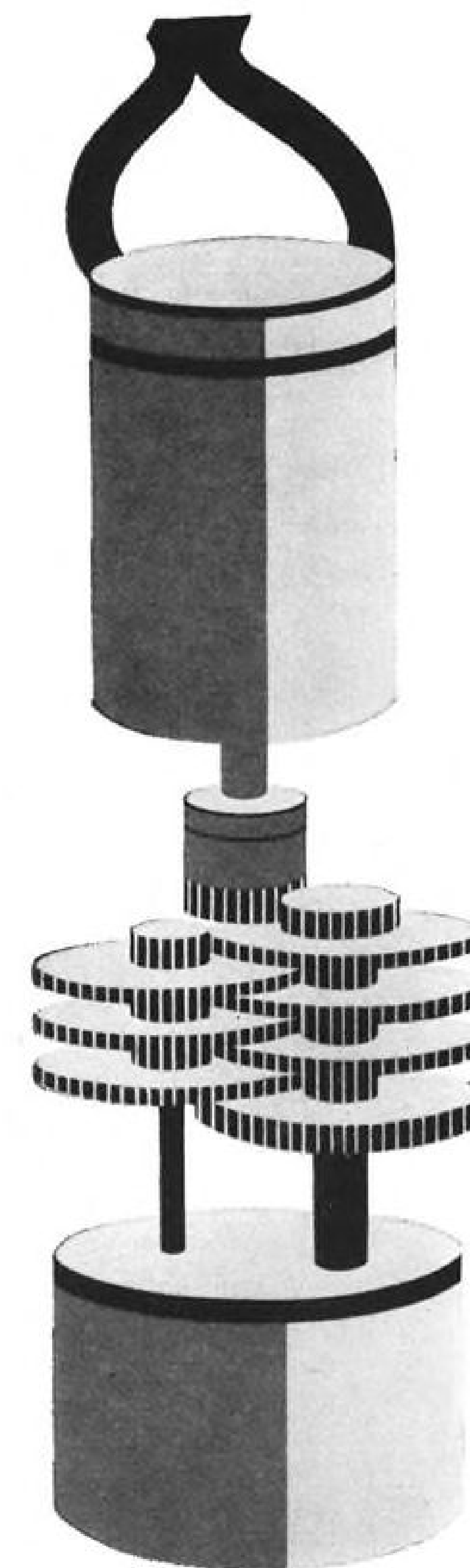
Many excellent engineering and scientific positions are now open in this and other Temco programs. We invite your inquiry.



TEMCO

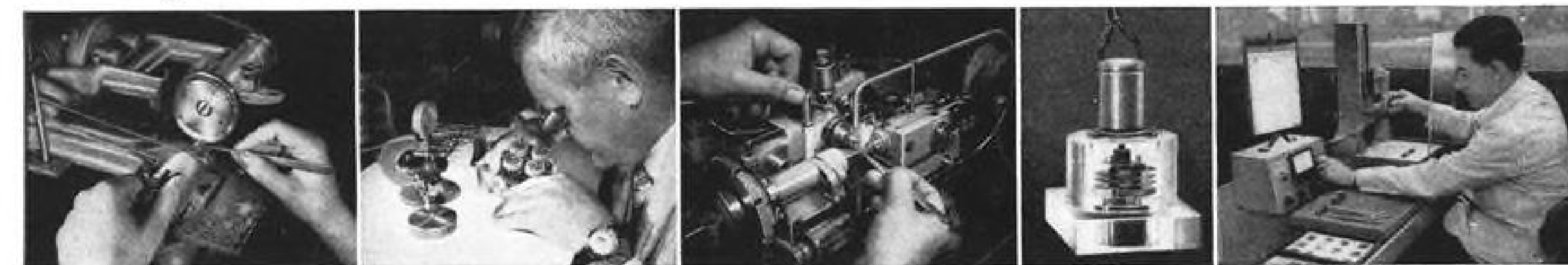
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gear reduction
within
one cubic inch...
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Experience in precision design and precision manufacture is the Bulova tradition, the Bulova capability. It has been for over 80 years. For more information write—
Industrial & Defense Sales, Bulova, 62-10 Woodside Ave., Woodside 77, N.Y.



ROLLER GUIDANCE— VITAL FACTOR IN BEARING LIFE

Roller guidance has been established by the Anti-Friction Bearing Manufacturers Association as a major rating factor for roller bearings. There is a direct relationship between this factor and the life and capacity of a cylindrical roller bearing under load.

Figure 1 illustrates the results of a loose fit between a roller and the guiding ribs of the raceway. Because of lack of guidance by the ribs, the roller is free to skew and skid under load. Such a condition invariably leads to early bearing failure.

To achieve close roller fit and proper roller guidance, Bower precision grinds each bearing race on specially designed centerless grinders. In this operation, Bower positions the integral raceway ribs from the theoretical centerline of the bearing. This method produces bearings with high dimensional accuracy and perfect symmetry.

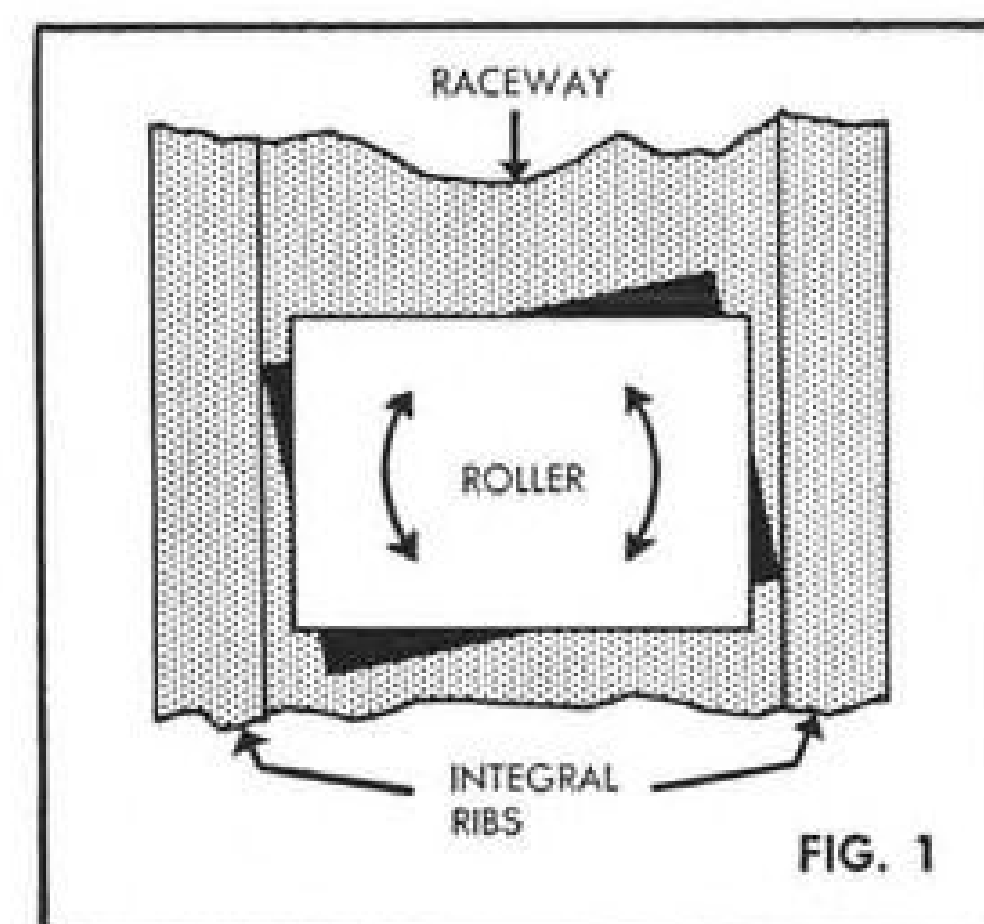


Fig. 1. Loose fit in raceway means poor roller guidance. Roller can skew and skid under load.

In addition, the close tolerances held in grinding the roller track and integral guiding ribs give Bower cylindrical roller bearings the ability to take thrust in any direction. A Bower cylindrical roller bearing has thrust capacity of

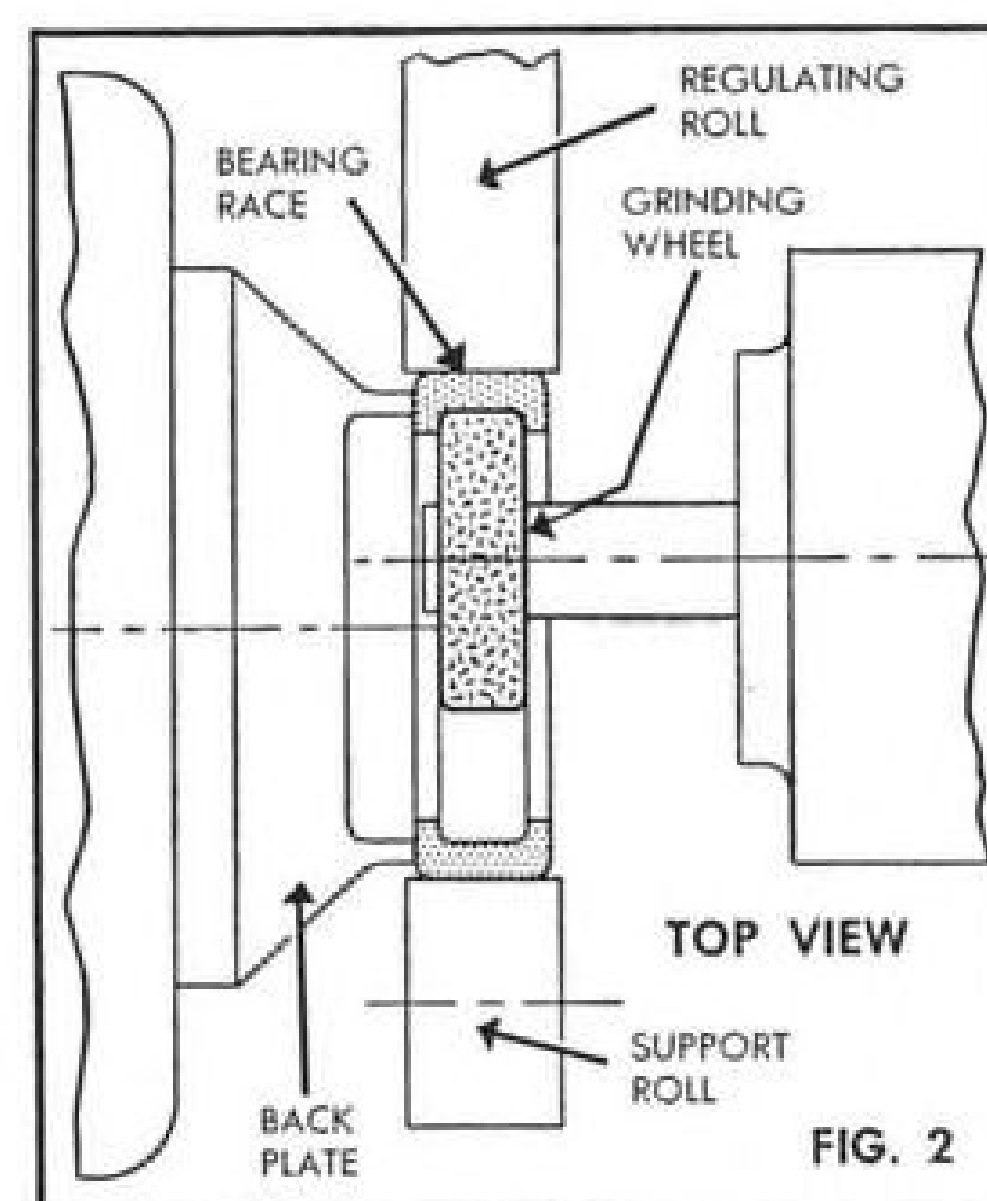


FIG. 2

CATION REGARDLESS OF HOW THE OUTER RACE AND ROLLER ASSEMBLY ARE INSTALLED. IT COMPLETELY ELIMINATES THE POSSIBILITY OF IMPROPER INSTALLATION.

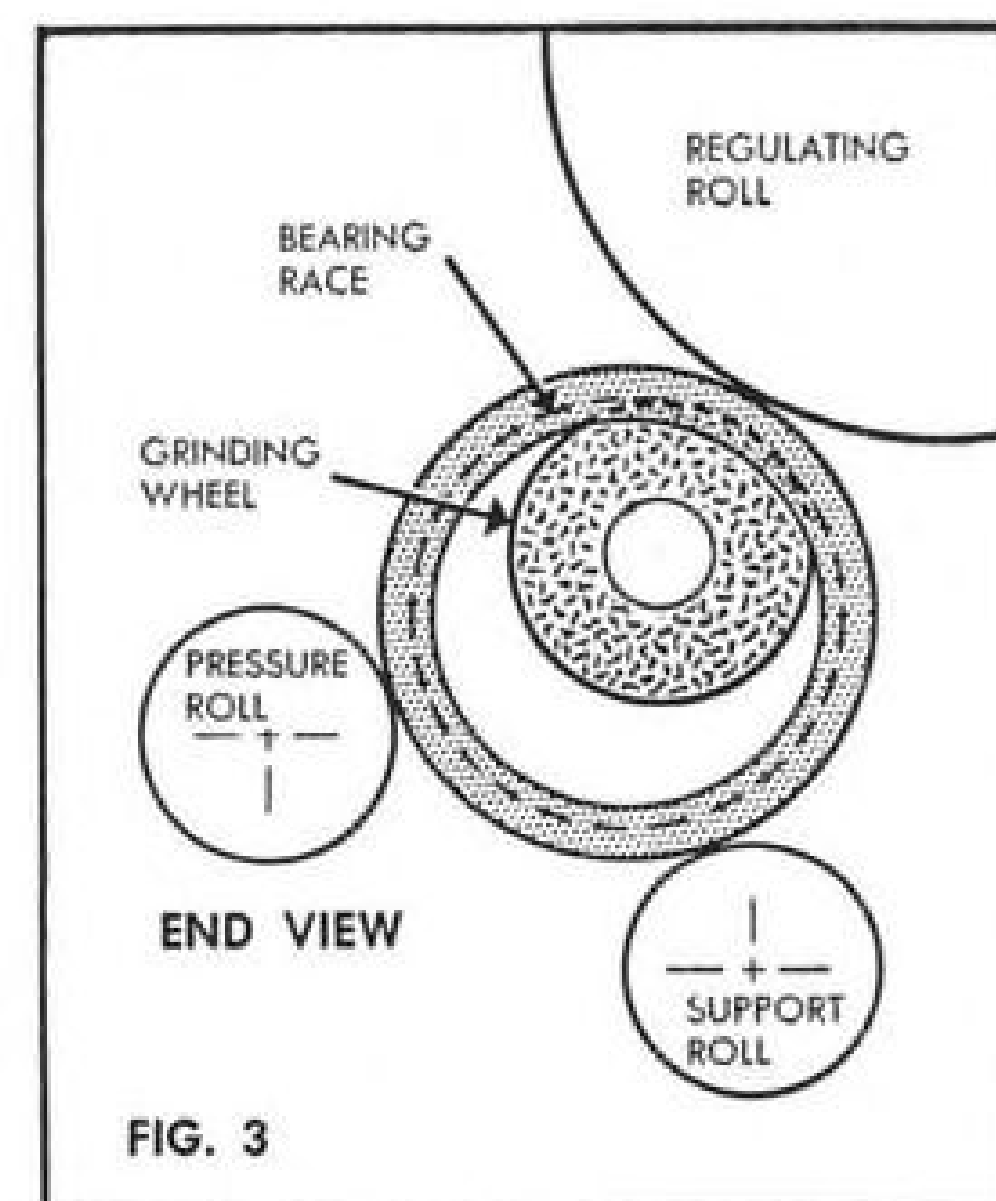


FIG. 3

from 10-15% of its rated radial capacity!

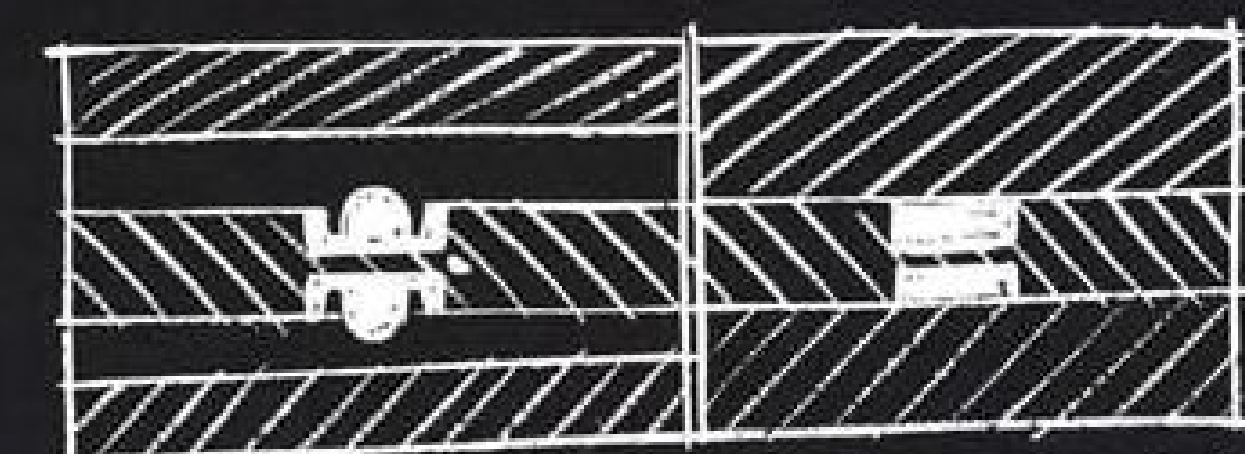
Figures 2 and 3 diagram the centerless grinding method used to finish Bower raceways. Use of this technique assures not only optimum roller guidance and maximum bearing life, but also virtually eliminates bearing runout. BEARING SYMMETRY WHICH RESULTS FROM THIS TECHNIQUE PERMITS ACCURATE SHAFT LO-

★ ★ ★ ★
Whatever your bearing needs, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

LEAKS CAN BE STOPPED!



BEFORE FASTENING AFTER FASTENING

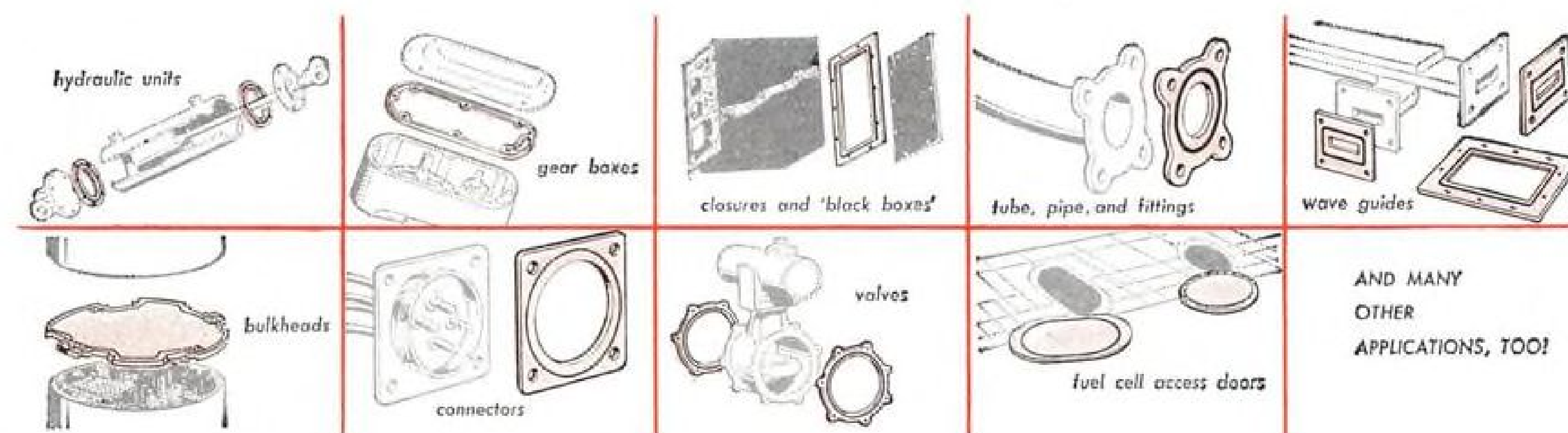
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COVER—Pan American World Airways Boeing 707-120 Clipper Tradewind taxis past Aeroflot's 170-220-passenger Tupolev Tu-114 while the latter was running up its 12,000-shp.-plus Kuznetsov turboprop engines during its visit to New York International Airport (AW July 6, p. 38). PanAm and the Soviet airline, Aeroflot, would cross the Atlantic from New York to Moscow under a reciprocal agreement still pending. For further details of the Tu-114, see pp. 50-51.

PICTURE CREDITS

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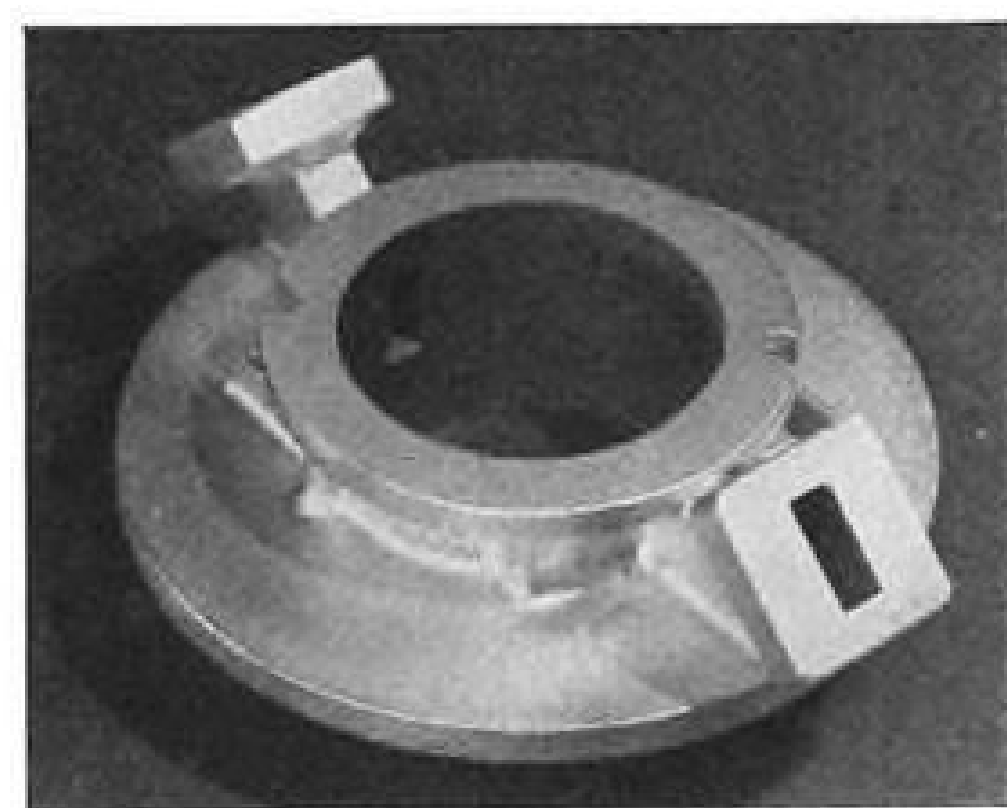
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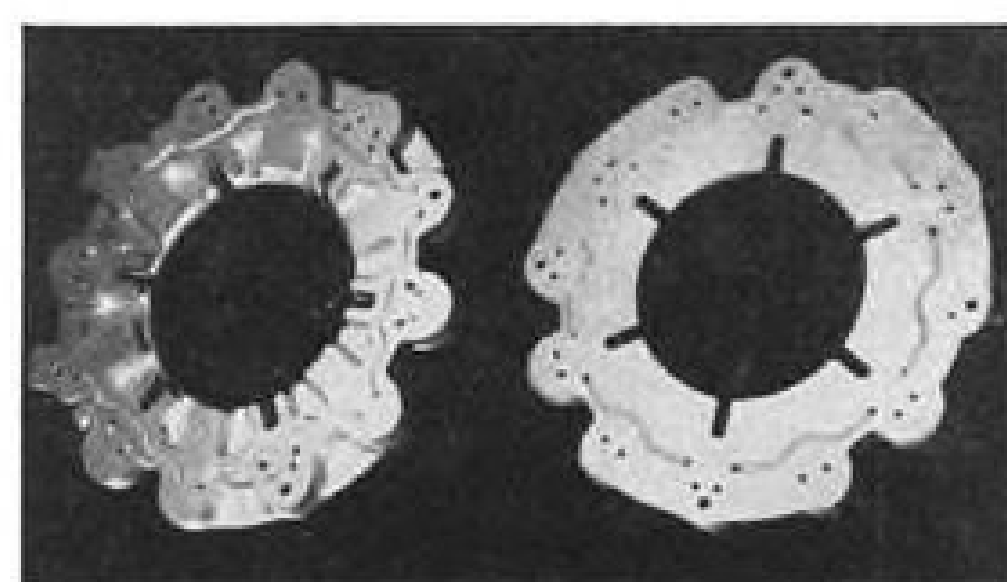
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EDITORIAL

Defense Trends

The passage by Congress of the Fiscal 1960 Defense Department appropriation bill provides some interesting clues to the trend of the defense business over the next three to five years if present policies continue.

Signing of the Fiscal 1960 appropriation bill into law by President Eisenhower will touch off a series of announcements from the Pentagon canceling and cutting back major weapons development and procurement programs. As is usual in such cases, the official excuse will be that these slashed programs are "marginal" and that it is "unwise and uneconomical" to continue them in view of the new super weapons that are just around the research and development corner.

In fact, the military usefulness of these weapons will have little to do with these actions. They are dictated solely by budget considerations that are getting tighter and tighter each year while both the Congress and executive branch of the government fail to face up to the genuine problems of providing a technologically modern and militarily superior defense program.

A further indication that the fixation with a constant-level defense budget in the face of rapidly expanding problems is the key to our defense program is found in Defense Secretary McElroy's frank admission that the Fiscal 1961 budget will require a 10% across-the-board cut in all weapons development and production programs. This 10% across-the-board cut for Fiscal 1961 piled on top of the major cuts already required by the Fiscal 1960 budget cannot help but result in a greatly reduced defense capability in the critical decade of the 1960s.

The dilemma in which the Pentagon now finds itself with a constantly decreasing defense capability (this is what the slogan of a constant-level defense budget really means) in the face of a constantly increasing challenge from the Soviet Union is a result of the failure of military and civilian defense leaders, the Congress and the President to really tackle and solve the complex technical, fiscal, and organizational problems involved in forging a truly effective modern defense capability.

Basic fault lies with the military hierarchy that has constantly placed its individual service welfare above the over-all considerations of an effective national defense.

The inability of military leaders to make decisions and settle vital matters of military policy within the framework of the Joint Chiefs of Staff has resulted in the imposition of a superstructure of civilian "experts."

These "experts" were given the job of making the decisions the military dodged and of revamping the obsolete land, sea and air structure of the defense organization. This superstructure of civilian bureaucracy erected on top of the military politicians has also failed signally in making any effective progress. It has simply added another tangle of red tape to Pentagon processes. And by its failure to make decisions, it has opened the door for the bookkeepers of the Budget Bureau to make vital military decisions based solely on fiscal considerations. The Jupiter-Thor parallel production programs, the Nike-Bomarc row in which Mr. McElroy frankly admitted the Pentagon could make no decision and invited Congress

to "hold our feet to the fire," provides specific examples of how this lack of military decision wastes money without providing any real increase in defense capability.

In view of this situation, which has grown steadily worse during the past five years, it is small wonder that Congress has been drawn into the vacuum created by the Pentagon's indecision and is now attempting to play the role originally cast for the Joint Chiefs of Staff and the Secretary of Defense. We can hardly blame Congress for attempting to bring some order out of the defense chaos. But its efforts during the current session indicate clearly the ludicrous and contradictory decisions that emerge from this activity.

The Nike-Bomarc controversy provided the ultimate absurdity when a House group recommended cancellation of the Bomarc and expansion of the Nike program, while a Senate group studying the same problem branded the Nike system "militarily obsolete" and recommended expansion of the Bomarc program. Clearly not much progress will result from this type of activity.

The result of this drifting, indecisive trend where only the Budget Bureau bookkeepers will make decisions has sharpened interservice rivalry to an intensity almost beyond reason; has left the top-level civilians in the Defense Department submerged in a welter of confusion and misinformation, and has turned most of the members of Congress into military "experts" second guessing the Joint Chiefs of Staff. All of this means that we are getting precious little in genuine defense capability from the close to \$40 billion we are pouring annually into the Pentagon hopper.

The pitifully small forces we were able to move to meet the twin crises in Lebanon and Formosa last year provide a measure of this sad situation. While defenders of the military budget have cited these efforts as proof of our effective defense capability, it is interesting to note that they have not discouraged the Communists from attempting similar efforts, including the brush fire now burning in Laos.

More money is certainly not the sole answer to our future defense problem. We need to make more effective use of the billions already provided before valid claims can be made for more.

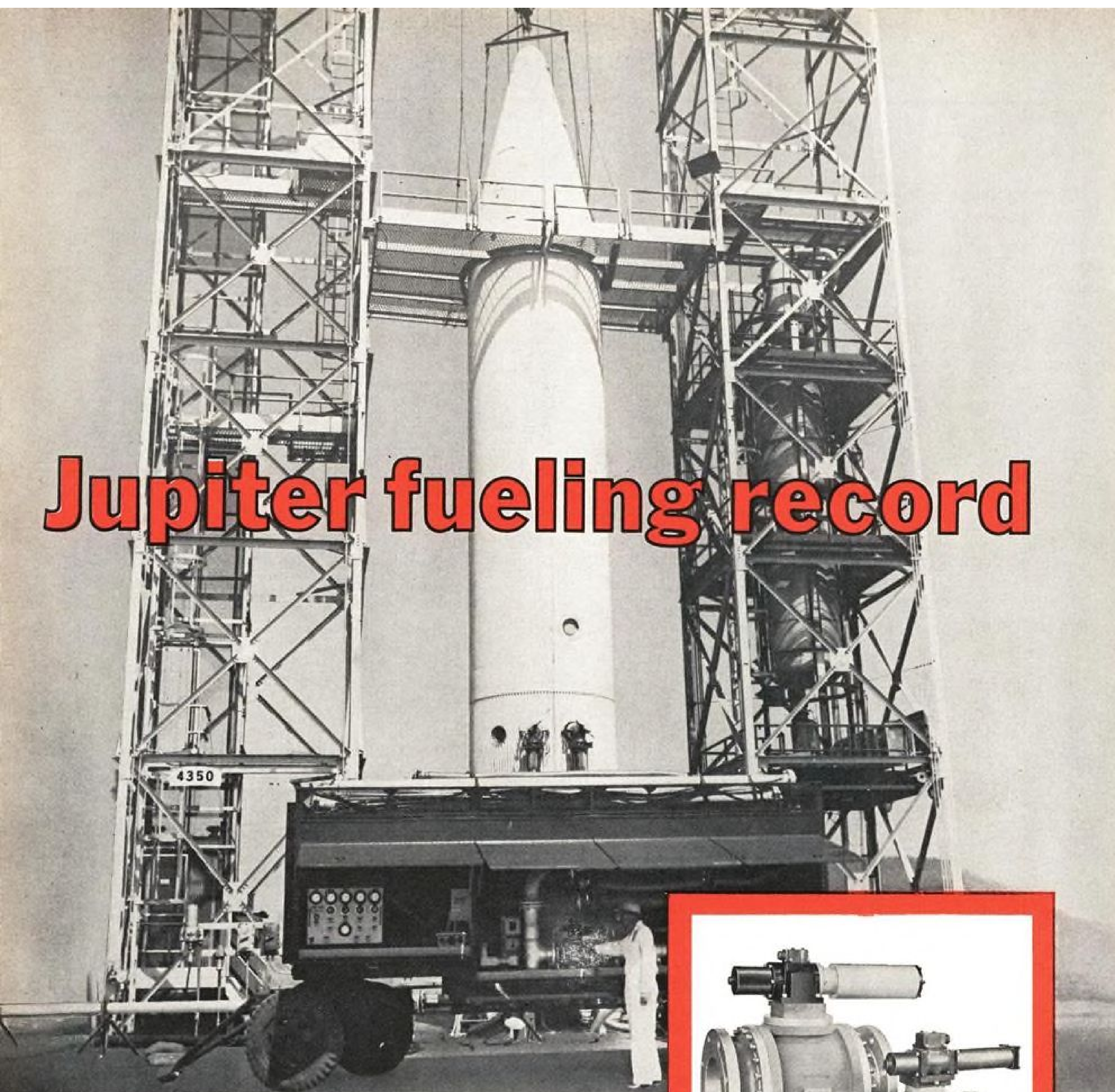
What we need even more is development of a technically and politically modern defense strategy and a defense organization that effectively integrates all elements of the three services into this strategy rather than attempting to equip each service to do the entire job by itself.

We also need a program to honestly inform the American public on the requirements of such a defense program in place of the manipulated half truths now emanating from the top level of the Pentagon in a futile effort to varnish over the expanding cracks in our defense structure.

We also need a determination that extends from the grass roots of our 50 states up into the White House and Congress that we can and will do whatever is necessary to preserve this country as a beacon of hope shining out over the dark seas of Communist oppression.

—Robert Hotz

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Charles A. Carroll, vice president and manager-aircraft sales, The Babb Co., Phoenix, Ariz.

Howard W. Helfert, Chief, International Field Service Division, Office of International Coordination, Federal Aviation Agency, Washington, D. C.

(Continued on p. 128)

INDUSTRY OBSERVER

► Project Transit, primary space program for which Navy has been given the go-ahead by Defense Department thus far, envisions placing a navigation satellite system into orbit by 1964-65. Boosters for the project will be purchased by the Navy as off-the-shelf items.

► Initial evaluation tests on Tactical Air Command's "portable overseas SAGE" air defense system will begin in the near future at Shaw AFB, N. C., using five radar sites located at air bases in North and South Carolina and in Georgia. The system, identified as 212-L, includes three types of search radar—a short-range low-altitude set; the AN/MPS-20 three-dimensional surveillance radar using an air-inflated antenna; the third a two-dimensional AN/TPS-22 extremely long-range set. Last two are produced by Westinghouse Electric. Tactical air control computers are supplied by Remington Rand. General Electric is responsible for systems integration plus design of data processing and display subsystems.

► Army recently met with four companies competing for its Mauler field air defense missile program to learn of any new ideas that had been developed since the original proposals were submitted in December. The often-postponed decision is now expected to be made within the next several weeks. Bidders include a Convair-Raytheon team, General Electric, Martin and Sperry Gyroscope Co.

► Navy, if it can find the money, is considering retrofitting the Douglas A4D attack bomber with the 7,500-lb.-thrust Pratt & Whitney J52 engine. Navy officials say installation of the J52 as a replacement for the present 7,200-lb.-thrust Wright J65 should provide substantial improvements in performance and reliability.

► Navy also may adopt the 8,000-9,000-lb.-thrust Pratt & Whitney JTF-10A-1 aft fan engine developed for Douglas' DC-9 short-range jet transport for use in the Grumman A2F "slow" plane designed to maintain a speed of Mach 9 at sea level. Original program called for use of the J52 turbojet in the twin-engine A2F. Under present planning, first production versions of the JTF-10A-1 are not scheduled before the summer of 1962.

► More than 100 of the nation's top civilian and military scientists completed a 10-day symposium last week on ballistic missile defense problems and possible solutions. Classified symposium was sponsored by Advanced Research Projects Agency.

► Last of the presently programed Nike Hercules anti-aircraft missile installations for the continental U. S. is scheduled to be in operation by mid-1960 according to present timetables.

► Navy hopes to fire the first sea-launched Polaris fleet ballistic missile from the USS Compass Island within the next four to six weeks.

► National Science Engineering Co., Pasadena, Calif., is conducting advanced analytical studies relating to the dynamic response of Navy's Polaris fleet ballistic missile system under subcontract to Lockheed's Missile and Space Division.

► North American Aviation and Boeing Airplane Co. are performing lunar observatory analyses for Air Force under Study Requirement 183, with contracts of approximately \$100,000 each.

► All Douglas Nike Ajax and Hercules anti-aircraft missile units scheduled for use by the Italian air force will have the primary mission of defending the Corporal missile sites of U. S. Army's Southern European Task Force in northern Italy (AW July 20, p. 31).

► Douglas Aircraft officials say the Nike Zeus system will have an anti-satellite capability in addition to its principal design function of destroying ballistic missiles.

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Washington Roundup

Radical ARDC Shuffle

Radical reorganization plan to regroup all Air Research and Development Command activities under four divisions—Ballistic Missile and Space, Aeronautical Systems, Electronic Control and Command and Research—was scheduled to be presented last week to Lt. Gen. Bernard A. Schriever, ARDC commander, for his approval. Under the plan, ARDC would establish a central headquarters for all of its electronic activities in the Boston area to direct and coordinate efforts of Cambridge Research Center's Electronics Directorate, the Rome Air Development Center, and most of the avionics equipment laboratories at Wright Air Development Center. Headquarters for Aeronautical Systems Division, responsible for manned aircraft and related weapons, would be located at Wright-Patterson AFB in Dayton. Ballistic Missile and Space Division headquarters probably would be located at Edwards AFB, although Holloman AFB is a contender. Research Division headquarters probably would be located in Washington. Weapon System and Electronic Support System Project Offices, now in Dayton, would function as part of the appropriate division, and they probably would move to Boston.

If approved, the plan, prepared by an ARDC group headed by Col. J. C. Maxwell, is expected to result in transfer of some avionics personnel from WADC and RADC to the new Boston division headquarters.

No Rush for ANP Changes

Apparently there is no hurry at top Defense Department levels to find a new management approach for the Aircraft Nuclear Propulsion program. Defense Secretary Neil McElroy has said there are some considerations of new approaches afoot, but that no proposals have reached him yet. As for a deadline on new management proposals, he said: "Well, I'd say that this isn't something that I am pressing for. I really don't have a time in mind."

ANP program director Maj. Gen. Donald Keirn is retiring, and this has been suggested as a good time to review ANP management technique and find a fresh approach. Air Force has appointed Brig. Gen. Irving L. Branch to replace Keirn in his USAF job, but Branch was not named to take Keirn's jobs as director of the Defense Department and Atomic Energy Commission ANP efforts (AW Aug. 10, p. 25).

Bomarc Base Study

Department of Defense is making a detailed study of the possibilities of locating Bomarc sites in Canada. House Appropriations Committee voted construction funds with this understanding. The money for sites in the northwestern part of the U.S. between the Great Lakes region and the Pacific Coast won't be used until the study is completed and prospects for the Canadian sites explored.

The committee commented that Defense Department's "master plan" of mixed Nike Hercules and Bomarc installations for air defense "is a major step in the right direction," but it is "by no means the final answer, it leaves much to be desired . . ."

Defense Secretary Neil McElroy was in Canada last week discussing North American air defense matters with Canadian Defense Minister George Pearkes. Discussions included the role of Bomarc, a matter of particular inter-

est since Canada has decided to rely on the Boeing interceptor missile in place of the canceled Avro CF-105 Arrow manned jet interceptor.

Mace Site Funds Deleted

In another area, the House last week took another action to discourage Air Force from buying any more tactical surface-to-surface Martin Mace missiles. It cut \$6.4 million for Mace facilities in Europe from Fiscal 1960 construction funds, which are now awaiting action by the Senate. Earlier, the House cut Mace procurement funds from the Fiscal 1960 Department of Defense budget. After a strong plea from Air Force, the Senate granted authority to transfer funds from other projects for Mace if the Secretary of Defense first certifies to the House and Senate Appropriations Committees that it is "essential." The House agreed to this Senate proposal.

Khrushchev's Military Sight-Seeing

Soviet Premier Nikita Khrushchev will be free to inspect a wide variety of major military installations when he visits the U.S. next month, but it will be up to him to decide whether he wants to visit military bases. Khrushchev has indicated he wants to avoid military installations to avoid giving his visit a warlike cast, but both President Eisenhower and Defense Secretary Neil McElroy think the Soviet premier ought to get a first-hand picture of the strength and competence of the U.S. military posture. Eisenhower said last week that Khrushchev will have a fairly wide choice in the character of installations open to him, and McElroy has suggested that Air Force Missile Test Center at Cape Canaveral and a Strategic Air Command base are the types of installations he might see.

McElroy's press conference statement that Khrushchev might be admitted to installations seen by the press but not open to the American public inspired Assistant Secretary of Defense for Public Affairs Murray Snyder to insist on a clarification. McElroy said that Snyder "feels that when I said that we would show him (Khrushchev) things which the average American citizen is not allowed to see, he thinks that I should follow that with a statement that we would not violate any law in doing so and the things that you people in the press have seen are things which the average citizen is not allowed to see, but that there also we are careful to abide by the law in the way we extend this privilege to you. . . . I am not wholly sure why that is required, but I abide by my expert advice."

Petty Resigns

George R. Petty, Jr. resigned unexpectedly last week as president of the Flight Engineers International Assn., with FEIA executive vice president Ronald Brown taking over until the vacancy can be filled at a union election scheduled for this spring. Petty resigned for "personal reasons," according to an FEIA spokesman. His resignation, however preceded a planned meeting between FEIA and the AFL-CIO to discuss the engineers' connections with the Teamsters union. While FEIA has accepted aid from the Teamsters, Petty has been opposed to any membership move to affiliate with the union headed by James Hoffa.

—Washington staff

Air Force, Navy Face Procurement Cuts

Tight Fiscal 1961 budget ceilings force reviews of weapon programs; boron fuels are early casualties.

Washington—Sharp cuts in Air Force and Navy procurement programs are now being pushed through as a result of an Administration decision to hold Fiscal 1961 defense spending at present levels plus the spiraling cost of advanced weapon systems.

Some cuts already have been ordered; others will be made within the next 60 days as the Fiscal 1961 budgets of the two services become relatively firm. Army also probably will feel the cut to some degree, but the over-all effect will be relatively light.

Denied an increase in Fiscal 1961 spending above the approximately \$40-billion defense budget authorized for Fiscal 1960, both Air Force and Navy are now conducting a project-by-project survey of weapon systems in their inventory, trimming programs already approved for Fiscal 1960 in an effort to make additional funds available for top-priority projects.

Air Force already has ordered a halt to the development of the high energy fuels and the General Electric J93-5 chemical engine planned for the North American B-70 Mach 3 bomber, and cut the Fiscal 1960 procurement program for Convair's B-58 Mach 2 bomber from 40 to 32. Over-all, the Air Force has trimmed its plans for the B-58 from five wings to three, with each wing having a total of 36 aircraft instead of the 45 originally programmed.

Other tentative steps planned by the Air Force include:

- **Trimming its Fiscal 1960 procurement program** for the Boeing B-52H intercontinental bomber from the 70 authorized to 60.
- **Diverting development funds** planned for a new early warning and control aircraft to other channels.
- **Sharply curtailing its buying program** for the McDonnell Quail electronic countermeasures missile planned for the B-52.

Specific Navy cuts are now being thrashed out in the Office of the Chief of Naval Operations, with the final decisions scheduled to be made by the end of the month.

The cutbacks by both Air Force and Navy, however, will go much deeper than trimming numbers from authorized procurement programs. One Pentagon spokesman said last week that "we've all slashed horizontally as much as we can. Now there are going to have to be vertical cuts . . . we're just going to have to have fewer programs." (For another view on cutbacks see p. 29.)

Defense Secretary Neil McElroy, in announcing the Administration decision to hold Fiscal 1961 spending to the Fiscal 1960 level, said the decisions now

under consideration are "major decisions, like certain aircraft programs, certain missile programs. . . ."

He added that "just as last year, when we came up to the making of a budget, you can't say that you are going to lop off one or two aircraft and solve the kind of problem we are up against. We are up against the justification of programs, and if they are marginal, they probably are going to have to disappear."

McElroy also stated flatly that "I think we pretty near have got to find a way to keep our rate of spending from advancing." He added, however, that he saw little chance that "we can really reduce our spending."

Latest Casualties

High energy boron aircraft fuels, the latest casualties of tightened defense spending, have been dropped back into the development laboratories by last week's Air Force and Navy cancellation of production plans.

Cancellation of the boron fuel program followed quickly upon the Air Force's decision to drop development of the General Electric J93-5 jet engine. Designed to burn conventional jet fuel, probably JP-6 in the turbojet section, the J93-5 was to use the higher energy boron fuel in the afterburner, primarily to extend operating range.

In total, these canceled fuel programs represent a government investment of more than \$150 million. To date, the Air Force has spent \$55 million on the development of boron-derived fuels, \$45 million on the construction of a production plant at Model City, N. Y.

XGAM-87A Engine

Aerojet-General Corp. will be propulsion subcontractor to Douglas Aircraft Co. on development of the air-launched ballistic missile, designated XGAM-87A. Aerojet-General was given the contract for early research and development work on the solid propellant engine propulsion system after being approved by a USAF source selection board.

and \$10 million on the development of the J93-5. The Navy has spent \$38 million on the construction of a production plant at Muskogee, Okla., and additional millions on boron fuel development, including a large pilot plant.

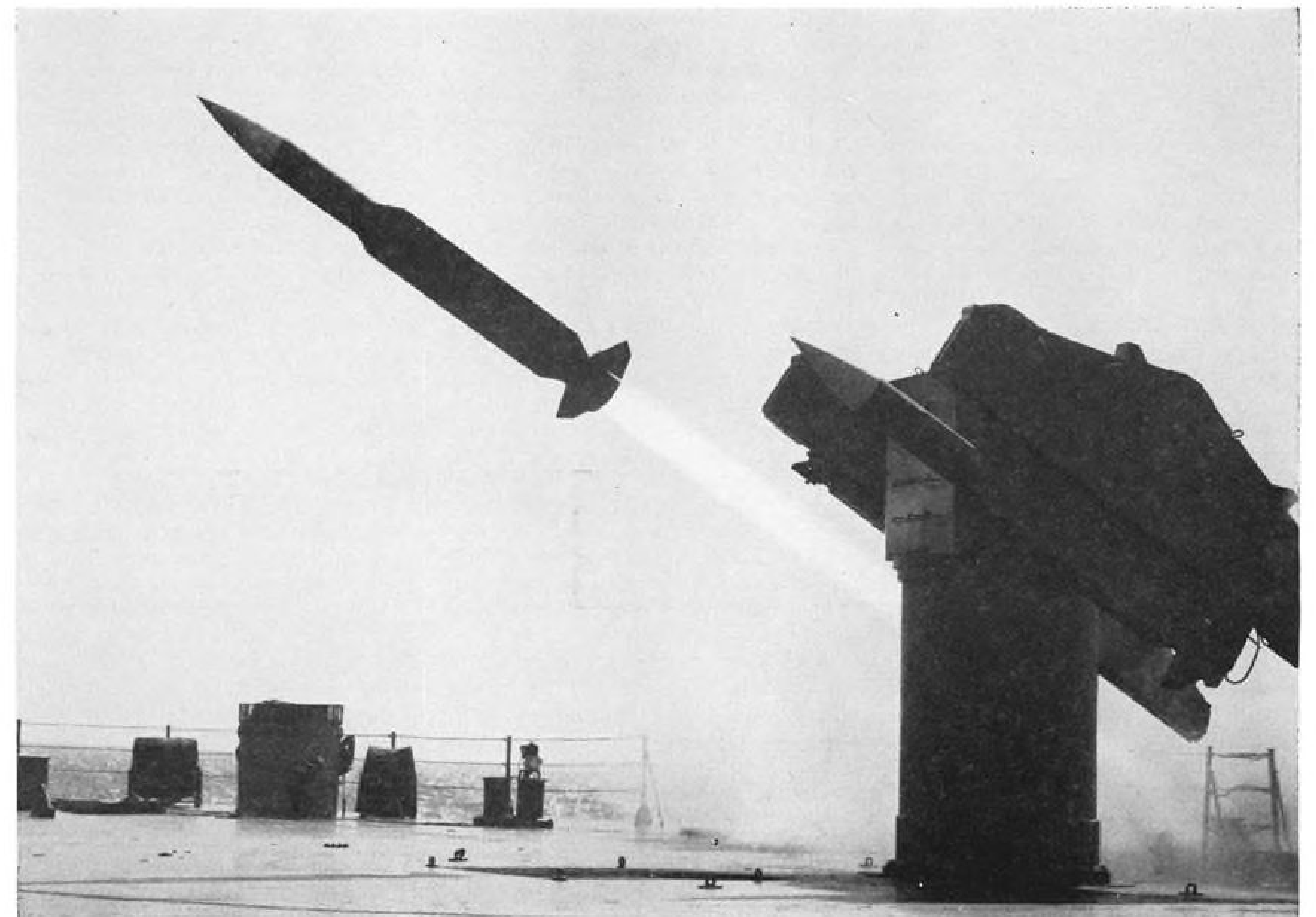
While the Air Force decisions are reviving speculations about the future of both the J93 and B-70 programs, as well as on the future of advanced military manned aircraft in general, the J93 and B-70, along with North American's Mach 3 F-108 fighter, are still active programs at present. New plans call for the B-70 to use the J93-3 engine which General Electric was developing in parallel with the J93-5. Designed primarily for the F-108, the J93-3 will use hydrocarbon fuels throughout, possibly some of the newer and more powerful hydrocarbon fuels now under evaluation by Wright Air Development Center (AW Aug. 10, p. 27).

Also, the boron compounds are not to be dismissed completely just yet as possible high energy fuels for future aircraft and missiles. Original orders for the cancellation of production plans specified that research and development efforts on the boron fuels are to remain active. In addition to the Air Force and Navy, National Aeronautics and Space Administration and Advanced Research Projects Agency are reported to be sponsoring research and development work on the boron fuels (including the efforts now under way to develop a solid boron-base propellant for missiles).

The production stop order, which is believed to have originated with the Department of Defense rather than with any individual military service, caught most Air Force, Navy and industrial groups involved in the program by surprise. All current indications are that the decision was based primarily on economic considerations, rather than technical ones.

As a liquid fuel, the boron derivatives offer a potential heat content of approximately 27,000 Btu./lb. compared with roughly 18,500 Btu./lb. for the JP-4 and JP-6 type hydrocarbon fuels. It was discovered early, however, that upon combustion in a jet engine, the boron-based fuels formed a boric oxide sludge on turbine elements, such as rotors and stators, that virtually precluded their use in the turbojet portion of the engine. The sludge also was deposited on afterburner walls, significantly lowering its efficiency.

But scientists believed they could defeat the afterburner problems of the boranes. And last February, President Eisenhower, in his report to Congress on the work of NASA, disclosed that a



First Photo Shows Navy Tartar Launch

First photo shows Tartar supersonic surface-to-air guided missile being launched from USS Norton Sound, a guided missile ship, off the Pacific Coast. Missile's configuration is similar to that of the second stage of Navy's advanced version of the Convair Terrier (AW July 20, p. 79). Tartar is about 15 ft. long and about 1 ft. in diameter. Missile, produced for Navy Bureau of Ordnance by Convair (Pomona) Division of General Dynamics Corp., will be primary anti-aircraft weapon on destroyers. Aerojet-General dual-thrust solid-fuel rocket generates high thrust during launch phase. Lower-thrust, longer duration burning period sustains the weapon until it reaches the target.

new afterburner had been designed and tested which was found to be "appreciably freer of the boron-oxide deposit problem than earlier versions." Plans to put the liquid boron fuels into large-scale production moved ahead. As late as last May, the Air Materiel Command's Aeronautical Systems Center at Wright-Patterson AFB was studying the matter of expanding the production facilities then under construction, in light of the large demand anticipated for the boron-based fuels in 1965.

Suddenness of Cancellation

The suddenness of the cancellation order caught the Aeronautical Systems Center off guard. Apparently, from what could be learned, USAF headquarters did not consult with either Air Materiel Command or Air Research and Development Command prior to making its cancellation decision and announcement. As a result, actual shutdown plans and procedures are still in a state of flux.

At the end of last week, however, here is what had already transpired and

what was expected to take place in the near future:

- **Defense Department** awarded a contract for a study of the entire boron fuel situation to Arthur D. Little, Inc., which was already surveying this field for the Air Force (AW July 13, p. 23).
- **Headquarters USAF** last week notified Congress that it had canceled its contract with General Electric for the development of the J93-5 engine. Following this came word that it had dropped its plans to process the boron-based HEF-3 high energy fuel at its new \$45 million plant in Model City, which was to be operated by Olin Mathieson Chemical Corp. The Air Force made both moves apparently without waiting for the results of the A. D. Little survey. Neither the Air Force nor the Department of Defense boron fuel study has been finished according to an A. D. Little spokesman.
- **Defense Department** announced the next day the cancellation of the Navy's plans to produce boron fuels at its new \$38 million plant in Muskogee, Okla., which was to be run by Callery Chemi-

cal Co. (Actually, the Navy was reported to be on its way out of the boron fuel work long before last week's developments. It is believed that Navy Bureau of Aeronautics' original requirement for a high energy fueled aircraft became an economy casualty in last year's budget.) Up until last week, the Navy had been pressing the Air Force to take over the Muskogee operation. The Air Force was already receiving and paying for about 80% of the output of the Navy's pilot plant at Model City.- **Following shortly upon USAF's cancellation of J93-5 and boron fuel production**, Aeronautical Systems Center received orders to close the production plant at Model City but to continue research and development effort on boron fuel manufacturing processes. Shutdown will follow this week.

- **Research and development effort on manufacturing processes** refers principally to a contract ASC Manufacturing Methods Division has with Stauffer-Aerojet for development of a low cost method of making boron-based fuels. This process will be proved out in a

large pilot plant now under construction in Sacramento, Calif.; A Stauffer Chemical Co. official told AVIATION WEEK that last week's Air Force decisions in no way affect this work.

- **At Model City,** Olin Mathieson expects to close both the Navy pilot plant and Air Force production facilities; it is currently awaiting instructions from the Air Force (on both units) as to how and when. Air Force plant was scheduled to produce the first batch of HEF-3 fuel at the end of this month. The company has closed its own pilot plant.

- **In Pittsburgh,** Callery Chemical Co. is also awaiting clarification of plans concerning the closing of the \$38 million Navy plant at Muskogee. The fourth and final unit of this plant was scheduled to go into production this week. Callery's own \$5 million boron fuel facility in Lawrence, Kan., will remain in operation. This plant was designed to produce small quantities of the high energy boron compounds for commercial development as well as to serve as a small interim fuel source. Callery reports that its boron fuel research and development contracts from the Air Force, Navy, ARPA and NASA are still very much alive. Consequently, most

of Callery's boron research, development and pilot plant facilities, located in Pittsburgh, will probably stay in operation.

- **At Evendale, Ohio,** last week, General Electric was expecting official word momentarily on the cancellation of the J93-5 contract. Neither General Electric nor North American officials felt that this would seriously affect the development of the B-70 and F-108. At the same time, however, some General Electric scientists and engineers were avowedly disappointed by the cancellation of the boron-burning version of the J93 which they considered an important part of meeting the mission requirements for the B-70. General Electric researchers say they have studied the "super hydrocarbon" fuels (AW Aug. 10, p. 27); they feel that such fuels have a limited payoff for a vehicle like the B-70 in which the use of boron fuel was expected to increase performance (principally range) roughly 10% over that of hydrocarbon fuels.

Some chemical industry officials contend that these cancellations will among other things, further increase the hesitancy of chemical companies about getting into the aircraft and missile propellant business.

Break in Stock Market Causes Re-Evaluation of Defense Issues

By William H. Gregory

New York—Last week's stock market break, which clipped some volatile defense issues especially hard, was a culmination of a trend months in building and not merely a reaction to the Eisenhower-Khrushchev exchange of visits.

As one analyst put it, interpretation of the visits as a break in the cold war was only an excuse. Though this may have served as a trigger, the price drop was general and American Snuff suffered along with Texas Instruments.

Or as Eliot Janeway of Janeway Research Corp. put it: "The market usually says the right thing but for the wrong reasons." He felt the break was an ominous sign for the entire economy.

Janeway called the market performance in bidding defense component stocks to "crazy levels" as "irresponsible and preposterous." What with cutbacks in progress payments and price cutting on development contracts as a gamble to win a production contract, the defense contractor is financing the government, Janeway said.

"The more real defense business a contractor gets," he said, "the more money he loses. Yet these profitless prospects the market interpreted as growth."

His outlook for the future—not only for the general market which appears to be headed for a major readjustment but for aviation stocks because of the measures that will be taken to deal with defense financing—is a pessimistic one.

"They will be cutting pimples off a cancer," he said. "Whenever they get serious about defense, there is about \$5 billion in redundancies that could be put into projects that are urgent."

Most market analysts pointed out the tendency for the boom stocks to feed on themselves. After their meteoric rise begins, the buyer loses sight of the traditional yardstick of dividend return and earnings and buys them to sell at a big profit to someone else. Eventually, the end of the buyer string is reached and the painful reaction begins.

Two long-term trends in aviation stocks now have evidently reached the same common denominator:

- **Some aircraft stocks** have been working downward in cycles since 1956. That year the price range for Douglas Aircraft was 95-72. The next year the range was 91-50 and last year it was 74-54. Last week Douglas was selling at \$45 a share. Boeing Airplane Co. in 1956—after a stock split—sold in a 65-45 range. The next year the range fell to 61-29. Last year the range was

58-34 but after closing at year end at \$46 Boeing last week was down to \$33.

- **Some rocket and avionic companies** on the other hand had prices rise into the exosphere in the same period and seemed on the verge of attaining escape velocity. Prices 40 or 50 times earnings were not uncommon for stocks like Thiokol Chemical Corp., Aerojet-General and Litton Industries.

A banker added the result this way:

"If cuts or changes in defense spending were going to affect the fortunes of the big, well-established companies like Boeing and Douglas, how could there also be enough defense spending to produce the tremendous growth assumed by the market for some of the rocket and avionic stocks?"

Perhaps the Eisenhower-Khrushchev visits suddenly emphasized this question, but the market's doubts about the answer were obvious in the wavering last week. Prices rallied after the big break Monday, but brokers passed this off as the expected reaction and waited to see what the real trend might be.

Uncertainty about the future in the aviation field was creeping noticeably into the market three months ago.

Boeing, Douglas and General Dynamics were affected early, not primarily because of worries about shifts in defense spending into missiles and electronics but because the big commercial jet programs of both were resulting in heavy development writeoffs.

With stocks such as Martin Co. showing sharp rises about the same time, this might have been dismissed as switching from companies identified primarily by the public with airplanes to companies regarded as strongly entrenched in missiles.

But in July Aerojet-General brought a 175,000 share new issue of common stock to the market, priced at \$75 a share. Based on Aerojet's 1958 figures, this was 55 times the company's earnings of \$1.38 a share.

The stock, though not gobbled up, was sold successfully, but the underwriter began moderate, short lived market support operations in a few days involving a few hundred shares to hold the price at \$75. When blocks of 1,000 shares or more hit the market, the support could no longer be maintained. The price broke to around \$70 a share, backed and filled for a week or two. Then the selling wave last week carried it to around \$55.

Some analysts felt that the break was only an interruption in the upward march of stocks, but there seemed little doubt that aviation and avionic stocks would be under a cloud for the next few months.

A reaction from Bache and Co. is typical of the attitude of the market:

"Although the announcement that President Eisenhower and Premier

Khrushchev will exchange visits this fall had little immediate impact on the securities market, we believe that the news makes a fresh look at the aircraft industry necessary. . . . Needless to say, any such relaxation of international tensions, unlikely as it may seem, would most likely be translated into lower defense spending, darkening the outlook for aircraft issues."

Bache went on to recommend switching into Lockheed, Martin Co. and North American—the latter two being virtually 100% military producers. The reasoning was that if there is no break in the cold war, these issues should do well; if there is, these same companies would be in a strong position to compete for the smaller number of defense contracts.

It viewed the prospects of Boeing, Douglas, and General Dynamics as less favorable because of the heavy development expenses of commercial jet transports. Regardless of the pros and cons of this line of thinking, which is common in the market currently, there were developments to support it and to add to the market jitters:

- **United Aircraft Corp.** cut its quarterly dividend from 75 cents to 50 cents a share and reported first half sales and earnings of \$545,512,546 and \$15,758,616, respectively, had declined from \$635,808,103 and \$22,377,699 last year.

- **Boeing Airplane Co.** reported a sharp drop in first half earnings—from \$19,572,367 or \$2.78 a share last year to \$3,551,688 or 48 cents a share this year. Sales fell from \$860 million for the period last year to \$667 million.

- **General Dynamics** reported earnings for the first half fell almost 50%—from \$20,052,000 last year to \$10,658,000. Sales showed a relatively small decline from \$789 million last year to \$752 million this year.

United's dividend cut was no real surprise to the market, although it knocked the share price down from \$51 to \$48 on the news. United's own-funds research and development expenses for the first half of 1959 totaled \$12,300,000, might increase to \$30 million by year-end, and 50% or more beyond that figure in 1960. Expenditures for new buildings and equipment are projected to total \$60 million in the next 18 months and bank borrowings, which amounted to \$52.5 million as of June 30 are expected to increase to a much higher level by year-end. Although 1960 sales will remain high, the corporation said it seemed advisable to cut the dividend in the light of these burdens on earnings.

News of the boron fuel cancellation gave Wall Street a special case of the jitters. Though the North American B-70 program itself seemed secure, many investment houses — Smith,

Barney and Co.; Bache; Kidder, Peabody, Burnham and Co., and Newburger, Loeb and Co.—had issued reports recommending North American for purchase.

Where the day-to-day market may tend to obscure the basic long-term trends, the operations of the mutual funds and institutions may provide a better over-all indication of what is happening.

An example is Keystone Custodian Funds, Inc., which manages a \$479 million stock portfolio broken into several types of individual funds. Keystone is switching away from the aircraft field for the time being, but is adding to its airline holdings.

The Keystone Growth Common Stock Fund S-3 eliminated United Aircraft and Boeing sometime ago, but is holding Cessna and Piper in the business plane field and several airlines.

"The basic deterrent to investment in this (aircraft) industry," Keystone said, "is technological progress and cost inflation, neither of which trends seem likely to be soon reversed. The first factor implies increasing proprietary research and development, short production runs and constant exposure to obsolescence, all conditions equating with narrow and unreliable profit margins."

A check by AVIATION WEEK of changes in fund portfolios over the past two years showed no clear trend through the end of last year. In the

first four months of this year, a clear trend away from Boeing, United Aircraft and Douglas became apparent. For example, after totaling the results of six fund purchases and seven fund sales of Boeing, the net reduction was 155,800 shares. United Aircraft showed a minus 25,100 shares after seven purchases and six sales.

Massachusetts Investors Trust, one of the largest funds, played a major role in this. It sold 110,300 shares of Boeing in the first quarter, leaving a holding of 90,000 shares, and in the first half sold 72,000 shares of United leaving a holding of 78,000 shares.

Martin and North American were the big gainers in the aviation field. Martin showed a net rise of 117,300 shares in fund hands and North American 65,200.

Only fragmentary reports are available of recent fund transactions, but these indicate they were not very active in the aviation industry. Martin, for example, had a price run-up from the \$30 range to around \$60 in May after the big fund purchases and a tour of Martin missile facilities by security analysts. But the price began to work down again during the summer and was around \$40 last week.

One factor that was generally overlooked by all the market analysts is the future of the U.S. space program, which may well be a billion-dollar-a-year effort (AW June 22, p. 152).

Pace Aims at Greater Civil Volume

New York—Program cutbacks are inevitable with the current emphasis on research and development, Frank Pace, Jr., General Dynamics board chairman, told the New York Society of Security Analysts here last week. But, he added:

"I think this is a good thing from the point of view of our company and for the country. From the company view, we are willing to take our chances for we are satisfied we will get our share of new business. From the country's point of view, this is the way we get the best defense systems."

However, Pace pointed out that General Dynamics was increasing its commercial volume toward a 50-50 goal. "If the net earnings of our proposed new acquisition, Materials Service Corp., were included in our 1958 figures, our volume should be 35% commercial," he said. "When our commercial jet transport business develops, we should reach or better this 50% level."

Pace said that the Convair 880 and 600 jet transport programs had met every expectation the company had for them—with one exception. The immediate market did not develop as the company expected, and it had evalu-

ated the medium range jet market as potentially the biggest. One reason for this, he said, was the heavy financial demands on the airlines which ordered long-range jets.

Since he does not see a supersonic medium range transport in the cards, Pace said the 880 and 600 as the fastest subsonic jet could have a minimum market life of 10 years and perhaps 15 or 20.

Company President Earl D. Johnson, in reply to a question about write-offs on the project, said they were at a peak now. Barring any major certification problem—and this seems unlikely—they should begin to taper off. One reason for this, he said, was the hard lessons the company learned about big high speed airplanes in the B-58 Hustler supersonic bomber program which saved costs.

Another point is sound suppressors and reversers. Johnson said the company refused to develop the airplane unless the engine manufacturer—General Electric, with its CJ805—designed and guaranteed them. "This little tag cost one of our competitors \$15 million to develop," he said.

Paddlewheel Satellite Probes Radiation

Washington—National Aeronautic and Space Administration's Explorer VI satellite, the most complex experimental payload launched by the U. S., is making a variety of measurements over a broad spectrum of space conditions as it follows its highly elliptical orbit around the earth.

Launched from Cape Canaveral by an Air Force Thor Able III vehicle, the satellite is using a new digital telemetry system to report measurements from an instrumentation complex which is using solar energy as a primary power source.

Since the four solar cell vanes protrude from the satellite to absorb solar energy resemble paddles, the vehicle as

a whole has been labeled the Paddlewheel satellite by NASA.

Paddlewheel satellite also was designated Explorer VI by NASA after it went into orbit, acquiring the designation from the radiation satellite which failed to get into orbit when its Juno II launching vehicle was destroyed shortly after liftoff (AW Aug. 3, p. 61).

Radiation satellite payload will be launched again, probably next month.

Explorer VI was launched 48 deg. to the north from the Air Force Missile Test Center and went into a highly elliptical orbit with an apogee of 26,401 stat. mi. and a perigee of 157 stat. mi., a pattern very close to the orbit origin-

ally scheduled. Orbital time is 12 hr. 46 min., and velocity varies between 3,117 mph. at apogee and 22,957 mph. at perigee. Explorer VI travels 91,140 mi. in each orbital circuit.

Launch Vehicle

Thor Able III launching vehicle was similar to previous Thor Able vehicles, using an Air Force-Douglas Thor for first stage and two modified Vanguard upper stages. Autopilot in the Aerojet-General liquid rocket second stage has been miniaturized and was lighter than previous models, and guidance system could be controlled from the ground for the first time.

Eight spin rockets were fired at second stage burnout to stabilize the payload and the Allegany Ballistic Laboratory solid propellant third stage. Explorer VI is spinning at 168 rpm. The satellite has an Atlantic Research Corp. solid rocket in it which could have been fired to provide 5 lb. of thrust to change the orbit if perigee had been too close to the earth, but this small kicker rocket was not needed.

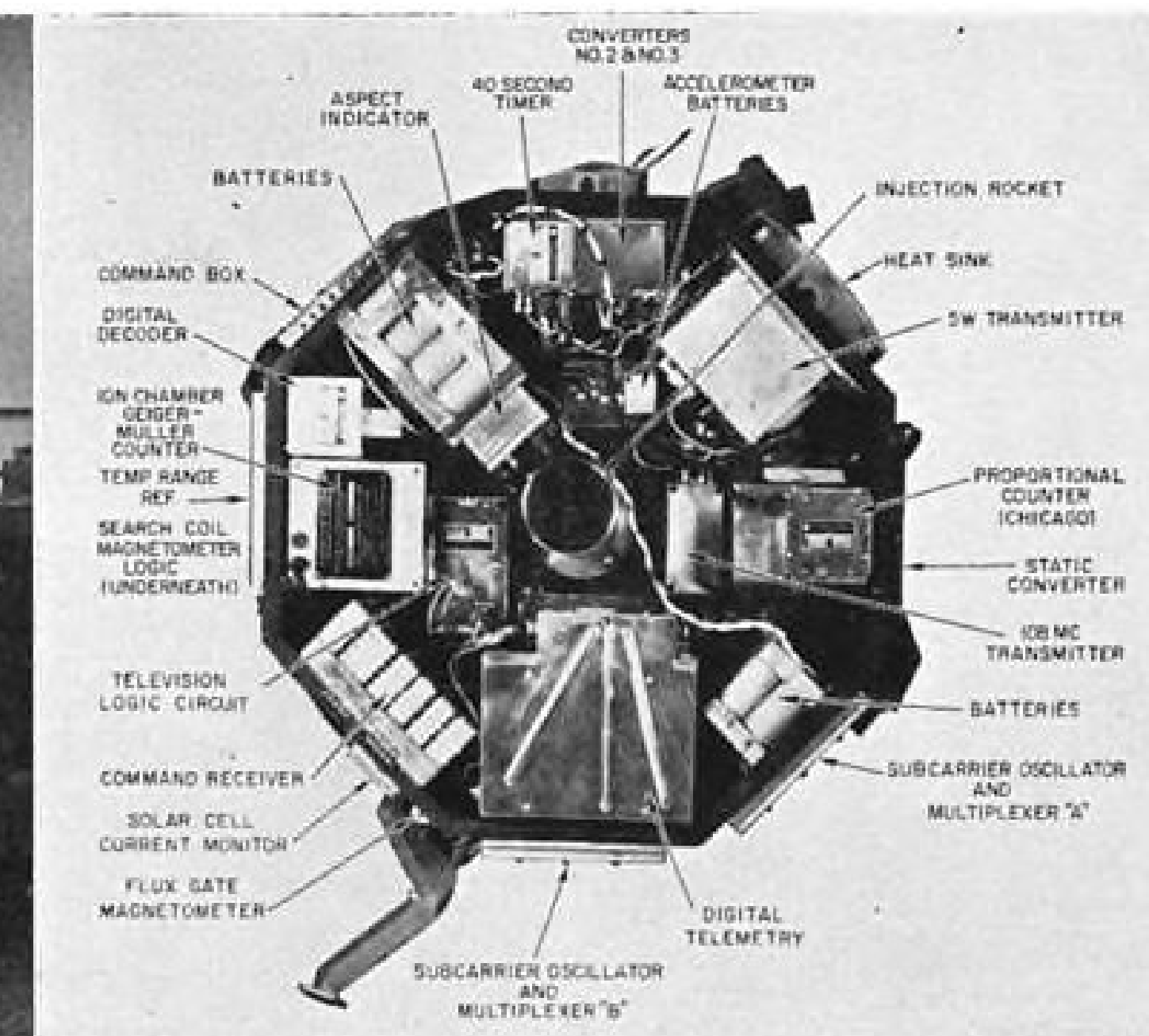
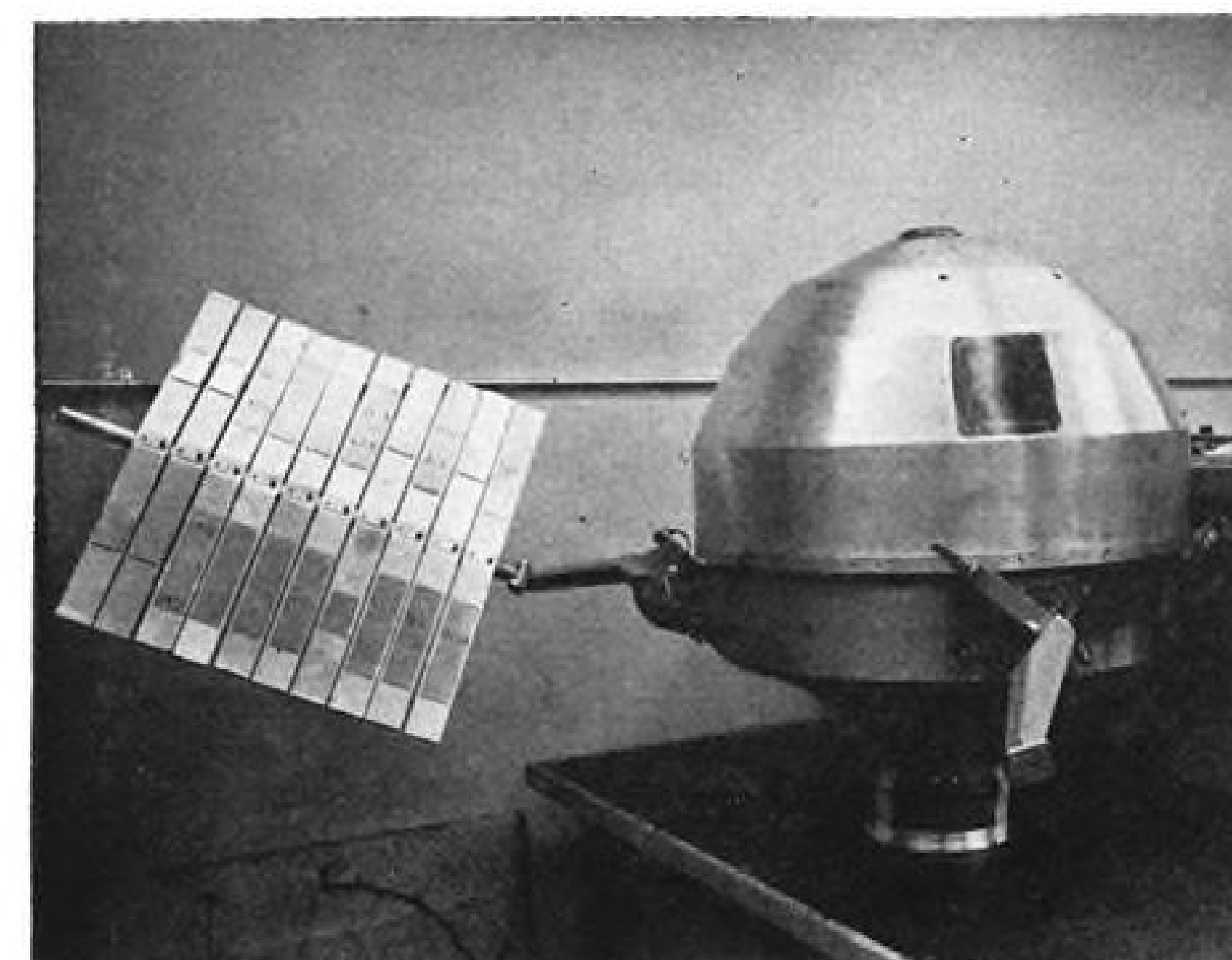
Explorer VI development and launching was an NASA project, with Air Force Ballistic Missile Division directly responsible for launching and contracting for fabrication of the satellite. Space Technology Laboratories, Inc., provided systems engineering and technical direction. A Douglas Aircraft Co. launch crew conducted the launching. Thor Able III was the 52nd Thor launching; 10 of these have been Thor Able vehicles.

Paddlewheel Structure

Paddlewheel satellite is a spheroid with a slightly flattened bottom. It is 26 in. in diameter, 29 in. deep and weighs 142 lb., and its aluminum skin is $\frac{1}{16}$ in. thick. The four solar cell paddles jut from the satellite's waist on arms that were spring-loaded to extend when the plastic nose fairing on the launch vehicle was jettisoned just before third stage ignition.

Each of these paddles is about 20 in. square, and each has 1,000 silicon solar cells on each surface. These 8,000 cells are shielded by glass filters which filter out harmful ultraviolet rays while admitting appropriate light energy. Hoffman Electronics produced the solar converters in modules of 100 cells, 50 on each side. Each module produces about $\frac{3}{4}$ watt of electricity under direct sunlight.

Solar cells charge the batteries which power the satellite systems and are expected to last as long as the satellite—about a year. A voltage gage measures solar cell output, and battery charging



TEST SOLAR paddle is fitted to satellite (left) to determine final design. Tightly packed instrumentation is at right.

rate can be changed by ground command if necessary. Complete power supply system, including batteries, weighs 30 lb. Solar cell element of the satellite operation is considered an important test of a potential power source for long range space vehicles.

Telemetry backup is provided with duplicate transmission of most experimental data by the three transmitters in the satellite. Transmitters operating on 108.06 mc. and 108.09 mc. send analog information, and the primary transmitter sends digital data on an undisclosed UHF frequency. Primary transmitter power requirements of 40 watts is too heavy for the solar cells and battery to support continuously, so the transmitter is being used on command

about one and a half hours out of every six.

Ground command is effected through a receiver in the satellite which can control 30 different functions, including broadcast cycle of the primary transmitter. UHF frequency of the primary transmitter and command receiver is undisclosed to avoid possible outside interference with the command function. Satellite also has a VLF receiver for radio wave propagation experiments.

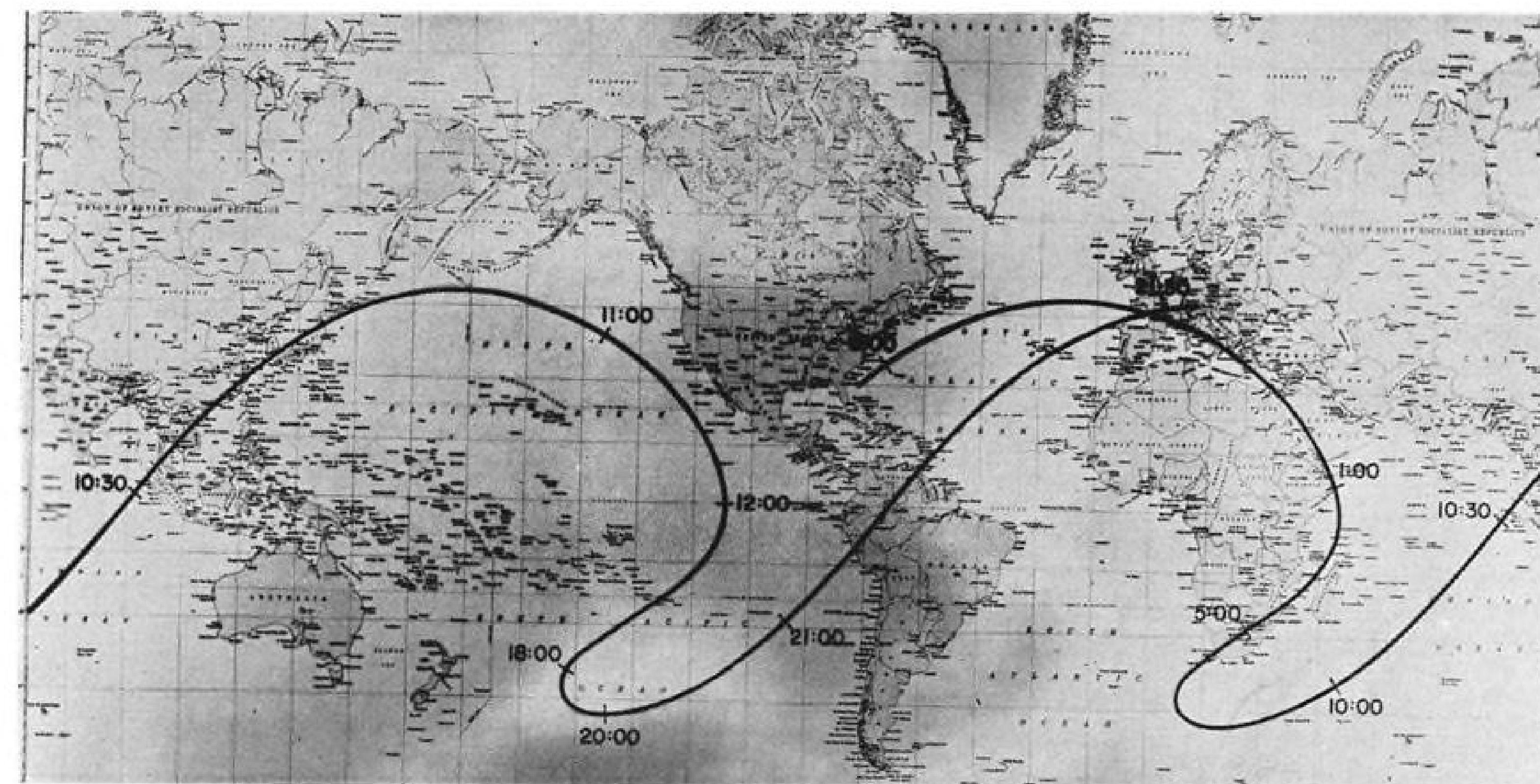
Digital Telemetry System

New digital telemetry system developed by STL permits on-off use of the primary transmitter. Called Teletbit, this digital system stores and tallies ex-

perimental data while the transmitter is off, then transmits the processed information on command. Digital system imposes a lighter load on the power supply than the usual analog system which must operate continuously, and the digital data is more easily processed on the ground.

Transponders in the satellite are used as a doppler system to measure its velocity. This provides a checkout of a system which provides mid-course information and which could be used for mid-course guidance of satellites with more difficult missions than Explorer VI.

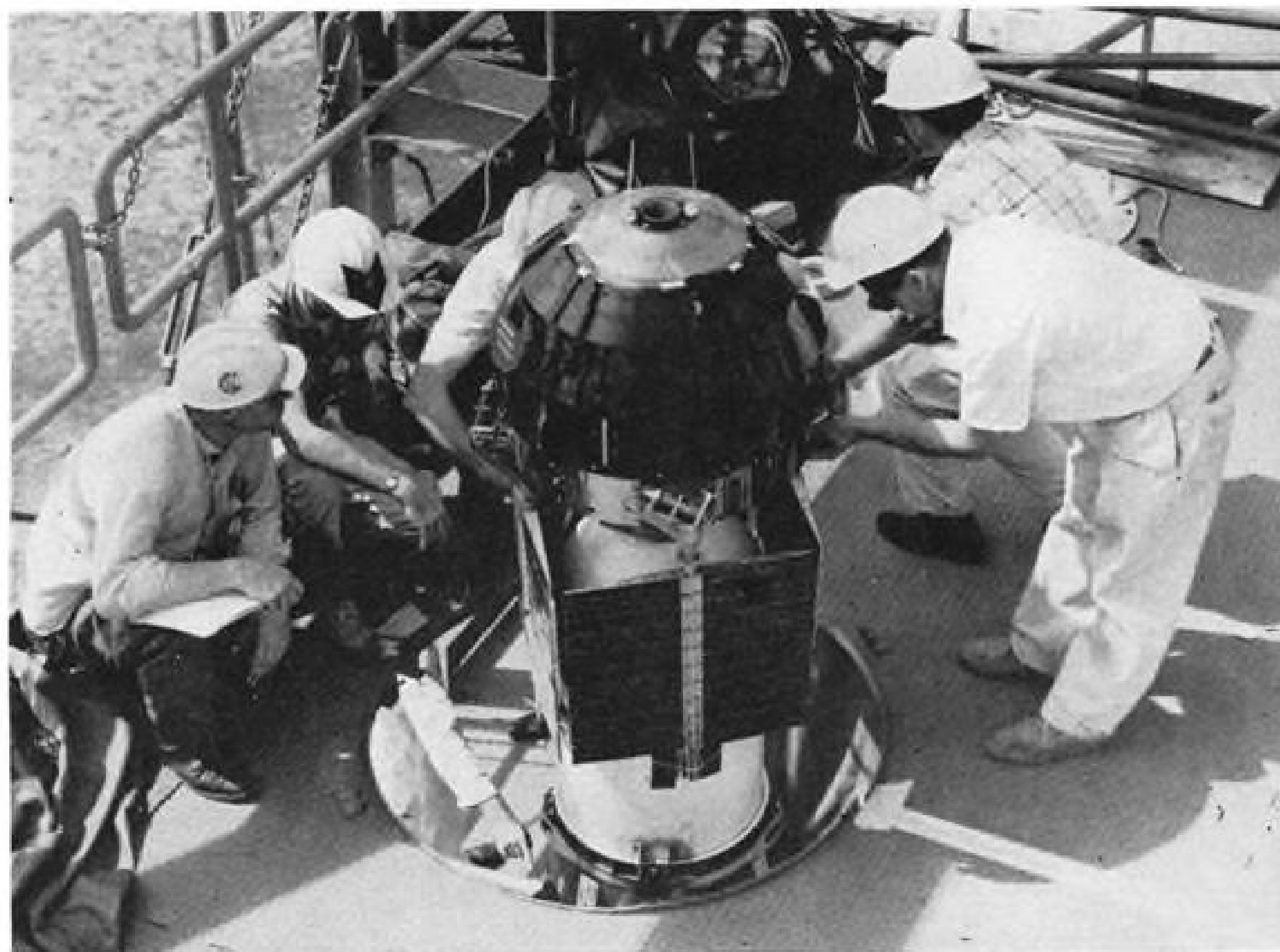
The highly elliptical orbit of Explorer VI permits a wide range of energy level measurements in the radiation



ORBITAL PATH during first 2½ hr. moved across Europe and Middle East relatively close to the earth. It then moved southwest toward Cape of Good Hope as satellite traveled farther away from earth and rotation caught up with Explorer's relative motion.



AIR FORCE Thor Able III launches heavily instrumented Explorer VI satellite.



EXPLORER VI PAYLOAD is prepared for installation on third stage of Thor Able III launching vehicle. The 20 in. square vanes folded down below the payload have 1,000 solar cells on each side and are providing electrical power for operation of the satellite's instrumentation. Hole on top of the satellite is the nozzle of the small rocket carried to raise perigee if it had been too close to earth; it was not used.

belts. These were measured by various earlier Explorer satellites and by Pioneer I and Pioneer III, but Explorer VI will provide more copious data over a greater period of time. During its year of life, the plane of the satellite's orbit will tilt toward the plane of the equator and provide data on the radiation belts where they are strongest.

Radiation counters in the satellite are measuring three energy levels. A device developed by the University of Chicago measures high energy particles. It consists of six gas-filled cylinders surrounding a seventh cylinder and is lead-shielded. Particles will ionize the gas and create an electrical impulse as they penetrate the cylinders.

Medium energy range is measured by a combination of two instruments provided by the University of Minnesota, an ionization chamber for total flux and a Geiger-Muller tube for count rate. STL scintillation counter is used to measure low energy radiation.

Density and pattern of micrometeorites in the area traveled by Explorer VI is measured by metal plates on opposite sides of the satellite's waist. Microphones pick up impacts on the plates for telemetry transmission.

Magnetic field of the earth is measured by magnetometers designed by STL. Search-coil magnetometer gages the magnetic field and its direction, and a flux-gate magnetometer is used with it to measure the spin axis component of the field. STL also has developed a phase comparator which measures the phase relationship between the output of a sun scanner and the search coil

magnetometer, providing the "H" direction of the magnetic field.

A facsimile system similar to a television camera was developed by STL for the Explorer VI payload. It scans the earth on each revolution and produces data dots which, in turn, form lines that make up a complete picture. Transmitted pictures will have a resolution of about five miles and can provide a crude picture of the earth's cloud cover.

Radio wave propagation experiments are conducted with Explorer VI to determine effect of the ionosphere. In one experiment, signals at 15.5 kc. from Navy radio station NSS at Annapolis, Md., are received by the VLF receiver provided for the satellite by Stanford University, and the results are telemetered to ground stations. In another, signals from one of the satellite's VHF transmitters may be received

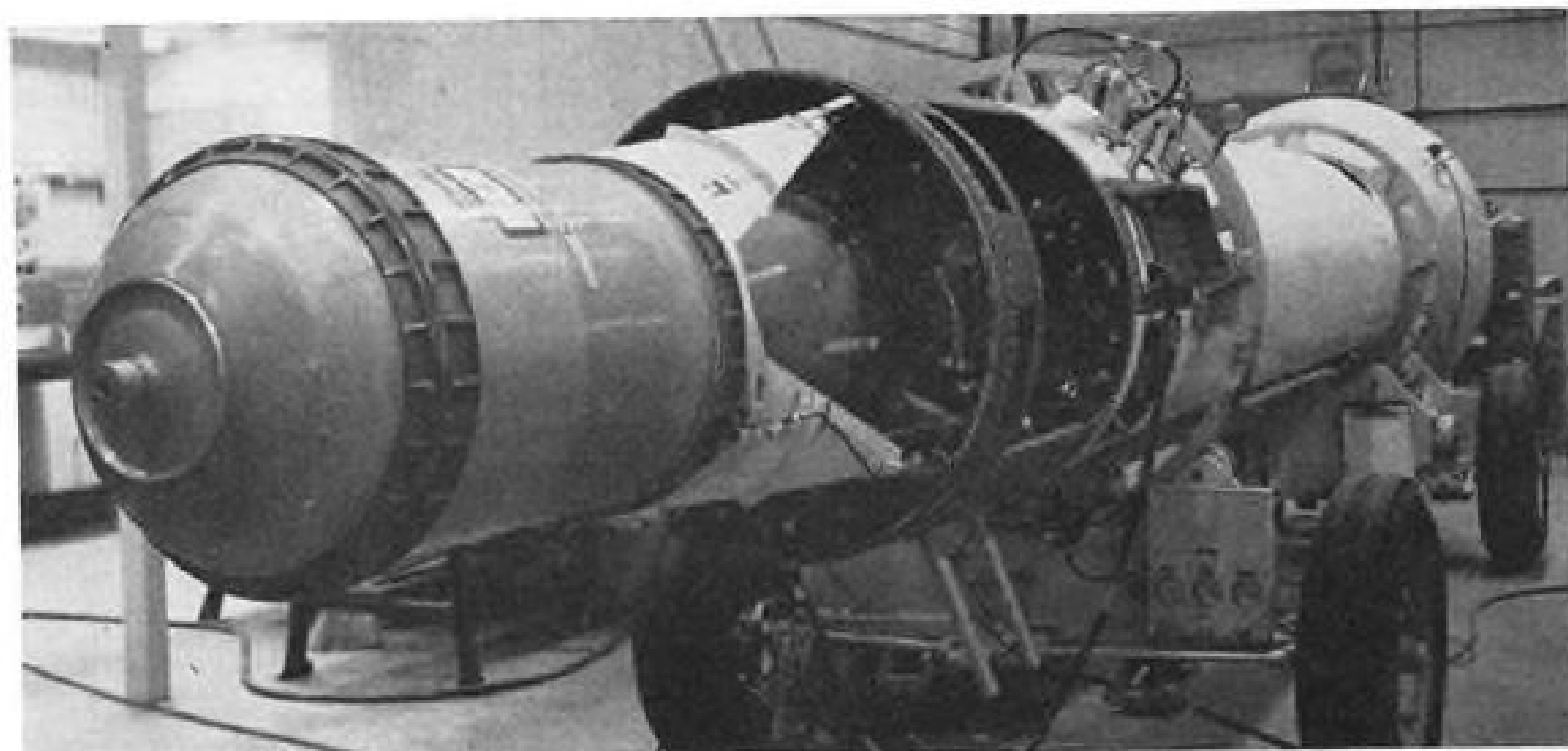
by two earth-based receivers spaced on a 475 meter base line to measure amplitude and phase fluctuations induced by the ionosphere. Ground equipment for this experiment is in place at the National Bureau of Standards Laboratory in Boulder, Colo.

Signals from UHF and VHF transmitters will be used at the Kalae, Hawaii station in a comparison of doppler shift. Comparing doppler shifts of the two transmitters will provide data on the relative effect of electron density in the ionosphere on signals with these two frequencies. VHF signal also will be used by the Hawaii station to measure the Faraday rotation caused by variation in electron density between the satellite and the ground station.

Internal temperature of the satellite is controlled by surface treatment of the skin. Readings are telemetered on payload temperature and temperature of the solar cells. An experimental device for controlling temperature inside the satellite being tested resembles a four-bladed propeller on the shell. A heat-absorbing black patch is on the surface with a wire coil under it. When temperature rises to a certain level, the coil expands and activates the propeller which moves to cover the black patch. When the covered patch cools, the coil rotates the propeller away, exposing the patch and allowing temperature to rise again.

Explorer VI is tracked by a number of U.S. posts, but principal command and data reception points are at Jodrell Bank, Manchester, England; Kalae, Hawaii; Millstone Hill, N. H.; Singapore, Malaya, and Cape Canaveral. These points are connected by a teletype circuit with the control point at STL's Space Navigation Center in Los Angeles. Experimental data will be partially reduced at tracking sites before it is moved to STL for complete processing.

Multiplexers have been installed on antennas at Jodrell Bank and Hawaii to permit reception and transmission of signals on a single antenna at the same time.



THOR ABLE third stage (foreground) is solid-propelled; second stage undergoes testing.

New Navy Radar Holds Promise Of Long-Range Missile Detection

By Philip J. Klass

Washington—New type radar which shows promise for detecting the firing of ballistic missile rocket engines and nuclear explosions at intercontinental distances has been reported by the Office of Naval Research.

The ionospheric back-scatter radar that can detect large volumes of ionized gas produced by hot rocket engine exhaust or a nuclear explosion operates in the high frequency band (3 to 30 mc.), normally used for long-range radio communications.

High frequency radio signals propagate over long distances, because they bounce off the ionosphere, reflect back to earth, then back to the ionosphere and back again to the earth, skipping around the globe in this fashion. At each contact with the ionosphere or the earth, a small fraction of the radio energy also is reflected backward toward its source.

It is this back-scattered energy, or echo, that is employed in the new radar. The radar transmits in short bursts or pulses, providing a non-transmitting period in which to receive the back-scattered echo.

Each reflection off the ionosphere and off the earth produces a weak echo, each displaced in time from the preceding one. When the radar energy strikes a large volume of ionized gas, such as that produced by a rocket launch or nuclear explosion, it produces an echo with a distinctive energy pattern which can be distinguished from ordinary ionosphere/earth produced echoes.

The new radar concept, credited to Dr. William J. Thaler of the Office of Naval Research, was developed under the code name of Project Teepee (or T. P.), derived from "Thaler's Project." Other groups participating in the program include the Nuclear-Products-Erco Division of ACF Industries, National Bureau of Standards, Lincoln Laboratory and the Naval Air Test Center.

The radar's advantages and limitations both stem from the fact that it operates in the high frequency band. Unlike more conventional radars which operate at higher frequencies, the new back-scatter equipment is not limited to short line-of-sight ranges. Intercontinental ranges can be achieved with moderately low powers when compared with that required by more conventional ballistic missile detection radars.

One of the more serious limitations is the fact that sun spots and solar flares seriously alter the ionosphere's propagation characteristics, causing

complete blackouts in high frequency radio communications. Presumably the new radar would be even more vulnerable than conventional radio communications. Furthermore, a small nuclear explosion in the upper atmosphere of the Project Argus type also could black out HF propagation for an extended period.

The new radar also may be vulnerable to electronic countermeasures. By placing a low-power HF transmitter in the vicinity of the missile launching site, an enemy could generate signals that could blot out the weak echo from rocket exhaust gases. It probably would be more difficult, perhaps impossible, to obscure a large nuclear explosion.

One high frequency back-scatter radar can provide a rough indication of the direction and approximate distance of a nuclear explosion or rocket launching, but unknowns in the propagation path make it impossible to determine location precisely. By using several radar stations, and triangulation, the target location could be established more precisely.

The new radar appears likely to find application as an early warning device to supplement other techniques, such as the Ballistic Missile Early Warning

System and Project Midas infrared sensing satellites.

The technique does not now appear suitable, however, for tracking ballistic missiles to establish trajectory for aiming anti-ICBM missiles since the HF signals do not penetrate the ionosphere, hence could not follow the missile after launch.

Dr. Thaler says that "promising results have been obtained over long ranges using breadboard equipment. We are confident that a system capable of reliable detection over intercontinental ranges is feasible." However, he makes no claims for the radar's ability to track a ballistic missile. The same technique has detected a nuclear explosion "thousands of miles away," according to the Defense Department.

The idea of using the high frequency band for long-range radar is not new. More than 10 years ago, Air Force's Rome Air Development Center sponsored development of an experimental HF radar. Tests indicated that the radar had little merit for use against aircraft, the targets of interest at that time. However, the equipment did find use as a means of determining what HF frequencies were best at any particular time of day for reliable communications with a distant station (AW Aug. 17, 1953, p. 327).

Rome recently has taken a fresh look at HF radar for ICBM detection and is currently conducting an in-house investigation.

Semiconductor Advance Detailed

Pittsburgh, Pa.—"Transistorized vacuum tubes" which require no heater or filament power may result from a recent discovery that certain semiconductor crystals can be made to emit electrons, according to Westinghouse Electric Corp.

Westinghouse reports that two of its research physicists have discovered that a tiny silicon carbide crystal will emit electrons when voltage is applied across a built-in junction. Current density compares with emission from the cathode of a small receiving type tube.

The use of a tiny semiconductor crystal to replace the heater and cathode of a conventional vacuum tube could, Westinghouse says, give tubes a new lease on life in their battle with conventional transistors by eliminating the need for heater power and the consequent problem of dissipating heat.

The materials and principles employed by Westinghouse differ from those used in "cold-cathode" tubes developed by Linfield College scientists and more recently by Tung Sol Electric Co. The former requires a strong electric field to draw electrons from a point-source type cathode. The Tung

Sol approach requires application of a trigger voltage to start electron emission from a magnesium oxide coated cathode. Delay in the flow of electrons after application of the trigger voltage in first models of the Tung Sol tube tends to limit use to lower frequencies.

Electron emission from silicon carbide crystal accompanies the emission of visible light in the form of electroluminescence, Westinghouse reports, when the voltage applied across the semiconductor junction is sufficient to cause the breakdown of its normal electrical resistance. The emitting spots measure only about 50 millionths of an inch in diameter, with densities of about one micro-ampere from each spot.

The fact that electrons are emitted from such tiny spot sources suggests that the new discovery might also find application in cathode ray tubes to provide an extremely thin electron beam without all of the complex focusing elements now required.

Westinghouse says it is continuing its investigation of the new technique in its research laboratories, as well as working on its application to specific devices.

Congressmen, Retired Officers Termed Sources of 'Pressure'

By Katherine Johnsen

Washington—E. V. Huggins, former Assistant Secretary of the Air Force for Materiel and now executive vice president of Westinghouse Electric Corp., told members of the House Armed Services Investigating Subcommittee last week that Pentagon officials are under "pressure" on procurement matters from both congressmen and former high-ranking officers.

Testimony by Huggins, Assistant Air Force Secretary between 1951 and 1953, was at variance with that given to the subcommittee by a number of retired officers—including Adm. Arthur Radford and Army Gen. Omar Bradley, both former chairmen of the Joint Chiefs of Staff—that during their long service careers they had seen little or no evidence of former officers influencing or trying to influence procurement.

The main emphasis of Huggins' testimony, however, was on the value of military officers to industry. He told the subcommittee that former officers "have not only technical knowledge but also a major amount of executive, administrative, and pure business ability."

Huggins reported that it is—or was—the practice in the Air Force to put a "pink tab" on the files of contractors who had employed high ranking officers to use influence on their behalf. He said the tab was "a warning flag" because the Air Force "wanted people to be aware that the fellow on the other side of the table had former Air Force connections." During his tenure as Assistant Air Force Secretary, Huggins said it was obvious that "certain retired officers were being too evident . . . were being around too much." He said Pentagon officials "resented" the "pressure" of both congressmen and retired officers.

When he heard that Westinghouse was likely to be rejected as a subsystem subcontractor on the North American B-70 Mach 3 bomber (AW May 18, p. 23), Huggins admitted that he promptly contacted Pentagon officials "to let them know our capability . . . I felt they lacked knowledge of our capability." Westinghouse subsequently received the subcontract. Hebert characterized this as "a classic example of good selling."

Other developments before the subcommittee investigating allegations of contractor influence in defense procurement included:

- **Officials of Boeing Airplane Co.** testified that they were forced to place advertisements on the merits of its Bomarc air defense system being built for Air Force in Washington newspapers to correct "misinformation" being advertised on behalf of the Army-Douglas Nike Hercules air defense system.

- **C. R. Smith**, vice president of Western Electric Corp., prime Nike Hercules contractor, termed this "a false charge." Smith said that it was "purely coincidence" that a Western Electric advertisement on behalf of Nike appeared in Washington newspapers on the eve of an Administration decision on a "master plan" for air defense.

It also was developed at the hearings that Boeing officials had contacted the House Appropriations Committee, Western Electric officials, the Senate Appropriations Committee, in connection with the Fiscal 1960 budget for air defense. Neither company considered this exerting "influence," but simply a matter of keeping congressmen informed.

Raytheon Wins Platform Contract

Washington—Raytheon has received a \$90,000 Air Force study contract from Wright Air Development Center for the company's proposed radio-powered unmanned helicopter which can be used as a flying platform for surveillance radar or extended-range communications (AW May 18, p. 38).

Several companies have submitted airframe proposals to Raytheon, including Sikorsky and Vertol.

The platform, which could hover indefinitely at altitude, would be powered by microwave energy beamed up to it from a ground radio transmitter. It would use a small gas turbine, powered by conventional fuel for initial takeoff and climb to altitude, to drive compressed air through tip jets in the rotor blades. Once on station, the vehicle would be maintained aloft by microwave energy beamed up to its antenna.

Raytheon estimates that approximately 1,000 hp. at the rotor would be required to sustain the vehicle and its airborne avionic equipment. To provide 1,000 hp. at the rotor, the company estimates that approximately 20,000 hp. (15,000 kw.) of electrical generating capacity would be required on the ground, based on over-all system efficiency of about 9.6%. The latter figure assumes a 65% efficiency for the ground-power transmitting antenna,

Defense Secretary Neil McElroy expressed reservations concerning the battle of advertisements in connection with the Bomarc-Hercules controversy but strongly defended "a company's right to put before the American people its confidence as supplier of high-grade military products as an evidence of its importance as a good citizen of the U.S."

- **J. D. Wright**, president of Thompson Ramo Wooldridge, conceded that "we do have a problem here" as owner of Space Technology Laboratories since the latter's role as technical adviser to the Air Force by joint Thompson Ramo Wooldridge agreement is to be completely divorced from the production operations of the company. As long as STL keeps operating in the black, he told the congressmen, "we have no interest in it. But as a duty to our stockholders, we may have to become active in its management if it were to go into the red."

A new headquarters for STL is being built at Canoga Park in southern California, 38 mi. distant from the headquarters of the Ramo Wooldridge Division of TRW to further complete divorcement of activities, Wright reported. STL's headquarters are now three miles distant. TRW elects the directors of STL.

75% pattern efficiency, 65% efficiency for the airborne-power receiving antenna and 30% efficiency for the airborne propulsion system.

Recent advances in techniques for cooling Raytheon's Amplitron microwave power amplifier tube have opened the door to the novel radio-powered flying platform. In the past year, the company says it has devised means for removing 10 times as much tube heat as previously possible.

Raytheon reports it is now producing Amplitrons that can deliver 20 hp. at 3,000 mc. frequency and says that 100 hp. units will be available within two years. With another several years of development, Raytheon believes it can produce tubes with outputs of 500 hp.

Ability to generate such large amounts of power at higher microwave frequencies, with sufficient phase stability to permit parallel operation of many tubes, makes it possible to transmit sufficient power to sustain a useful payload using moderate size antennas. Present thinking is that a group of small antennas located in 400 sq. ft. would serve for the ground station. Like a battery of searchlights, their beams would be aimed to converge at the flying platform's hovering altitude into a circular spot less than 100 ft. in diameter. Helicopter would carry a light-



J79: world's most-flown Mach 2 engine

General Electric's J79 turbojet has demonstrated its reliability by logging more flight hours than any other Mach 2 engine in the world. Typical of the J79's record is its outstanding performance in the Lockheed F-104 Starfighter—world record holder for speed, altitude, and time-to-climb.

Operational flying with the USAF's Air Defense Command and Tactical Air Command demands the most of an aircraft and its engine. In the face of these requirements, the F-104 is compiling an outstanding record.

Evidence of its J79 engine's reliability grows more overwhelming daily. During 1959, USAF Starfighters have been realizing an unusually high aircraft utilization rate, with a correspondingly low percentage of in-flight engine complaints.

Some key reasons for the J79's outstanding operational record are the simplicity of its single rotor variable stator design, high resistance to foreign object damage, unusual throttle sensitivity, high altitude afterburner light-off characteristics, and ease of maintenance.

More than 90% of total U.S. Mach 2 flight time has been logged by General Electric J79s . . . further evidence that it is today's top Mach 2 fighter-interceptor powerplant. General Electric Co., Cincinnati 15, Ohio.

235-32

Progress Is Our Most Important Product

GENERAL  ELECTRIC



O'er the ramparts...

U. S. Army's

NIKE HERCULES...

Solid rocket motor built by Thiokol for Nike Zeus has produced greatest mass discharge rate and thrust of any single

Through the combined efforts of the U.S. Army, Western Electric, Douglas Aircraft, Thiokol Chemical and other key members of the missile industry, America is moving toward the realization of a critically needed anti-missile missile.

The Nike-Zeus system — big brother to the Army's Nike Hercules which now stands guard over major population centers — is being designed to detect, charge and destroy attacking ICBMs many miles from their targets.

Assigned development of the boost for the Zeus, Thiokol has already designed, built and successfully test-fired a motor achieving over

Thiokol®
CHEMICAL CORPORATION
Bristol, Penna.

Nike Hercules

NIKE ZEUS

solid propellant motor ever test-fired in the free world... unleashes more than 400,000 lbs. of thrust in static firing!

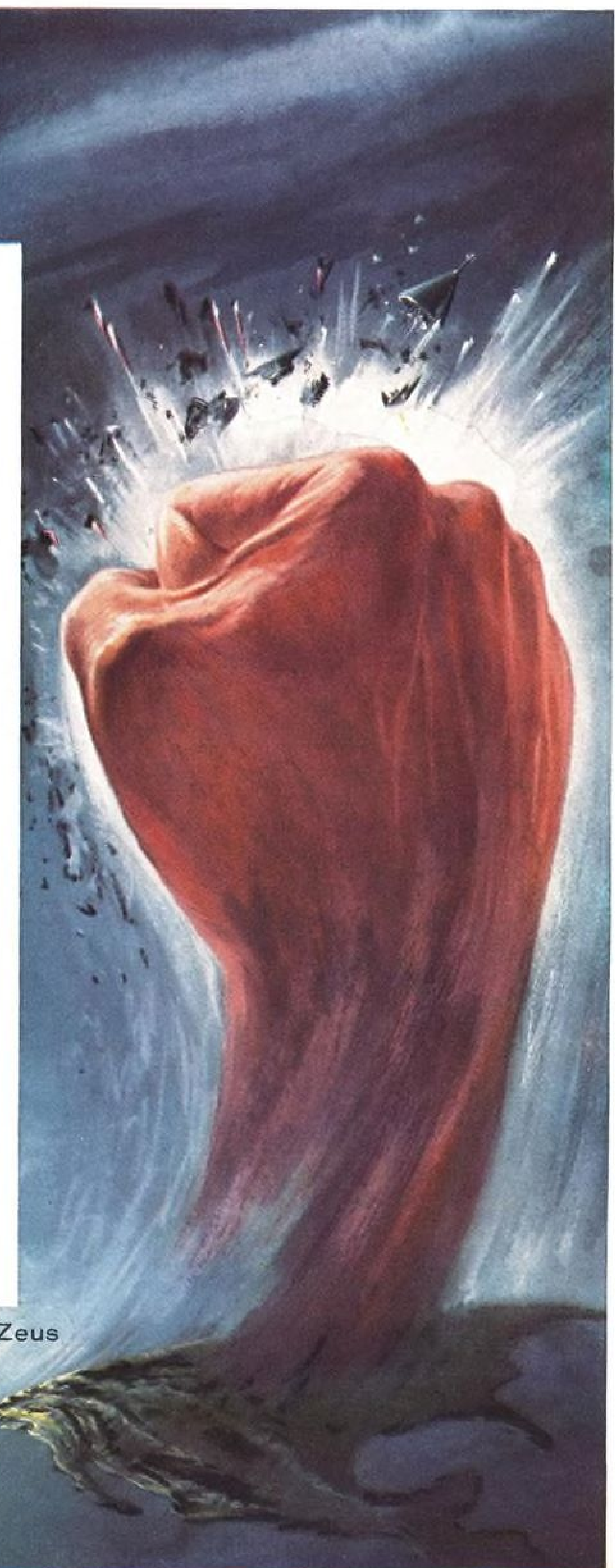
400,000 pounds of thrust—power enough to deliver the instant reach of high altitudes needed for effective defense.

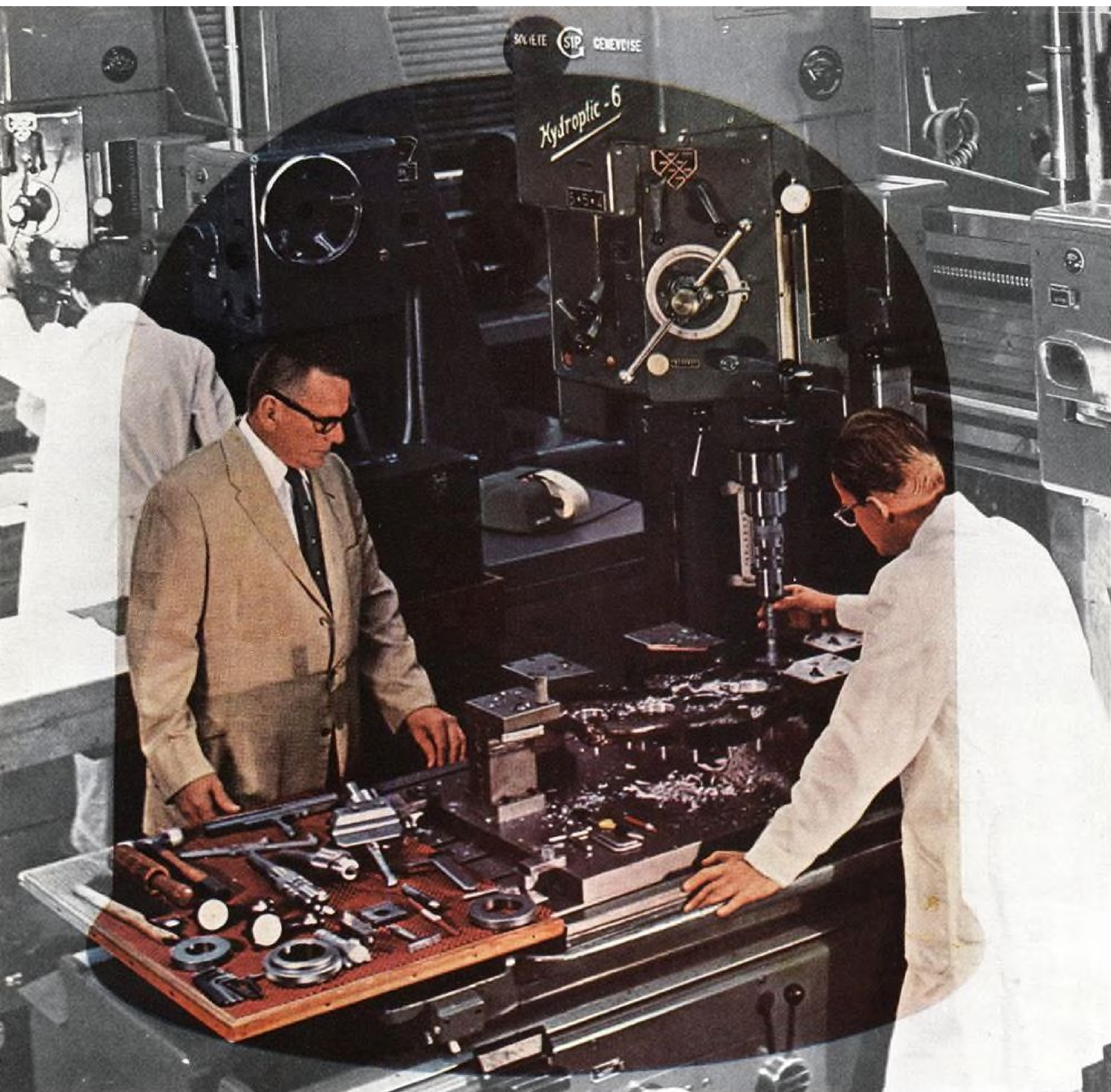
While the Zeus booster stands as the most powerful solid propellant motor now on record, it in no way represents the ultimate capability of present Thiokol facilities. Current capacity includes motors still larger—of ICBM and even satellite size.

Under Army direction, and in cooperation with Douglas Aircraft, Thiokol development in the Nike program has advanced the science of rocket propulsion.

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Like in a huge bell jar, temperature and humidity are controlled to exacting standards in I. G. W.'s precision jig bore room.

Precision is our only product!

At Indiana Gear, precision goes far beyond the usual customer requirements. Precision is a part of order coordinating, engineering, production, inspection . . . a part of *every* Indiana Gear operation. Precision is a way of thinking at Indiana Gear . . . a method of always working beyond the fringe of the state of the art.

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weight circular receiving antenna of about the same diameter.

Microwave energy received by the vehicle's antenna would be carried by waveguide to glossy elements which would convert it into heat. Compressed air or gas heated by these elements would then drive the turbines which supply power to the rotor tip jets.

In addition to the fuel carried for initial takeoff and climb to station, the vehicle would carry a small reserve to tide it over in the event it briefly moves out of contact with the ground-transmitted radio beam.

To hold down the weight of the vehicle's payload, Raytheon proposes that the flying platform used for radar surveillance carry only the search antenna, duplexer and a receiver instead of a complete airborne radar. The radar signal would be generated on the

ground and transmitted to the search antenna, and the received radar signal would be telemetered back to the ground. The Amplitron tubes used to supply power lend themselves to various forms of modulation, permitting the radar pulse-form to be superimposed on the power beam, then extracted at the vehicle and routed to the search antenna.

A series of flying platforms could be used as a chain of microwave repeaters to provide secure communications in the Arctic or over the Atlantic, Raytheon says. At microwave frequencies, 30 mc. bandwidths can be obtained which would provide more radio channels than now available in the entire high frequency band used for long-range communications and without the frequent outages due to ionospheric disturbances.

Unions Outline Industry Demands

Seven-point bargaining program for 1960 was adopted by union representatives of aircraft, missile and related electronics workers at the International Association of Machinists and United Auto Workers joint conference in Kansas City, Mo.

The seven basic proposals, which will be presented at the next round of negotiations with major employers in the aerospace industry, are:

- **"Wages—**Actual cents-per-hour wage increase to be sought in the next negotiations will be decided at a joint IAM-UAW 'price tag' conference to be called later this year. . . ." Unions stressed elimination of inequities in job classifications and changes.

- **"Severance pay—**Any employee who is laid off or terminated and who has one year or more of service should receive severance pay proportionate to this length of service, in addition to payment for any unused portion of vacation or sick leave allowance for which he or she is eligible. Severance pay shall be one-half day's pay for each month of service.

- **"Relocation pay—**Any employee whose work site is transferred or moved from his initial place of employment shall be entitled to pay for travel time and compensation for the expenses of maintaining two homes, or for disrupting and moving his home.

- **"Union security—**Achievement of union shop across the board in the aircraft and missile industry is a basic and serious objective for both unions.

- **"Hospital, surgical and medical insurance—**There should be established a sound and adequate basic benefit which will satisfy the normal and usual hospital, surgical and medical requirements of the employees. . . .

- **"Life insurance—**In those contracts where life insurance coverage does not at least equal average annual income, every effort should be made to achieve this objective. . . .

- **"Pensions—**The following principles will be adhered to in renegotiating pension contracts: The plan shall be 100% employer financed; systematic funding of benefits will be provided on a sound basis; all aspects of the plan will be jointly administered. Provision should be made for voluntary retirement before age 65. Workers should be entitled to \$1,000 lump sum benefit on death after retirement. We should strive to protect the purchasing power of the pensions by provision for adjustments geared to changes in the cost of living."

Third X-15 Delivered

Third North American X-15 rocket research aircraft is undergoing instrumentation check at National Aeronautics and Space Administration high speed station at Edwards AFB.

The third X-15 will demonstrate contractor compliance; the first two X-15s were used for aerodynamic and power-plant testing, so the No. 3 vehicle will require less flight testing before beginning actual research program flights.

A metal mockup of the Reaction Motors 50,000-lb.-thrust XLR99-RM-1 rocket engine is installed in the third X-15, prior to installation of the actual engine. First flight of this aircraft has not yet been scheduled.

The second X-15 will soon make its first powered flight. Two XLR11 engines will be substituted for the XLR99-RM-1 designed for the X-15 (AW Mar. 30, p. 59).

News Digest

Air Force Convair Atlas 14-D launched a heat sink nose cone about 5,000 mi. down the Atlantic Missile Range last week in the third successful test of recent fuel system modifications. One more test shot is scheduled, but the success of the first three is expected to lead USAF to launch an Atlas D within a few weeks from Vandenberg AFB to establish the initial operational capability originally scheduled for July 1 and delayed after a succession of Atlas test failures (AW July 6, p. 27).

Boeing Airplane Co. has consolidated its Seattle and Pilotless Aircraft Divisions and its Systems Management Office into a single new Aero-Space Division with Boeing Vice President Lyle A. Wood as general manager (AW April 27, p. 34).

Fairchild Engine & Airplane Corp. reported a first half net profit of \$245,000, compared with a net loss last year of \$5,003,000. Comparable sales were \$60,399,000 this year and \$67,801,000 last year.

Grumman Aircraft Engineering Corp. reported first half earnings rose to \$3,826,601, or 84 cents a share, from \$2,180,804 or 47 cents a share last year on a \$23.9 million sales increase from \$107,532,602 to \$131,463,446.

Ryan Aeronautical Co. will design and build a Navy A2F-1 jet fighter tailpipe which will enable the plane to make "extremely short takeoffs and landings." Contract was awarded by Grumman.

Sperry Gyroscope Co. is developing one of the high-power radar transmitters to be used for target tracking in the Army's Nike Zeus anti-missile missile system under a \$4 million contract with Bell Telephone Laboratories.

Army aviation officials this week will start evaluation of the Sikorsky S-60 flying crane under a contract calling for several weeks of evaluation at Ft. Rucker, Ala., Ft. Benning, Ga., and Ft. Bragg, S. C.

Gen. Minoru Genda, chief of staff of Japan's Air Self Defense Force, and a team of six officers, are in the United States for a two-month inspection tour to see the Grumman F11F-1F, Lockheed F-104, Northrop N-156F and Convair F-102 and F-106.

Folland Aircraft Managing Director W. E. W. Petter and Assistant Managing Director E. N. Egan will be leaving the company after its acquisition by Hawker Siddeley (AW Aug. 3, p. 30).

Bilaterals Strengthen Foreign Carriers

BOAC, Air France gain round-the-world routes to meet competition from U. S. jet operations.

By Robert H. Cook

Washington—Foreign airlines are moving successfully to meet the competitive threat posed by the introduction of jet operations over the global routes of U. S. flag airlines by securing expanded traffic rights under the bilateral agreements their governments have with the U. S.

White House approval last week of a Tokyo stop for British Overseas Airways Corp. was the latest indication of what U. S. carriers fear may be a trend toward wholesale demands by foreign airlines for new routes to this country.

BOAC's authority followed on the heels of a new bilateral agreement expanding French traffic rights (AW Aug. 10, p. 39). Together, these route awards form the basis for two new round-the-world services to compete with U. S. carriers at a time when turbojet transports are just making such global service truly practical.

BOAC will take immediate advantage of its new authority by starting a global service Aug. 22 with two Britannia 312 turboprop flights a week between London and Hong Kong via New York, San Francisco, Honolulu and Tokyo. These flights will connect with the British carrier's Comet 4 turbojet service between London and Tokyo through the Middle East to complete the global service.

Air France will start biweekly service on its new polar route between Paris and Los Angeles next year after its Boeing 707-320 transports are delivered, and the French carrier plans to establish round-the-world service in 1961 when Transports Aeriens Intercontinentaux begins flying its Douglas DC-8s into Los Angeles over its new route from the South Pacific.

State Department Stand

Department of State officials, who say that a complete renunciation of the bilateral could have resulted in a loss of Fifth Freedom traffic rights for U. S. carriers flying beyond France, view the new French bilateral as a compromise favoring the U. S. They point out that France gave up its demands for "double track" routes, or duplication of every route granted U. S. carriers. The pact also fails to give the French the route they wanted most—access to the West Coast from New York.

While Air France has gained entry to the U. S. West Coast with a polar routing, an Air France spokesman em-

phasized the equal importance of extension of French routes from Tahiti to the West Coast via Honolulu. This Pacific route permits Transports Aeriens Intercontinentaux, a private French airline, to connect with Air France and provide the French with round-the-world service.

South Pacific Route

This South Pacific route is considered significant in view of French plans to develop Tahiti as a tourist center in competition with Hawaii. A new 12,000 ft. runway at Tahiti will be available for turbojet operations by early 1961 when TAI and Air France can establish their joint global service.

Air France will make a stop at Montreal when it begins operating the Paris-

Los Angeles route with Boeing 707-320s. Meanwhile, Pan American World Airways plans to introduce turbojet service over its Los Angeles-Paris polar route by Aug. 26. This route also is served by Trans World Airlines and Scandinavian Airlines System, and BOAC and Lufthansa also have rights to fly it.

BOAC Reaction

A BOAC spokesman said the airline is "delighted to have approval at last" of its Tokyo stop but termed the four-month delay while awaiting White House approval "utterly incomprehensible."

BOAC estimated that the delay cost it \$2.8 million in lost revenues. An airline spokesman said inaugural service over the route, minus a Tokyo stop, would not have been begun last March if BOAC had considered U. S. approval anything more than a formality. In addition to revenue losses, BOAC had to refund advanced fare bookings made over the Tokyo-San Francisco route.

The carrier also was forced to hold slip crews and their families idle at Honolulu throughout the course of negotiations between the two countries in expectation of a pending decision in the case.

As approved by the Civil Aeronautics Board, BOAC was authorized to provide three trips a week on the new route, but U. S. airline sources claim intervention by the Japanese government forced the British carrier to reduce its schedule pattern over the route to a twice weekly basis.

Japan Air Lines spokesmen say the airline has no plans to increase its nine weekly flights to this country as a result of the BOAC award. However, the carrier is negotiating for the lease of a Boeing 707-120 from Continental Airlines to meet competition from Pan American and BOAC (see p. 43). Pan American on Sept. 5 plans to inaugurate twice weekly jet services between Los Angeles and Tokyo and San Francisco and Tokyo.

Northwest Airlines, which fought the BOAC proposal, also says it has no plans to change its scheduling as a result of the addition of Tokyo to the British route.

However, the carrier is not convinced that the threat of direct competition with the British airline is past. While BOAC will fly a mid-Pacific route to Tokyo, as opposed to Northwest's routing on a Pacific polar route via Anchor-



707-420 Will Enter BOAC Service

First Boeing 707-420 intercontinental turbojet transport is the 35th 707 to be produced at Renton, Wash., by Boeing's Transport Division. The aircraft will enter British Overseas Airways Corp. service.

age, company attorneys claim that an Air Transport Agreement between the U. S. and Britain contains a clause allowing BOAC to use Anchorage as a fueling stop. This, they say, makes possible direct BOAC flights between Tokyo and San Francisco. Terms of the Bermuda Agreement, under which the route was spelled out, allows BOAC to drop any intermediate points, such as Honolulu and Wake Island, making a Pacific polar routing practical, according to Northwest.

Other U. S. airline spokesmen believe that the British carrier will divert a significant amount of traffic from both U. S. domestic and international carriers. More than 90% of the traffic potential BOAC may realize is Fifth Freedom traffic accounted for by Americans traveling to Japan. Tokyo, the spokesmen point out, represents 80% of the total transpacific air traffic and adding the city, along with New York and San Francisco, to the BOAC route gives the carrier three prime traffic gates not enjoyed by any single U. S. carrier.

Their fears were echoed by CAB member Louis J. Hector, who said that, although the Board discussed the public interest aspects of the BOAC request, the outcome of the issue was actually predetermined by the U. S. government's obligation to honor bilaterals.

Backing CAB Examiner Ferdinand D. Moran's rejection of the BOAC request, Hector said that although he concurred in granting the request he questioned much of the Board's reasoning in doing so. In essence he contended that, while the CAB conducts public-interest hearings on such matters under Section 402 of the Federal Aviation Act, such hearings are immaterial since the government already is bound to honor the route terms of its bilateral agreement.

Delta Proposes Low Coast-to-Coast Fare

Washington—Delta Air Lines has proposed a reduced fare "thriftcoach" service on a coast-to-coast schedule as one of its major plans for improved service if the carrier is granted West Coast routes in the Southern Transcontinental Service Case.

Testifying at Civil Aeronautics Board hearings last week, the airline said its plans also call for five daily turbojet schedules linking Atlanta and Miami with the West Coast and two daily all-cargo flights between these points with piston engine planes.

The airline has requested an extension of its present route system beyond Dallas, Ft. Worth and Houston to Los Angeles, San Diego and San Francisco. Delta also proposes to link San Juan, Havana, Caracas and other cities on its Caribbean routes with the California cities through a link-up at New Orleans.

Delta told the Board that it plans to offer 231 million thrift coach passenger miles in 1960 and expects a profit potential of \$1.86 per plane mile on the planned service. Using DC-7s, in a combination of 67 thriftcoach and 18 first class seats, maximum passenger revenue per plane mile is expected to be \$3.85.

Proposed thriftcoach fares would be about 3.87 cents per passenger mile, compared to current fares of 6.5 cents for first class and 5 cents for tourist service, the carrier said.

Based on an average trip length of 743 mi., Delta estimates the cost of the reduced fare service would run about \$2.15 per plane mile, and break-even passenger load factor would be 51.69%.

Cargo flights planned by Delta would use DC-6As on an initial schedule of two daily flights connecting Miami and Atlanta with San Francisco and Los Angeles, with additional schedules added as long haul traffic increased.

Braniff, Continental Report Profit Gains

Washington—Mid-year earnings reports of trunk airlines continue to register heavy gains, with Braniff Airways net income increased 107% over the first six months of last year, and Continental Airlines operating revenues reflecting a gain of 43% in the same period.

Braniff recorded a net income after taxes and capital gains of \$1,805,888, based on operating revenues of \$36,731,793 and total expenses of \$33,468,314 for the first six months of this year.

In the same period of 1958, the carrier earned a net profit of \$870,869 on operating revenues of \$33,213,540 and expenses of \$31,814,844. Depreciation and amortization costs during the 1959 period were \$2,799,922, compared to \$3,401,433 for the six month period last year.

Continental had a net income of \$859,000 during the period, compared to a net loss of \$383,000 for the first half of 1958. Operating revenues increased to \$17,466,000, compared to \$12,213,000 during the first half of last year, while expenses advanced from \$12,377,000 to \$16,584,000 in the same period. Much of the rise in interest and other expenses this year was canceled out by a net capital gain, after taxes, of \$1,028,000 from the sale of aircraft.

First *electra*/*JET* service along the Pacific Coast



LATEST IN A 33-YEAR SERIES OF AIR TRAVEL "FIRSTS" is Western Airlines' new *electra*/*JET* service. Fastest and most comfortable flying ever between Seattle-Tacoma, Portland, San Francisco, and Los Angeles! The revolutionary *electra*/*JET* is big, powerful, *jet-fast*—and its combination of jets and propellers has some wonderful advantages over ordinary jets. The ability to take off and land more quickly...faster climbing to cruise altitude...greater nimbleness on the ground to cut taxi and loading time. As a result, the *electra*/*JET* is one jet whose gate-to-gate timetable really tells the truth! Now, more than ever, Western's the *wonderful* way to fly!



"First in the West with *electra*/*JETS*"

**WESTERN
AIRLINES**

Japan to Lease 707 for Pacific Jet Race

By Glenn Garrison

New York—Japan Air Lines is negotiating with Continental Airlines for the lease of one Boeing 707-120 jet transport to enter the Pacific jet competition, AVIATION WEEK has learned. If the deal goes through as expected, the Japanese carrier could come close to matching the Sept. 5 transpacific inaugural date Pan American World Airways has set for its Boeing 707-320 aircraft.

Continental last week received its fourth jet, the final unit in its initial firm order. But the airline had optioned a fifth 707-120, and this airplane is off the production line and now is parked at Boeing's Renton, Wash., plant. It is fitted with a Continental interior and is in overwater configuration.

Japan Air Lines has ordered four Douglas DC-8 jet transports, the first of which is scheduled for May, 1960, delivery, and service with the airplane is expected to begin some time before July, 1960, (AW July 13, p. 39). But in the meantime, others in the turbine competition across the Pacific would gain a considerable lead on the Japanese carrier. Pan American expects to begin with two San Francisco-Honolulu-Tokyo and two Los Angeles-Honolulu-Tokyo flights a week and this schedule will extend through the winter season.

Northwest Orient Airlines has ordered five DC-8s for 1960 delivery and hopes to start service early next year. British Overseas Airways Corp. has announced plans to start transpacific schedules next Sunday with its Britannia 312 turboprop transports, which will connect at Tokyo with BOAC Comet 4 jets to provide a round-the-world turbine-powered service.

Continental Crews

AVIATION WEEK learned that initial use of Continental crews is contemplated. It is likely that Japanese crew members will be trained to at least partially replace the Continental personnel after the service gets under way. JAL now operates its piston-powered transpacific services partly with U. S. pilots (AW July 20, p. 39) and some U. S. first pilots probably will be used on initial DC-8 runs.

The Japanese airline now flies nine weekly round trips between the U. S. and Tokyo, most of them with Douglas DC-7C equipment and the rest with DC-6Bs. It serves the three Pacific Coast gateways of San Francisco, Los Angeles and Seattle.

Service with the Continental 707-120 would undoubtedly begin at Los An-

gles or San Francisco, and possibly alternate between the two cities, with a traffic stop at Honolulu en route to Tokyo.

The lease with Continental probably will extend past the start of DC-8 service. Such an arrangement would add to JAL's jet capacity while its DC-8s were being phased in and would provide additional crew training opportunities. It appears likely from prestige considerations that all-Japanese crews will be flying the 707 as soon as practicable.

Previous Leases

If the JAL-Continental deal is consummated, it will mark the third instance of an airline, temporarily without jets, leasing aircraft to meet or beat its competition. First was National Airlines' deal with Pan American, giving National the use of 707-120s for the highly competitive New York-Miami run; and Northeast Airlines recently arranged to lease TWA jets for the same route next month (AW June 29, p. 31).

Continental's four delivered jets will be able to handle its needs for the immediate future, according to the air-

line. Since start of jet service, June 8, between Los Angeles and Chicago, Continental has carried about 30,000 passengers on the aircraft. It has been flying three nonstop round trips daily between the two cities, and was scheduled last week to add two more schedules, one with a stop at Denver and the other with a stop at Kansas City. On Sept. 5, the airline plans to add a second Chicago-Denver-Los Angeles schedule, for a total of six round trips daily between the two terminals.

Continental has been averaging 11½ hr. of daily utilization with its two jets in scheduled service. The fourth airplane will take over flight training duties, providing an active fleet of three.

The airline saves its jet passengers, using Continental's new in-flight ticketing system (AW June 15, p. 38), are averaging 45 sec. through the check-in line at Chicago. Longest check-in, according to the carrier, took 2 min.

By Sept. 5, Continental will be operating more than 80% of its daily seat miles with turbine-powered equipment including the Boeing jets and 15 Vickers Viscount turboprops.



Boeing Tests Fifth Pod on Qantas Jet

Qantas Empire Airways Boeing 707-120 jet transport, carrying its spare Pratt & Whitney JT3-C engine slung under its left wing in a fifth pod, takes off on a test flight from Boeing Field, Seattle, Wash. Boeing pilots said extra pod does not materially affect flight handling qualities. Aircraft is not a 707-420 as was previously reported (AW Aug. 10, p. 37). Below, Qantas "City of Canberra" flagship is shown on arrival at Honolulu, Hawaii, airport. Airline flies weekly jet service between Sydney, Australia, and San Francisco, Calif. Inaugural flight took 14 hr. 44 min. for 7,650 mi. route.





Airline profit-makers

The Boeing jetliners shown above are designed for profitable operations over all airline routes, from short intercity segments to very long overocean stages.

Their outstanding earning power has already been demonstrated by the 707. Since going into service last October, this Boeing jet has attracted unprecedented load factors of 90 to 95%. Operators describe it as the most popular airliner in aviation history.

Within weeks the 707 Intercontinental—the world's longest-range jetliner—will begin commercial operations. With a range of more than 5000 miles with full passenger payload,

it will fly nonstop over the longest stages of airline routes, at cruise speeds above 600 miles an hour.

The 720 is the fastest airliner of its class, with a cruise speed of 614 miles an hour. Backed by Boeing's unequalled multi-jet experience, the 720 is an extremely versatile jetliner able to operate profitably over short intercity and medium-range routes.

Boeing jetliners, now in scheduled service on United States and international routes, are demonstrating tremendous earning power, extremely high initial utilization and unprecedented public acceptance.

These airlines have already ordered Boeing jets:

AIR FRANCE • AIR INDIA • AMERICAN
B.O.A.C. • BRANIFF • CONTINENTAL
CUBANA • IRISH • LUFTHANSA
PAN AMERICAN • QANTAS • SABENA
SOUTH AFRICAN • TWA
UNITED • VARIG • Also MATS

BOEING
Family of jet airliners

Senate Approves \$25 Million For MATS Jet Transport Fleet

Washington—Senate has tacked \$30 million onto a supplemental appropriations bill to begin a comprehensive modernization program of Air Force's Military Air Transport Service.

Previously, both House and Senate had turned down Air Force's request for \$53 million for 10 cargo jets for MATS in voting the Fiscal 1960 appropriation for Department of Defense (AW Aug. 10, p. 26). Air Transport Assn. fought the project, claiming MATS would use the jets in competition with commercial operations. However, USAF and its supporters on Capitol Hill apparently decided on another attempt after final passage of the defense bill.

The \$30 million was approved after a brief presentation to a Senate Appropriations Subcommittee considering supplemental appropriations by Sen. Howard Cannon (D-Nev.). Cannon reinforced his presentation with a letter from Air Force Secretary James H. Douglas supporting the measure.

As outlined by Cannon, the three steps in the MATS modernization:

- First, "a high-speed alert force" which would consist of two or three squadrons of Boeing 707, DC-8, or Convair 600 aircraft in a military configuration for efficient cargo handling. Approximately \$25 million of the \$30 million would be available for these cargo jets.
- Second, a larger, faster, long-range "workhorse" aircraft for cargo handling and troop transport. It would replace the piston-engine C-124, of which MATS now has 140. Cannon said the replacement would "very possibly be something like the C-130B." The additional \$5 million in the \$30 million bill is earmarked for the development of an advanced powerplant for the new workhorse aircraft.

- Third, completion of the program for the Douglas C-133 turboprop cargo aircraft now in the inventory. The programmed build-up to 50 is scheduled to be completed in three years.

An ATA spokesman suggested that Air Force "dragged in" the \$5 million for the workhorse cargo aircraft to gain support for the jet cargo aspect of its MATS modernization program, particularly the support of Sen. Mike Monroney (D-Okla.). Monroney has been pushing for the development of such a plane for commercial as well as military cargo operations. Monroney estimates that, if an economical plane were developed which could operate for about 4.5 cents a ton-mile, about 300 of them could be used in commercial operations (AW May 18, p. 25).

In May, Assistant Secretary of Defense Perkins McGuire informed Monroney that Defense was working with the Federal Aviation Agency on the development of a commercial-military cargo aircraft.

Last week, after the Senate voted funds for USAF to undertake the development, Federal Aviation Agency Administrator Elwood Quesada canceled a scheduled press briefing on FAA's program for development of an economic commercial cargo plane.

At the subcommittee hearing, Monroney opposed placing control of the development with USAF. "I am certain, from the record that we have had in the past, that the Secretary of the Air Force, and none of his people, have ever been successful in designing or procuring a common type of cargo plane where the cost factor in day-to-day operations per ton-mile is the important element," Monroney said. "It is not the important element for the military, because they are seeking performance, and in getting performance they automatically get a lot of gadgetry, added equipment, built-in headwinds, and things of that kind."

Cannon reported that USAF has "several proposals" for the commercial-military cargo aircraft.

American Claims Revenue-Miles Peak

New York—American Airlines flew 559,854,000 revenue passenger miles last month, a total the airline said was an all-time monthly high for commercial aviation. The figure was about 20% higher than the July, 1958, total and, for the first time in American's postwar experience, the July total topped the June total. June usually is the airline's biggest traffic month.

Other increases were reported in air freight, up 10% over July of last year; air mail, up 15%; and surface mail, up 11%. American said its turbine fleet, now totaling 35 Boeing 707-120 jets and Lockheed Electra turboprops, was largely responsible for the July record.

American last week announced new expansions of its turbine aircraft services. By Aug. 21, when the new pattern is to be completed, plans call for new jet services which include two Dallas-Los Angeles flights daily, Boston-San Francisco service via Chicago, daily Chicago-Dallas round trips, and a second daily Baltimore-Los Angeles round trip.

New Electra services under the plan will include Chicago-Detroit flights, a Detroit-Chicago-Dallas-El Paso schedule, and an increase to nine daily round trips in New York-Chicago service.

Slick Places Order For Three 1049Hs

Slick Airways has placed an order with Lockheed Aircraft Corp. for three 1049H Constellation convertible cargo-passenger airplanes. Contract value is about \$7 million, including spares. The first airplane will be delivered immediately; the other two will be transferred to Slick next month.

The move, according to Slick, is the first step in re-establishing the carrier in U. S. domestic air freight common carrier cargo service after temporary suspension (AW Mar. 10, 1958, p. 31).

Purchase of the 1049Hs brings Slick's total order for Lockheed planes to nine within one month. The line placed an order with Lockheed's Georgia Division for six Super Hercules freighters with a contract value of about \$22 million (AW July 27, p. 53).

27 Airlines Bid For MATS Contracts

Washington — Twenty-seven commercial airlines have submitted bids to Military Air Transport Service for airlift of passengers and cargo to Europe, Alaska and the Pacific area during the year starting Oct. 1.

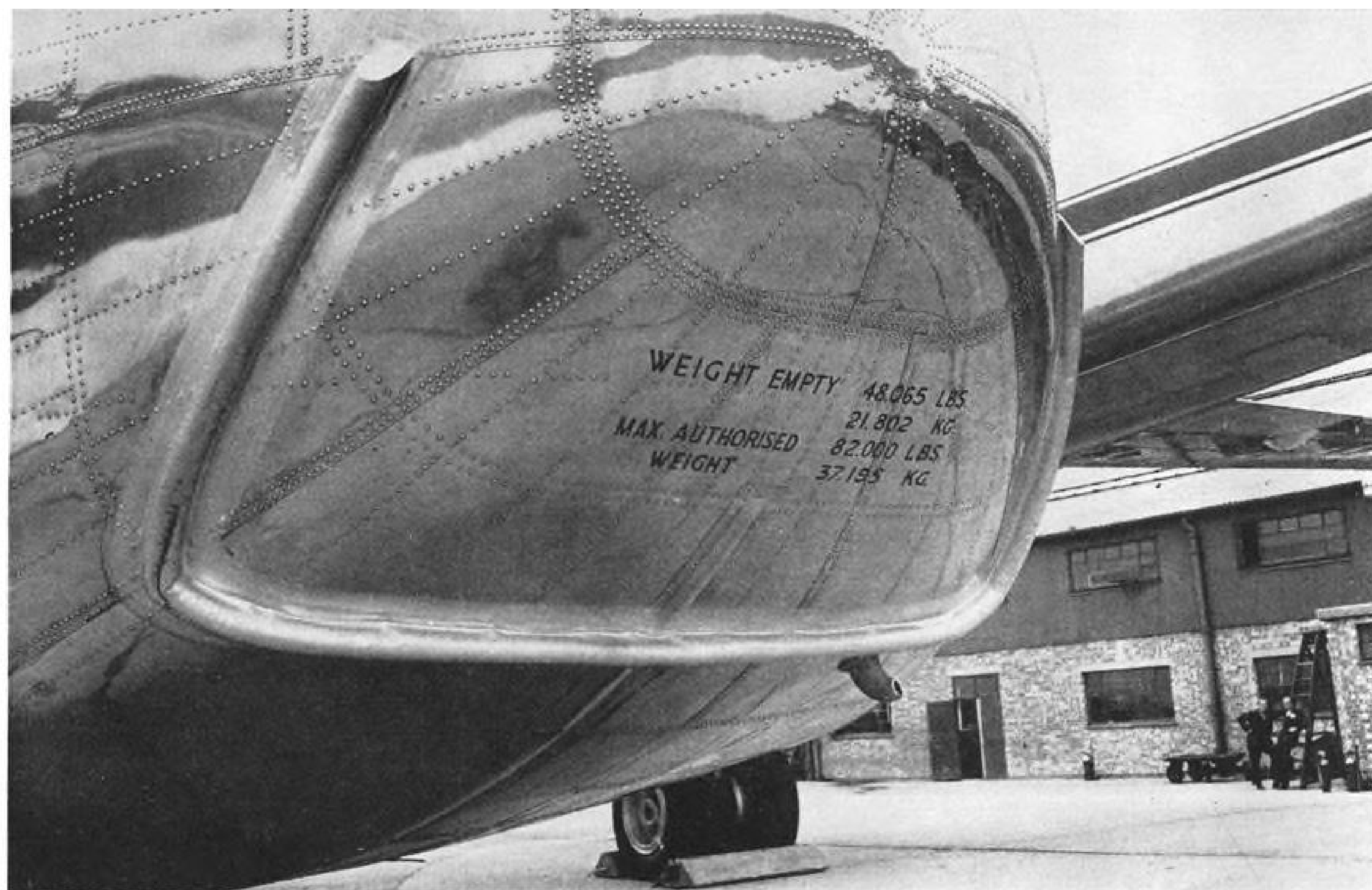
Considered by MATS the largest single military airlift purchase ever made, award of the contracts about Sept. 1 will cover airlift of 288,600 passengers, 10,320 tons of cargo and 6,144 tons of mixed traffic during the year. Commercial carriers will transport 129,000 passengers, 4,920 tons of cargo and 6,144 tons of mixed cargo in the Pacific; 123,600 passengers and 5,400 tons of cargo across the Atlantic; and 36,000 passengers in Alaska area.

Total of 87 operators which requested bid information for the airlift was the largest number ever to be placed on the military bidding list. Bid requirements were divided into 14 route segments.

BEA Signs Order for 24 Triple-Turbojet DH-121s

London—British European Airways contract for 24 Airco-de Havilland DH-121 jet airliners worth \$87 million was signed last week. The airline holds an option for an additional 12 aircraft.

A 12-month contractual delay (AW Feb. 17, 1958, p. 41) was caused by specification changes reducing the size of the aircraft.



BREAKER STRIP around AW 650 rear fuselage dome prevents strong underside flow from causing turbulence on tail plane.

Argosy Modified to Cut Aft Turbulence

By John Tunstall

London—With one third of the Armstrong Whitworth AW 650 turboprop freighter development completed, virtually trouble free, designers expect full U. S. and British airworthiness certification by next March. This is two months ahead of a schedule prepared nearly two and a half years ago when the project was started.

Using the first four production aircraft, the company has logged 350 flying hours since the maiden flight six months ago. Only three flights out of a total of 361 were canceled for maintenance.

The only significant modification has been due to a flow breakaway along the upper surface of the fuselage, exciting low frequency vibrations in the rear fuselage and tail plane. The vibra-

tions were barely perceptible at the rear of the fuselage and the company was originally undecided on need for correction.

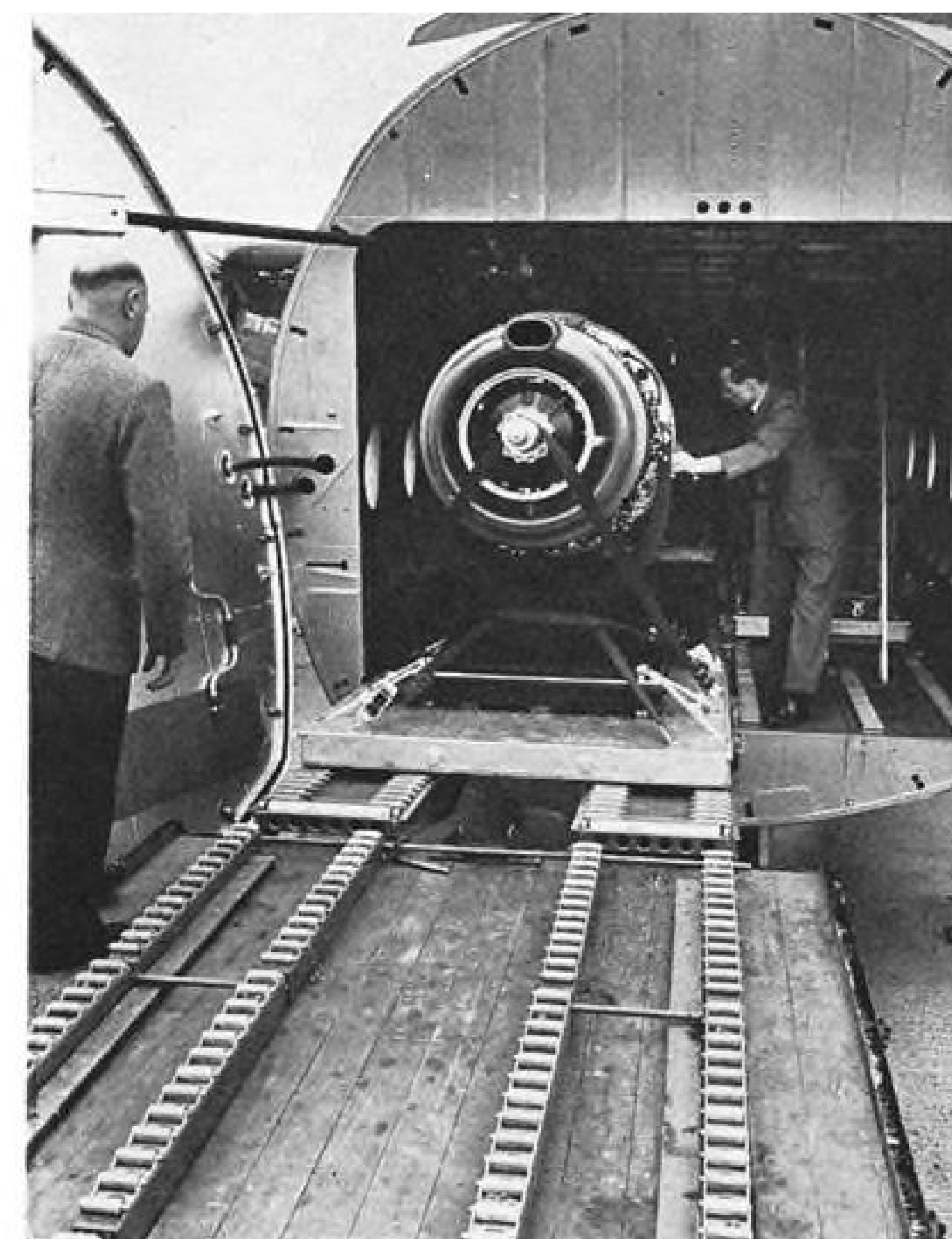
Otherwise, Deputy Chief Engineer David Woodley told AVIATION WEEK, modifications have been minor, and the behavior of the aircraft systems which have been fully installed in all four aircraft has been good.

Cockpit Slope

Breakaway of the top fuselage flow is due, Woodley said, to the relatively steep downward slope of the cockpit rear and to the high wing position. Also, the fuselage in a twin boom configuration was particularly susceptible to vibration, due to buffeting produced through lack of the damping influence of an integral empennage.

Because of the broken top flow, the strong undisturbed pressure flow along the bottom of the fuselage is able to sweep upward and direct the turbulent wake on to the tail plane. The excitation is dependent on speed and appears to be in the 7-30 cps. band.

Current attempts to improve the flow include vortex generators on the rearward slope of the cockpit blister and a breaker strip around the lower part of the fuselage and dome which impedes upward flow from the bottom fuselage surface. The fifth aircraft currently is being fitted with a larger wing



TRUCK HEIGHT loading floor speeds cargo operation (left); at right, palletized freight is secured to floor by locking pieces.



fillet which may be able to replace the breaker strip.

In the basic airworthiness phase of the test program which has now been concluded, all the systems have been cleared, and the aircraft has flown at maximum weights over its full center of gravity range. Docility of the 82,000 lb. aircraft is pointed up by its ability to hold 75 kt. with full flap, landing gear down and one engine feathered.

The company is now proceeding with the detailed evaluation of performance criteria.

Tropical trials are due to start in September.

In the static test program, all the critical loading cases have been covered,

and fatigue testing now under way on a complete aircraft in the water tank has logged 5,000 hr. of simulated flight. Production is now one aircraft a month.

Following acceptance of a restricted certificate of airworthiness in May, Armstrong Whitworth has been using the fourth production aircraft for demonstration flights to airlines and for freight handling exercises. Fitted out as a mixed passenger/freight variant with seating for 18 passengers, it will later be used for route-proving trials. Seats which fold flat against the sides and removeable bulkheads enhance the rapid convertibility of layout.

Company's palletized freight system is based on use of lightweight metal strips mounting small rollers which are

bolted to the freight floor. Pallets can be stressed, unstressed or box type. Company studies, Woodley claimed, proved that the added weight of the palletizing equipment is amply justified by the flexibility and increased loading rates obtained.

Argosy sales tour of the U.S. is scheduled for early 1960. Company now has expressions of intent for about 40 aircraft, but no signed contracts.

Riddle Airlines has ordered four AW 650s, with Rolls-Royce Dart engines (AW June 22, p. 112).

Company is negotiating with British Ministry of Supply for a military order of about 12 aircraft and envisions future development of up to 110,000 lb. gross weight.



TWO MEN can load palletized freight in a short time, aided by roller strips on flooring.



VORTEX generators (left) are installed on cockpit blister to help eliminate buffeting at rear. At right is AW 650 cockpit layout.



The man:



A member of an Army Medical Corps air evacuation team. He belongs to one of the Army units which rush the sick and wounded to general hospitals by air. Fast evacuation of casualties to hospitals has dramatically reduced the number of fatalities in "brush fire" or general warfare.

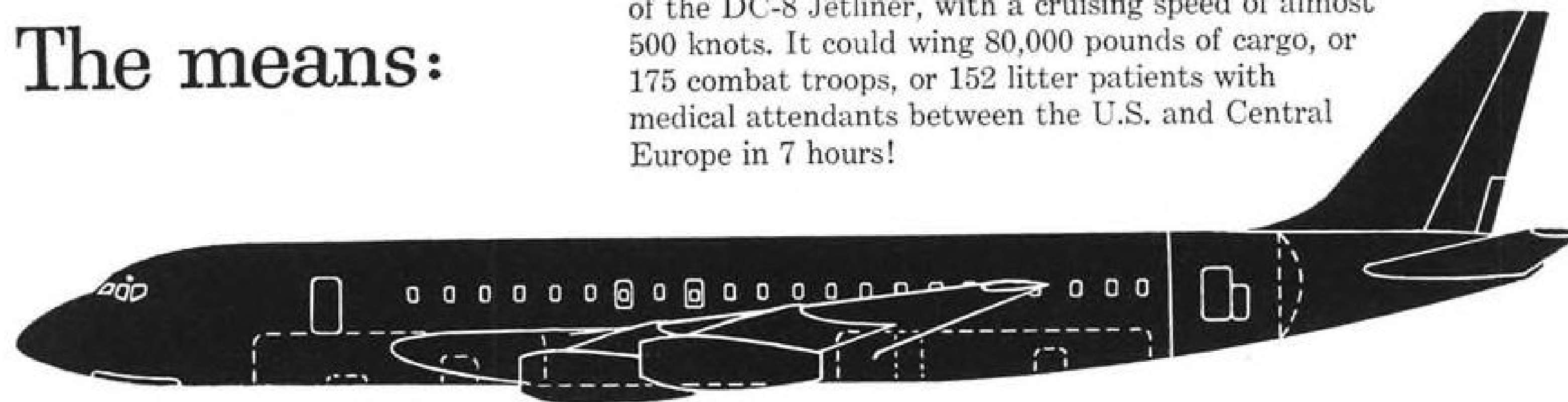
The mission:

In addition to its priority mission of supporting the strategic striking forces, Military Air Transport Service also has the humanitarian mission of air evacuation—high-speed movement of wounded from base hospitals in the theatre of operations to the finest stateside medical care.



The means:

The Douglas "Jetmaster," proposed military version of the DC-8 Jetliner, with a cruising speed of almost 500 knots. It could wing 80,000 pounds of cargo, or 175 combat troops, or 152 litter patients with medical attendants between the U.S. and Central Europe in 7 hours!



Depend on **DOUGLAS**
The Nation's Partner in Defense

Airline Traffic—June, 1959

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American.....	709,949	541,558	80.6	1,716,928	844,274	8,625,687	63,179,285	66.6
Braniff.....	177,149	80,425	61.7	329,280	172,744	697,542	8,917,969	51.7
Capital.....	355,145	145,290	62.2	448,731	257,601	412,352	15,039,318	54.8
Continental.....	100,582	60,631	64.5	124,667	52,894	167,660	6,159,333	54.7
Delta.....	262,024	132,400	59.7	386,688	288,455	1,205,982	14,627,653	53.9
Eastern.....	723,501	384,725	53.35	981,042	506,133	1,431,233	39,960,237	43.47
National.....	134,928	80,077	54.5	255,559	63,987	525,261	8,566,078	44.5
Northeast.....	109,442	41,881	50.7	81,710	34,314	106,373	4,230,640	40.8
Northwest.....	174,535	137,245	64.5	523,872	255,808	1,241,041	15,203,244	54.8
Trans World.....	477,467	441,389	80.3	1,253,656	647,294	2,514,308	46,703,089	67.5
United.....	673,849	498,650	75.2	2,692,130	1,014,775	6,668,420	58,191,346	65.6
Western.....	134,997	77,624	60.6	271,755	80,264	364,843	8,152,204	52.5
INTERNATIONAL								
American.....	9,873	9,573	60.3	10,568	452	244,368	1,244,382	64.0
Braniff.....	4,440	8,156	57.2	24,249	.....	125,100	1,037,933	53.2
Caribbean-Atlantic.....	24,348	1,691	63.0	1,743	.....	4,623	183,805	69.2
Delta.....	4,555	6,071	55.2	6,577	.....	52,363	735,451	49.4
Eastern.....	38,620	56,346	59.90	75,922	.....	104,713	5,984,326	74.66
Mackey.....	9,557	1,823	45.7	.....	76	2,280	198,971	45.6
National.....	6,932	4,548	56.0	8,306	4,714	44,243	541,004	50.2
Northwest.....	20,505	39,096	63.5	1,176,382	26,191	965,297	6,281,322	67.8
Pan American.....	.....	.....	.....	.....	.....	.....	.....	.....
Alaska.....	5,916	6,232	66.2	43,787	.....	181,838	899,391	64.8
Atlantic.....	122,582	189,712	76.9	1,338,112	.....	2,824,994	23,987,382	66.6
Latin America.....	115,259	133,565	71.2	391,729	.....	4,156,432	17,179,463	66.9
Pacific.....	29,897	119,294	83.3	1,245,792	.....	1,944,250	15,638,671	75.6
Panagra.....	10,034	14,277	55.5	61,196	.....	464,249	2,077,745	57.5
Resort.....	20	31	19.8	.....	.....	4,336,431	4,344,161	79.5
Trans Caribbean.....	.....	.....	.....	.....	.....	.....	.....	.....
Trans World.....	39,894	126,572	75.1	741,470	.....	1,922,913	15,671,171	71.4
UMCA.....	126	41	30.6	.....	.....	1,110	5,445	36.7
United.....	14,071	34,956	84.5	163,256	.....	128,279	3,864,968	80.4
Western.....	4,294	6,677	61.6	12,560	.....	10,997	750,938	64.5
LOCAL SERVICE								
Allegheny.....	55,505	9,863	53.2	11,570	21,494	27,723	1,002,433	52.3
Bonanza.....	19,627	4,820	45.6	5,856	2,423	10,316	480,097	43.9
Central.....	14,619	2,797	38.1	7,593	3,460	11,799	290,772	34.6
Frontier.....	26,238	6,782	44.1	21,358	10,686	72,146	757,153	51.7
Lake Central.....	20,163	3,250	45.6	3,809	.....	18,609	333,587	49.3
Mohawk.....	51,026	10,078	57.9	8,324	17,768	15,730	1,003,398	57.6
North Central.....	88,862	16,088	47.0	33,332	48,133	17,016	1,663,372	46.92
Ozark.....	51,392	8,890	46.7	13,959	25,956	28,146	917,766	48.9
Pacific*.....	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont.....	45,624	9,725	47.1	17,612	14,127	17,411	981,267	48.1
Southern.....	22,743	4,015	40.0	10,093	9,429	15,127	419,437	40.5
Trans-Texas.....	24,279	5,751	42.5	17,019	9,321	34,222	610,534	43.3
West Coast.....	29,343	5,546	51.64	5,725	2,303	8,499	546,119	51.54
HAWAIIAN								
Aloha.....	28,549	3,999	60.8	2,197	.....	7,811	331,447	43.2
Hawaiian.....	43,530	14,885	76.0	3,822	.....	136,469	1,481,072	74.1
CARGO LINES								
AAXICO.....	.....	.....	.....	4,283	8,637	2,787,081	2,800,001	75.72
Aerovias Sud Americana*.....	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger.....	3,124	14,803	100.0	42,414	64,762	12,354,979	13,942,497	86.8
Riddle.....	.....	.....	.....	.....	.....	.....	.....	.....
Domestic.....	.....	.....	.....	7,716	19,581	3,909,305	3,936,602	74.7
Overseas.....	.....	.....	.....	.....	.....	472,681	472,681	66.0
Seaboard & Western*.....	.....	.....	.....	.....	.....	.....	.....	.....
Slick.....	3,791	24,380	99.16	.....	.....	.....	.....	99.16
HELICOPTER LINES								
Chicago Helicopter.....	20,130	367	58.9	1,385	.....	.....	36,415	51.4
Los Angeles Airways.....	4,417	152.6	59.4	4,895	2,305	.....	21,789	65.8
New York Airways.....	13,125	240	61.2	1,560	1,087	600	26,204	55.2
ALASKA LINES								
Alaska Airlines.....	10,834	9,860	69.5	43,664	3,074	759,262	1,783,828	62.4
Alaska Coastal.....	6,479	688	57.1	3,400	.....	4,898	78,156	59.9
Cordova*.....	.....	.....	.....	.....	.....	.....	.....	.....
Ellis.....	6,145	363	51.9	2,266	.....	3,714	42,688	61.07
Northern Consolidated.....	3,410	1,164	48.6	31,104	.....	92,560	249,804	63.3
Pacific Northern.....	14,343	14,583	63.1	112,535	9,057	349,002	2,049,671	72.1
Reeve Aleutian.....	2,108	1,896	53.3	37,997	.....	78,183	321,161	63.8
Wien Alaska.....	5,581	1,932	37.8	50,100	.....	371,704	617,584	66.2

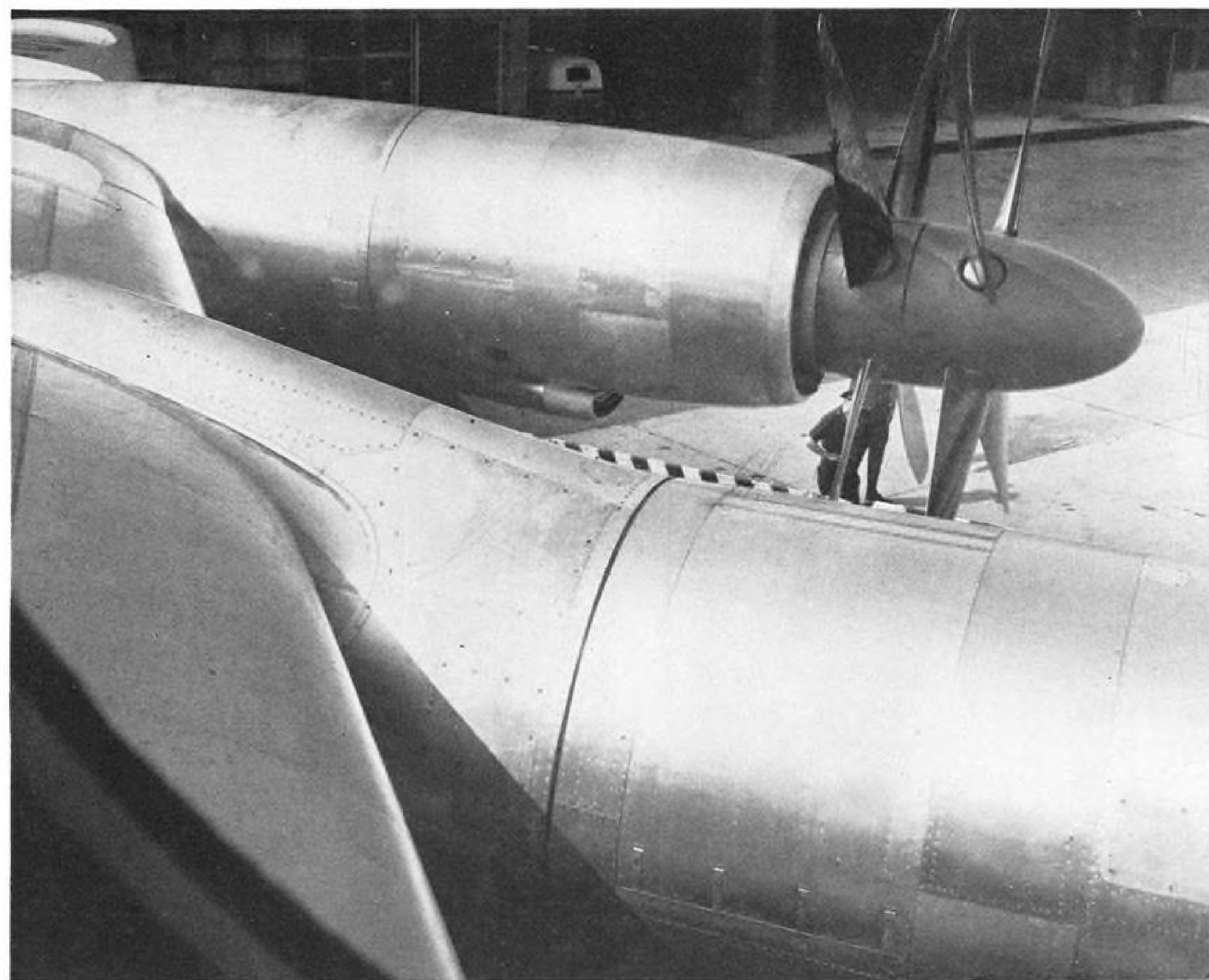
* Not available.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.



BEING TOWED to taxiway at N. Y. International Airport for engine runup, Tupolev Tu-114 shows clean cross-section in rear view, marked negative dihedral of its swept wings. Huge size is apparent when compared with personnel walking turboprop transport to taxiway.

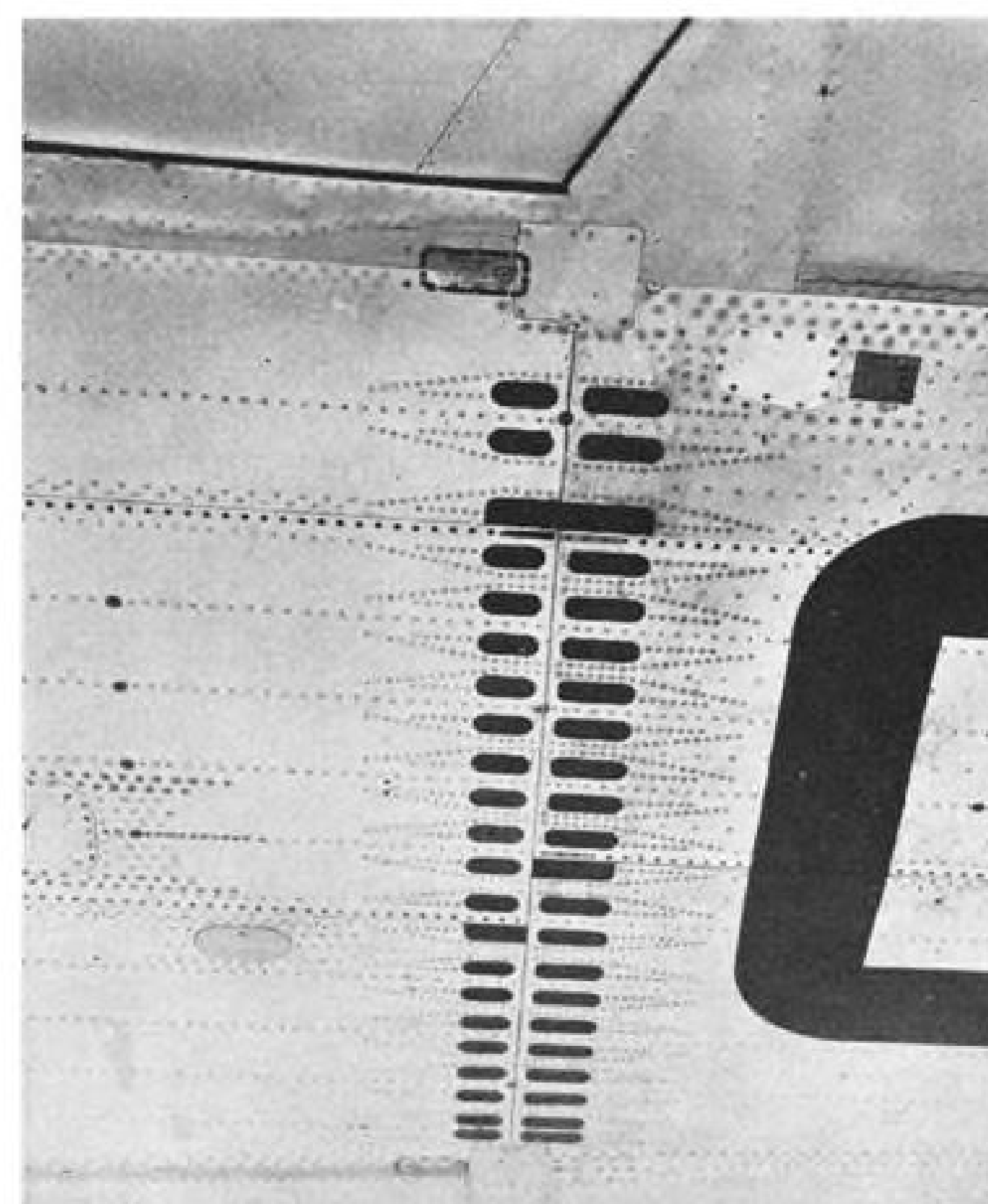
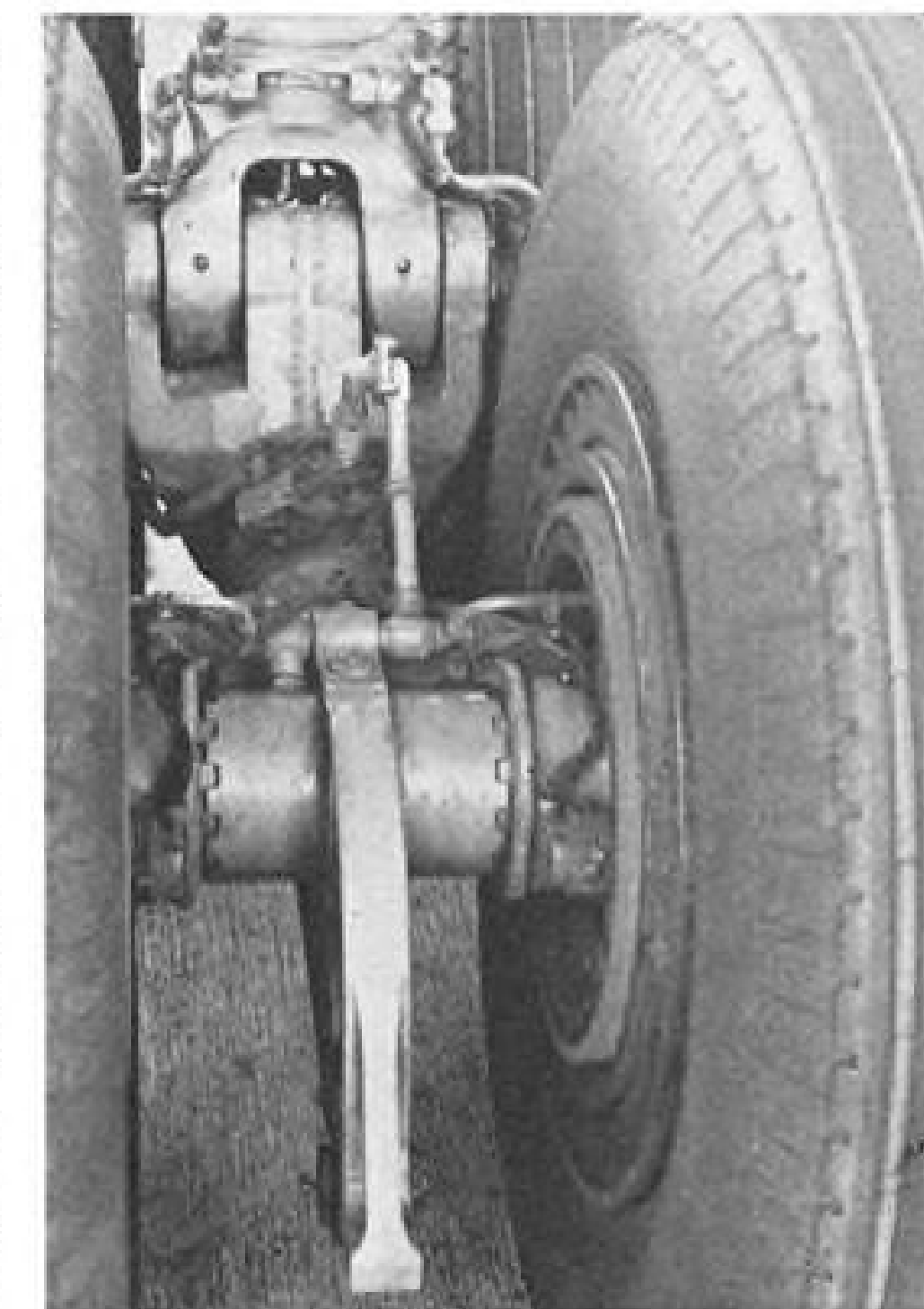
Design Details of Aeroflot Tu-114 Turboprop



CLOSELY COWLED Kusnetzov axial-flow turboprops develop well over 12,000 shp. each, according to the Russians, and use JP-1 type fuel and synthetic lubricants. Hubs of 18.3-ft. diameter reversible contrarotating props are cleanly faired into spinners. Propellers apparently have no brakes, since a pair was observed turning, lashed together, when a breeze sprung up suddenly.



LARGE inner engine nacelle (top) houses huge four-wheel main gear which is retracted using two big electric motors in each well. Gear describes half-circle in retraction cycle, according to Russians. Nose gear (left) is hydraulically retracted, as is twin-wheel tail-bumper. Russian engineers make up gear struts from several components, weld them together, rather than spend time designing single-piece unit. Thin vertical member between fork was welded just above U-fitting. Closeup (right) shows main landing gear truck, facing forward wheels, detail of wheel axle. Chordwise wing splice (lower left) is located between aileron. Fairing strip narrows gap between wing and flap (upper left). Extensive riveting is used throughout Tu-114, rather than spotwelding or honeycomb bonded structures. Tail assembly (lower right) features movable horizontal stabilizer, markings indicating travel were on left side only, just ahead of stabilizer leading edge. Control surfaces are fitted with hydraulic boost system.



The Breakthrough Air Freighter that *smashed* the cost barrier!



CANADAIR JET-PROP CL-44

*...the first aircraft designed
specifically for the air cargo industry*

The jet-prop CL-44 was designed specifically to meet the immediate requirement for an aircraft that would significantly lower the cost of cargo movement.

In this highly important role, the Canadair CL-44 breaks through the transportation cost barrier and will revolutionize the whole air cargo market. It provides direct operating costs of less than 4¢ a ton mile and breakeven load factors as low as 28%, which are both lower than those of any other aircraft anywhere in the world.

The swing-tail CL-44 is already in production for the largest air cargo carriers in the world—Seaboard & Western Airlines Inc. and The Flying Tiger Line Inc.

- Payload—64,000 lbs. • Range—3,000 mi. • Speed—400 mph
- Engines—4 Rolls-Royce Tyne 12 • Cubic capacity—7,391 cu. ft.
- Floor loading—300 lbs. per sq. ft. • Passengers—up to 183
- Span—142 ft. • Length—138 ft. • Cabin length—98 ft.
- Gross weight—205,000 lbs. • F.A.A. takeoff field length—7660 ft.

The Canadair CL-44 is also available as a passenger or as a convertible passenger/cargo aircraft.

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GENERAL DYNAMICS CORPORATION

AIRLINE OBSERVER

► Watch for Iberia Air Lines of Spain to announce the purchase of at least three turbojet aircraft within the next few weeks. Probable order will be for Douglas DC-8s, although the company also has been looking at both Boeing and Convair jets. Order would be placed by the National Institute of Industry, owner of the airline, and is reported awaiting the official backing of Spain's Council of Ministers. The aircraft would be used to meet expected jet competition from both European and South American operators and would be placed on Iberia routes to New York, Mexico City and the Caribbean.

► Hawaiian Airlines has signed a credit agreement for \$3.25 million that will permit the airline to complete its re-equipment program with the purchase of four additional Convair 340 aircraft. The company, which now operates four Convair 340s, seven Douglas DC-3s and one Douglas DC-6C, plans to phase out the DC-3s within the next two years. Terms of the agreement call for loans of \$750,000 each from the Bishop National Bank and the Bank of Hawaii, with the \$1.75 million balance to be provided by the First National City Bank of New York. Loan is scheduled to be retired by Dec. 31, 1965, and was obtained without a guarantee from the Civil Aeronautics Board.

► Trans-Canada Air Lines has completed installation of airborne weather radar on its fleet of 50 Vickers Viscounts and 13 Lockheed Super Constellations. Cost of the refit program, which began last September, is estimated by TCA at \$1.5 million, with Bendix and RCA radar units costing between \$10,000 and \$11,000 each. Modification and installation expense for each aircraft is about \$15,000.

► Two trunk airlines have introduced commuter ticket plans on an experimental basis and may expand the new service if it proves successful. Capital Airlines last month put its first commuter ticket books on sale, effective Aug. 2 over its Chicago-Minneapolis-St. Paul route. By the time the service began, the airline had sold \$125,000 worth of commuter tickets, according to Walter H. Johnson, senior vice president of marketing. American Airlines' first commuter tickets were scheduled to become effective last Saturday over the Boston-New York-Washington route. They will be good for seats in either direction. Each airline sells its commuter tickets in books of 10. Holders of the tickets book space by telephone and write flight number, date of departure and time information—or, in Capital's case, a code number—on the flight coupon. This ends the transaction until the passenger surrenders his coupon upon boarding his flight. Johnson said Capital may extend the commuter service to the New York market within the next 30 days. He said the plan was in line with Capital's intention "to make air transportation easier to use and more convenient to buy." American expects to evaluate the results of its commuter service at the end of October and then possibly apply it to other cities.

► Continental Airlines is providing free bus transportation between Chicago's Midway Airport and O'Hare Field for interline passengers connecting with the company's Boeing 707-120 flights between Chicago and Los Angeles.

► Vickers-Armstrongs, Ltd. says U. S. operation of Vickers Vanguard turbo-prop transport could bring an airline a potential profit of \$6.5 million annually per plane. The British manufacturer bases its profit picture on U. S. costs over 300-mi. stage lengths, a beginning load factor of 48.5% by 1962 and attainment of an 86% load factor by 1968. Applied to European routes, Vickers says the Vanguard would earn a per plane profit of more than \$19 million in the same seven-year period.

► British European Airways' net profits for Fiscal 1958-59 dropped more than \$1.25 million from the previous year and totaled about \$644,000, according to a preliminary financial report by BEA chairman, Lord Douglas of Kirtleside. Profits before paying interest charges on capital were about \$3.6 million. Passenger traffic for the first quarter of the current fiscal year, however, was up 22% above that for the same period of last year.

SHORTLINES

► Air Express Division of the Railway Express Agency reports that it handled 2,945,724 shipments on U. S. scheduled airlines during the first six months of 1959, 15.9% above that for the same period last year. Revenue for the period was up 20%—\$22,398,438 as compared with \$18,666,780 for the first six months of 1958. Ton-miles totaled 26,659,618, a 22% gain over the 1958 period.

► Allegheny Airlines carried 58,797 passengers over 10.2 million revenue passenger miles during July, a 27% increase for the latter over July, 1958. Air freight and express boardings totaled 557,000 lb., with air freight up 36% over July, 1958.

► Maritime Central Airways is now operating a Vickers Viscount V. 805 turboprop transport on its Moncton, New Brunswick-Goose Bay, Labrador, and Gander-St. John's, Newfoundland routes. The airline plans to use a combination freight passenger configuration on the flights.

► Mexicana Airline (CMA) is scheduled to begin Bristol Britannia non-stop service between Los Angeles and Mexico City on Sept. 1. The Britannias will operate on Wednesdays, Saturdays and Sundays, with CMA's Douglas DC-6 aircraft operating on the other four days of the week.

► Mohawk Airlines carried 47,118 revenue passengers in July for a 30.2% increase over July, 1958. Load factor for the month was 53.1, a 6.1% increase over July, 1958.

► Northwest Airlines flew 165,718 domestic passengers 130,128,649 revenue passenger miles during July for 16.5% and 18.6% increases respectively over the same month of last year.

► Seven Seas Airlines, recently organized under authorization of the Federal Aviation Agency to operate contract air service on a world-wide basis, has purchased two Douglas DC-4 aircraft. The carrier, which was incorporated in June, has offices in New York and Amsterdam. Seven Seas purchased the DC-4s from Twentieth Century Aircraft, Inc.

► United Air Lines has begun Chicago-Milwaukee daily round trip service using Convair aircraft. The carrier also has inaugurated Douglas DC-7 daily through-service from both Philadelphia and Pittsburgh to Las Vegas; a nonstop DC-7 service from Salt Lake City to San Francisco and daily one-stop DC-7 service from San Diego to Chicago.



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SPACE TECHNOLOGY

Simulators Train Mercury Space Pilots

By Craig Lewis

Langley Field, Va.—Mercury capsule pilots will use a variety of simulators and simulation techniques to gain practice with the equipment they will use and become familiar with the conditions they will meet when they make the first manned U.S. orbital flights through space.

National Aeronautics and Space Administration's Space Task Group will be putting the Mercury pilots through a number of simulation systems and techniques here at Langley Research Center and elsewhere to familiarize them with the Mercury capsule and its operation. Pilots also will acquaint themselves with those space conditions which can be simulated on earth.

Basic Element

Simulator work is a basic element in the intensive training and indoctrination program the seven Mercury pilots began in April (AW May 18, p. 30) to prepare them for the first U.S. launching of a man into orbit, probably in 1961. Mercury pilots are now moving into the initial stages of the simulator elements of the program.

Using standard computer simulation techniques, Space Task Group has de-

veloped a closed loop analog simulation of the Mercury mission, and this is the first system to be used in the training program. Early version of the simulator includes a chair, sidearm controller and rudder pedals, a configuration similar to the X-15 control system simulator. The Mercury system is isolated by canvas curtains.

Pilot will be active as part of the closed loop system, and various displays and controllers will be tested during the program. Later version will have a moulded couch of the type to be used in the Mercury capsule and will be equipped with a three-axis controller.

This simulator is limited in its analog capability and cannot run a continuous flight cycle for the pilot. It can simulate re-entry, for example, only at discrete points. Although the complete Mercury mission cannot be animated, the orbital phase, retrograde firing mode and re-entry phase can be simulated, and the pilot can be moved from one to another by some quick switching in the computer system.

Since the simulator is a static device, no dynamic motions can be introduced and work is confined to flight control coordination and evaluation of control system and displays. There is no capability for introducing emergencies

into the system. More advanced simulation, including some dynamic aspects of the Mercury mission, will be encountered during the sessions this month and next January in the Navy's centrifuge at Johnsville, Pa. Computer-run centrifuge simulator will have the basic Mercury instrument panel with attitude, rate, altitude and acceleration instruments animated. It will have the Mercury couch and the present version of the restraint harness, and it will also have the current production type hand controller.

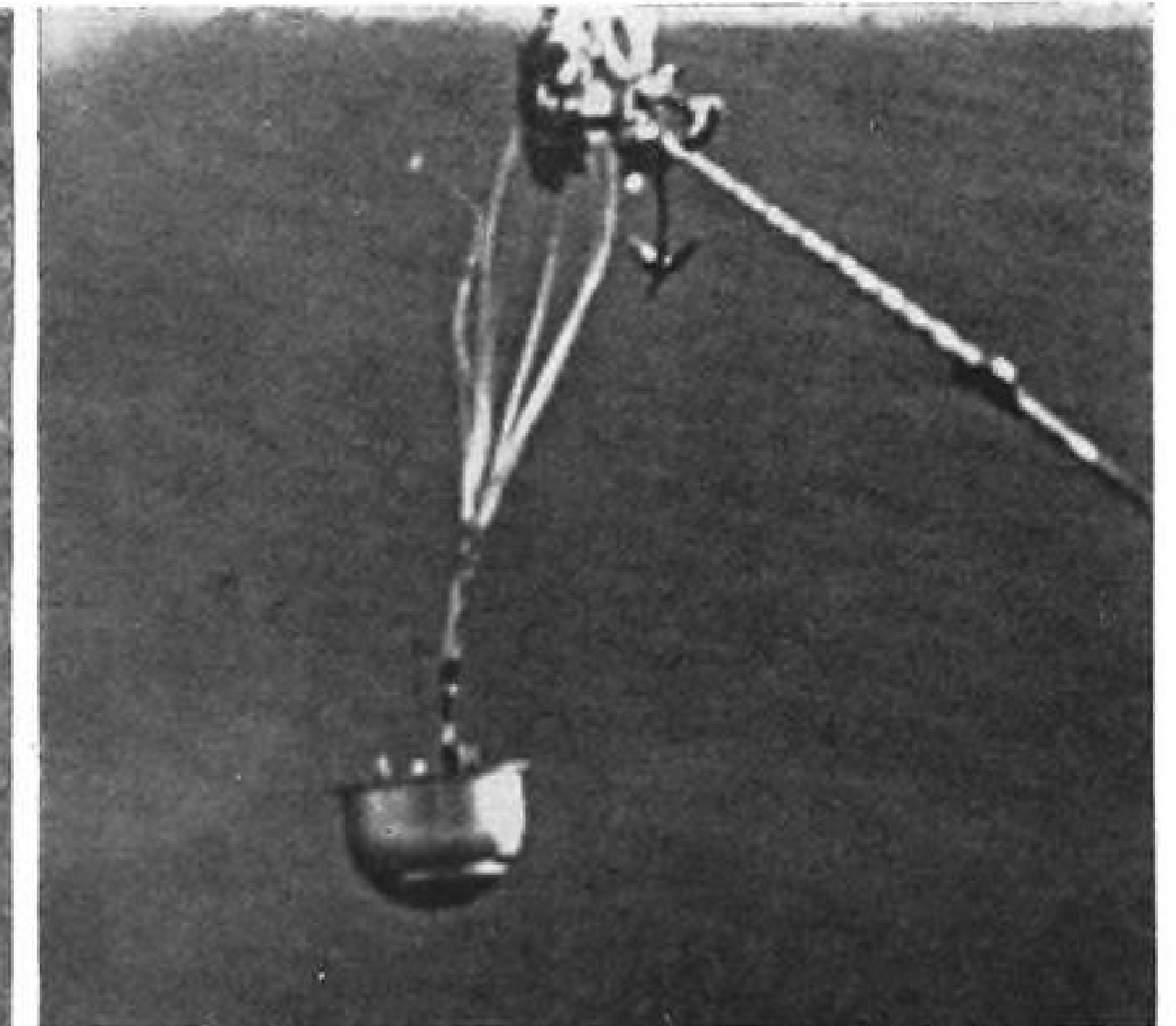
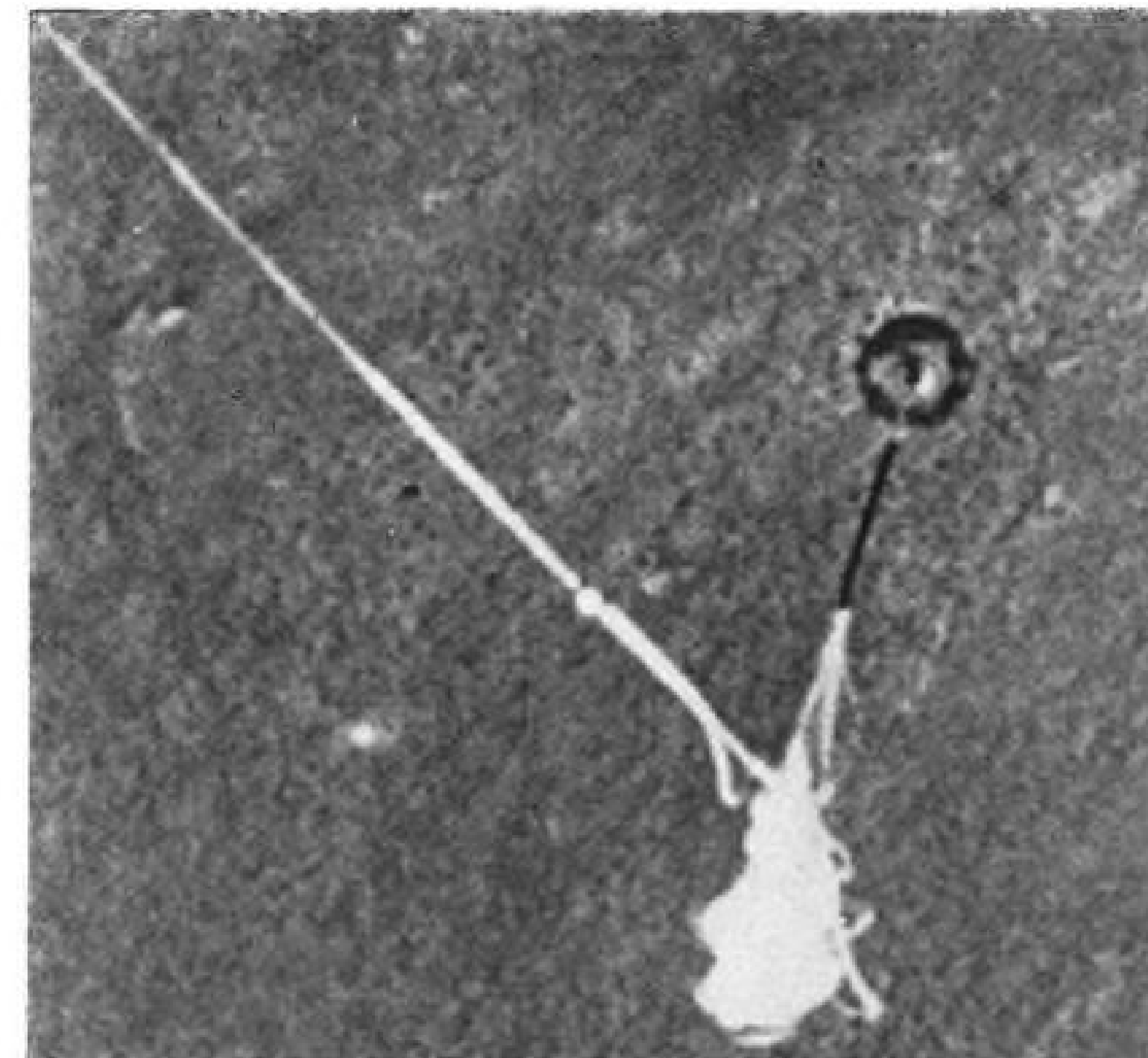
McDonnell Aircraft Corp., the Mercury capsule prime contractor, is responsible for the controller design. It will be a three-axis type in which the pilot controls yaw through the palm of his hand by moving the controller left or right, pitch through his wrist by moving the controller back or forward, and roll by twisting his hand left or right around a pivot point three inches below his hand.

This three-axis controller is a departure from the usual aircraft control system, and it has been suggested that the Mercury pilots might do better with yaw control in the pedals they are familiar with from aircraft operation. Space Task Group expects the pilots to accept the three-axis controller as a superior system once they get some practice with it in the simulators.

Launch Acceleration Pattern

In the centrifuge, the launch acceleration pattern will be run open loop since there will be no pilot control function during the actual Mercury launch. There will be no dynamic motion in the retrograde maneuvering simulation because there are no large accelerations involved. In this phase, the Johnsville simulator will be a closed loop analog system much like the simulator at Langley. Centrifuge will be used in the re-entry phase, and accelerations will depend to a limited degree upon pilot control, although there is not much change in acceleration vectors possible with the Mercury capsule during re-entry.

Simulation at Johnsville will include some escape maneuvers and re-entries following aborted missions. Accelerations on the order of 20g are the highest expected in the Mercury mission, but the pilot will not necessarily reach that level in training. Space Task Group wants to avoid chances of injuring the pilots, and the higher accelerations will be used only if they



C-119 Recovers Discoverer Payload in Test

Parachute of General Electric payload for the ARPA-Lockheed WS-117L Discoverer satellite is snared by a cable trailing from a Fairchild C-119 during practice tests of air recovery of the unit after it has been ejected from orbit. In tests, the payload is dropped from another aircraft. In the picture at right, winch system pulls the capsule into the C-119's bay.

definitely have training value, according to Harold Johnson, chief of the training devices section of STG's Operations Division. Some acceleration forces will be used to check out the harness with the Mercury pilots.

The training exercises in the early simulator here at Langley are largely for engineering evaluation of the system, the controllers and the displays. The work at Johnsville will have this function, but it also will provide the pilots more realistic familiarization with the Mercury system. The January session at Johnsville will be generally the same as the August program, except it will be somewhat more sophisticated, probably with more capability for simulating aborts and with added emphasis on the Redstone-boosted training flights the pilots are scheduled to make.

An air bearing orbital attitude simulator will be used at Langley to train the pilots in attitude control during orbital flight. This iron-cross type simulator uses an air bearing to eliminate friction and to give the pilots some realistic practice with the reaction jet system they will use to control attitude.

In this simulator, the pilot lies on his back in a Mercury couch. A wide angle lens and mirror system are used to project an earth model picture in a simulation of the Mercury periscope system. The pilot will use this horizon picture to practice attitude control and to acquire some navigational training.

McDonnell is scheduled to build a series of trainers in the actual capsule configuration, using Space Task Force specifications. Two similar trainers will have faithful reproductions of the

Mercury cockpit. One will be used as a procedures trainer, and the other will be given analog capability. The more sophisticated crew trainer will have animated instruments and possibly a periscope display mockup. It will have more capability for simulating a real time mission.

Environmental trainer will be a simplified capsule with prototype environmental equipment to familiarize the Mercury pilots with the operation of this key system. Trainer will have a simple fault insertion capability. Initial work with the environmental equipment will be done at sea level pressure, and the simulator will later be put in a vacuum chamber.

Post-Landing Training

Escape and recovery trainer will deal with conditions the pilots will meet after landing. It will cover the use of recovery equipment, getting out of the capsule in various sea conditions and removing and using the raft. The trainer will have all the internal impediments the pilot must contend with in leaving the capsule, and it will have the same center of gravity as the Mercury capsule so that it will behave the same in water.

Training will take place with the escape and recovery simulator in the water. It will be done wherever the necessary sea states can be found, including swimming pools, rivers, Chesapeake Bay and the Atlantic Ocean. Training may be coordinated with rehearsals of the Navy recovery crews.

An actual capsule will be gimbal-mounted in the altitude wind tunnel at

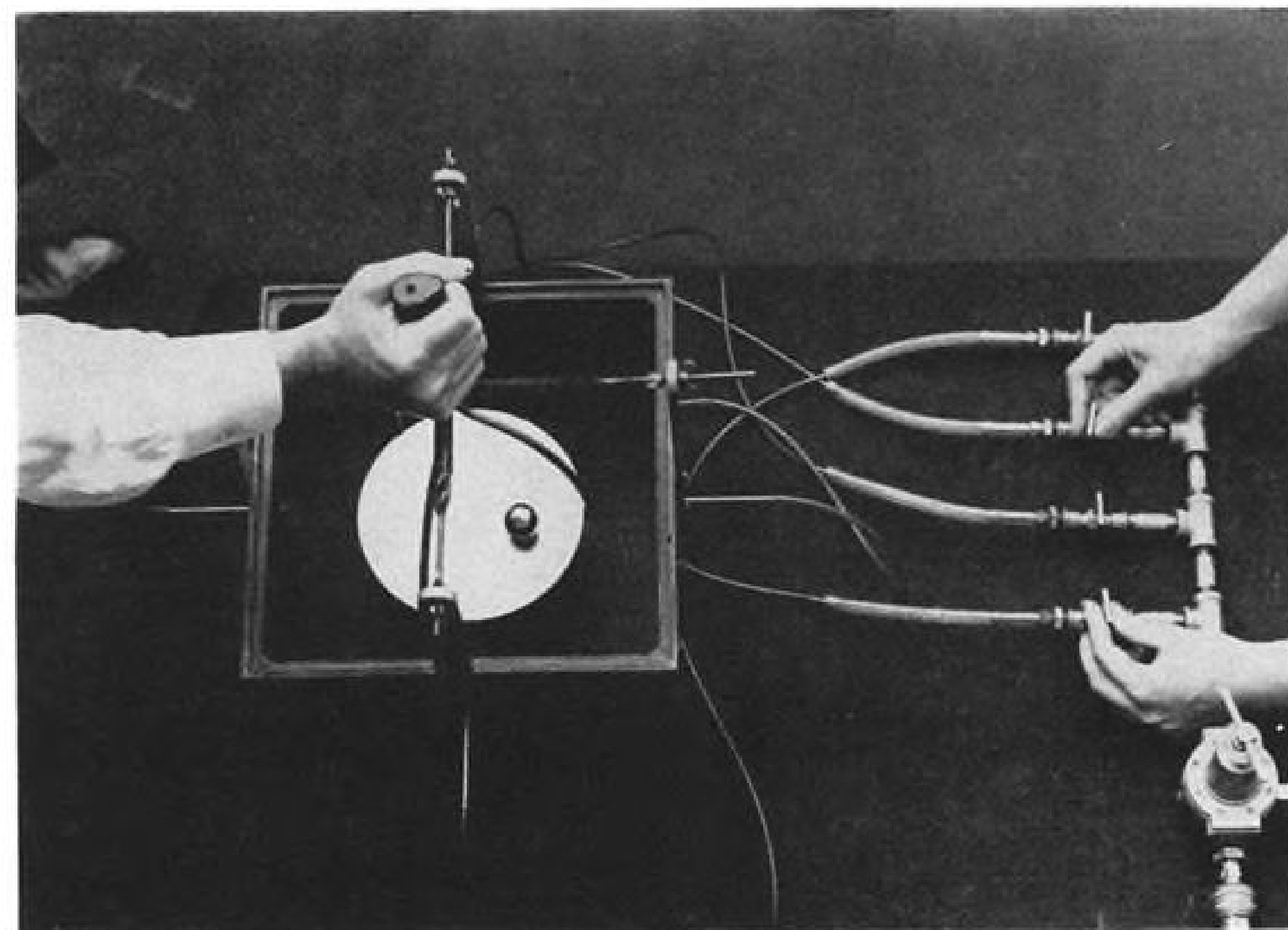
Lewis Research Center for firing of retrorockets and checkout of the reaction control system. There, the pilots will become familiar with the sound of the retrorockets firing and will become accustomed to using the hydrogen peroxide jet control system.

Familiarization with the weightless condition of orbital flight will be continued with zero gravity aircraft flights. Some of the pilots made such flights early in the program in a specially equipped Convair C-131, and more of these flights are planned. Space Task Group wants to determine the possible effects of acceleration following a zero gravity condition. Some effects were noted in work done at Wright Air Development Center, but they were not considered severe.

Zero gravity flights of longer duration than is provided by the C-131 may be arranged, and STG is studying the use of the Lockheed F-104B for this purpose. Pilots also may fly the Bell X-1B or X-1E during the training program, but no final decision has been made. They will not fly the North American X-15.

Mercury pilots may use a water tank zero gravity simulator developed here at Langley, although this will be questionable until the tank system has been tested. With this simulator, a man is put in water where he cannot see and is disoriented. This furnishes a fair simulation of zero gravity.

Ball disk space flight control simulator developed here will provide practice in using control systems with no damping and no spring response. The pilot grasps a handle with a disk sus-



BALL DISK space flight control simulator provides Mercury pilots with practice in using control systems with no damping and no spring response. Pilot grasps handle and maneuvers the disk to keep the freely rolling ball centered on it. Air jets can be used to blow the ball across the disk to simulate motion when retrorockets are fired on the Mercury capsule. Reactions required to keep the ball centered on the disk are similar to those used to keep the earth image centered in the Mercury periscope.



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pended under it. A ball rolls freely on the disk, and the pilot maneuvers the disk to keep the ball centered on it. The movements and responses required to keep the ball in the center of the disk are the same as those the pilot will use to keep the earth image centered in his periscope. Ball can be blown across the disk with an air jet.

Space Ship Simulator Will Recycle Water

Drinking water will be recycled in Minneapolis-Honeywell Regulator Co.'s space cabin simulator.

The simulator (AW June 22, p. 235), is 90% completed and is expected to be delivered to the USAF School of Aviation Medicine, Brooks AFB, Tex., by the end of September. It is being constructed by the company's Aeronautical Division plant in Minneapolis, Minn.

Urine and all other waste water will be purified by a Honeywell process that includes chemical treatment, filtering, super-heating, freezing and final filtering through activated carbon.

Feces and other solid wastes such as food particles and hair will be dehydrated and burned in an incinerator. Gases produced by this process will be disposed of with an afterburner so the final residue will be a small amount of fine ash.

The seven ton simulator is 8 ft. high and 12 ft. long.

Wind Tunnel Burner Will Heat to 3,500F

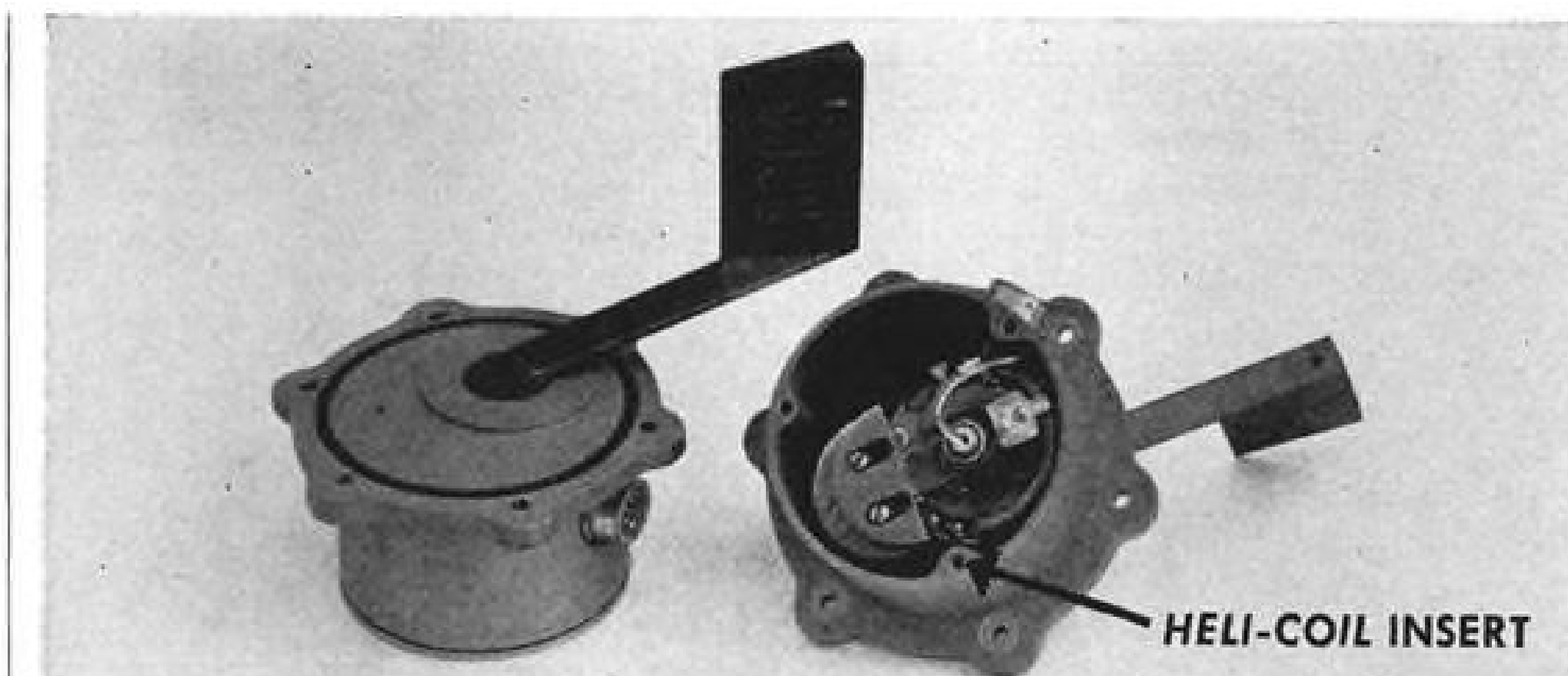
Montebello, Calif.—Hirt Combustion Engineers, Montebello, Calif., will build a 10 million Btu./hr. pebble heater burner to help simulate heating effects encountered by high speed aircraft and missiles during flight in Douglas Aircraft Co.'s Mach 10 hypersonic wind tunnel (AW June 22, p. 249).

Heating range of the Hirt burner will be from 300F to 3,500F.

Subcontract for the burner was awarded by Southwest Welding and Manufacturing Division of Yuba Consolidated Manufacturing Co., which is constructing the pebble heater.

Burner will be designed to withstand back pressure of 2,500 psia. during backflow operations and will be the largest pebble heater burner ever built by Hirt.

Due to the harmful effects of combustion products, wind tunnel heating cannot be achieved directly. The unit in Douglas' Aerophysics Laboratory tunnel will use alumina pebbles heated by the Hirt burner. After the pebbles become hot the burner is turned off and the hot pebbles heat the air.



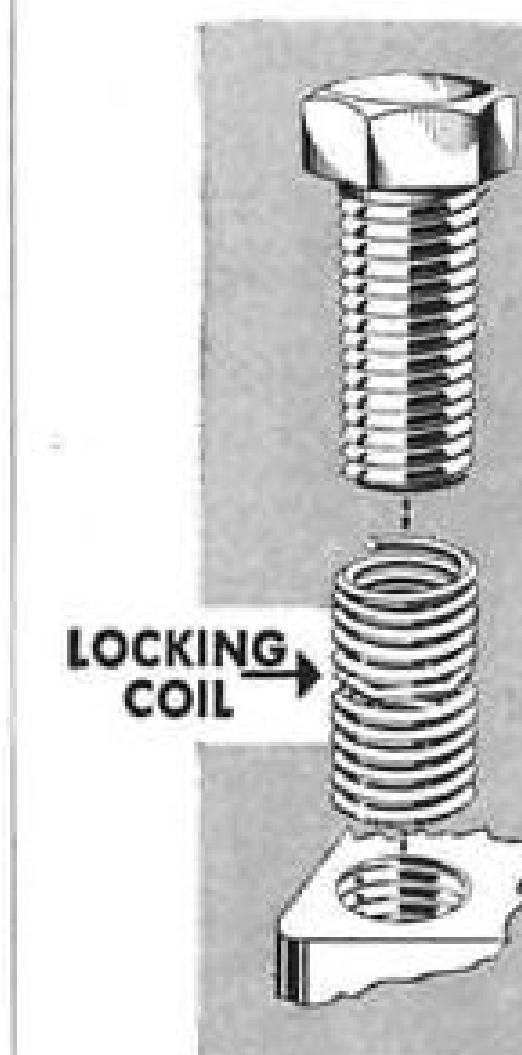
Heli-Coil® Screw-Lock Inserts* lock screws against impact and vibration and permanently protect critical tapped holes in this transducer assembly.

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Electronic control devices for aircraft and missiles, like this angle of attack vane transducer made by U. S. SCIENCE CORPORATION, LOS ANGELES, CALIF., have to withstand severe vibration, impact, corrosion and temperature change. They must be made of light materials and still have strong threads—able to hold fasteners tightly and stand frequent assembly and disassembly.

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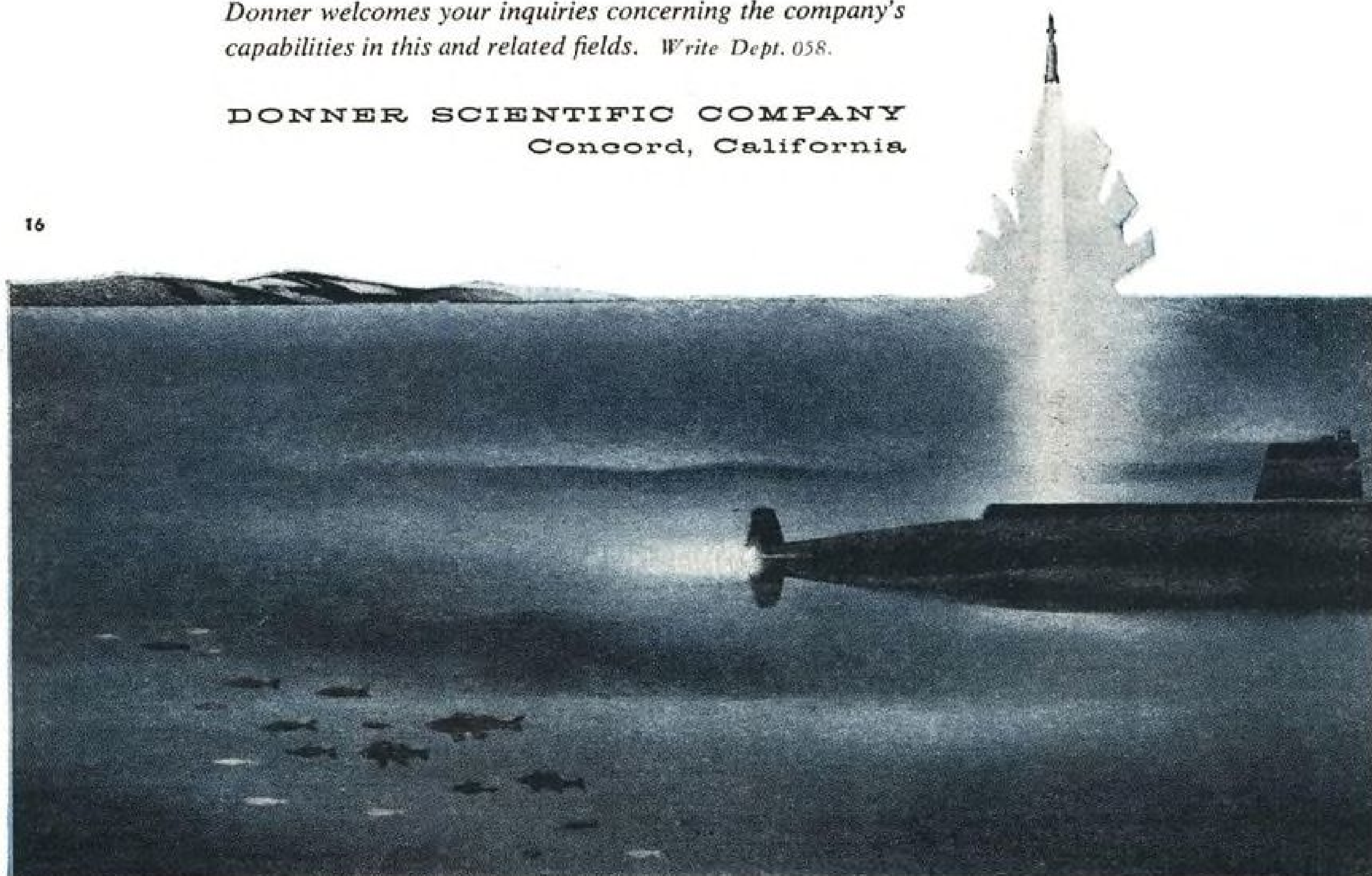
Smaller and lighter than other intermediate range ballistic missiles, this formidable Lockheed developed weapon features much that is new in advanced electronics. It even "thinks" for itself.

One such "think" device aboard the Polaris is a system developed by Donner Scientific Company using as a base a standard Model 4310 Accelerometer. The system monitors flight performance like a policeman directing traffic. If, for example, in the initial portion of the flight, the missile does not achieve sufficient velocity by a pre-determined time, the Donner system aborts the flight. The missile gets the go-ahead only as programmed.

Donner's role in the Polaris project represents another basic contribution from an engineering team which specializes in accurate systems, interlocking time, acceleration, velocity and other inputs designed to meet customers' requirements.

Donner welcomes your inquiries concerning the company's capabilities in this and related fields. Write Dept. 058.

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16

Satellite Radar Must Be Ultra-Reliable

By Philip J. Klass

Washington—Development of a lightweight ultra-reliable weather radar requested by National Aeronautics and Space Administration for use in a meteorological satellite represents a major challenge to the ingenuity of the nation's radar designers.

With a radar-equipped meteorological satellite, NASA scientists hope to obtain a three-dimensional picture of precipitation around the earth, enabling meteorologists to detect major storms early in their development and to measure the earth's heat balance.

Design Requirements

Here are a few of the challenging requirements outlined in the specification which NASA sent to industry:

- **Reliability:** Radar must be able to operate continuously and reliably for a minimum of six months, preferably for a full year. Some simple adjustments for improving performance may be possible by means of remote radio control.
- **Coverage:** Meteorological satellite will be stabilized so that one axis remains perpendicular to the earth's surface, with no rotation about this axis. NASA would like a scanning radar which can provide full coverage of all of the earth that can be viewed from the satellite but will settle for a strip a few hundred miles wide beneath the satellite if the former is not feasible.
- **Range:** First models of the radar will operate from a satellite at an altitude of about 300 mi., but the ultimate design must be suitable for orbits at altitudes of 500 to 1,000 mi.
- **Resolution:** NASA seeks a resolution equivalent to about 5 mi. on the earth's surface. This corresponds to a beam-width of about one degree for a satellite at 300 mi. altitude. To establish height of precipitation above the earth, NASA seeks a range resolution of about 1,000 ft.
- **Electric power:** First models will be powered by solar cells and storage batteries capable of supplying only 50 to 100 w. average power, NASA says. Ultimately, the power available in the meteorological satellite is expected to be one to five kilowatts. (By way of comparison, existing airline weather radars with a maximum range of about 150 mi. require 750 to 1,000 w. power).
- **Sensitivity:** If possible, radar should be capable of detecting precipitation falling at the rate of 0.1 in. per hour, corresponding to a radar reflectivity of 0.0000005 sq. meters per cubic meter. Radar receiver should have a logarithmic response as a function of received signal strength.

Receiver output should be in discrete steps with 5 to 10 levels.

• **Antenna.** Because physical movement of the radar antenna to achieve scanning would produce torques that would disturb satellite stabilization, NASA suggests the use of slot type antennas and electronic scanning techniques.

Requesting Proposals

NASA is asking industry for proposals on both a feasibility study of the satellite weather radar and on a second phase that would include fabrication of a working laboratory model. Feasibility study is to be completed by July, 1960, and should indicate how an early model

can be developed into a more sophisticated ultimate system for use in an operational satellite. NASA is asking that the laboratory model be available by spring of 1961.

Unclassified Techniques

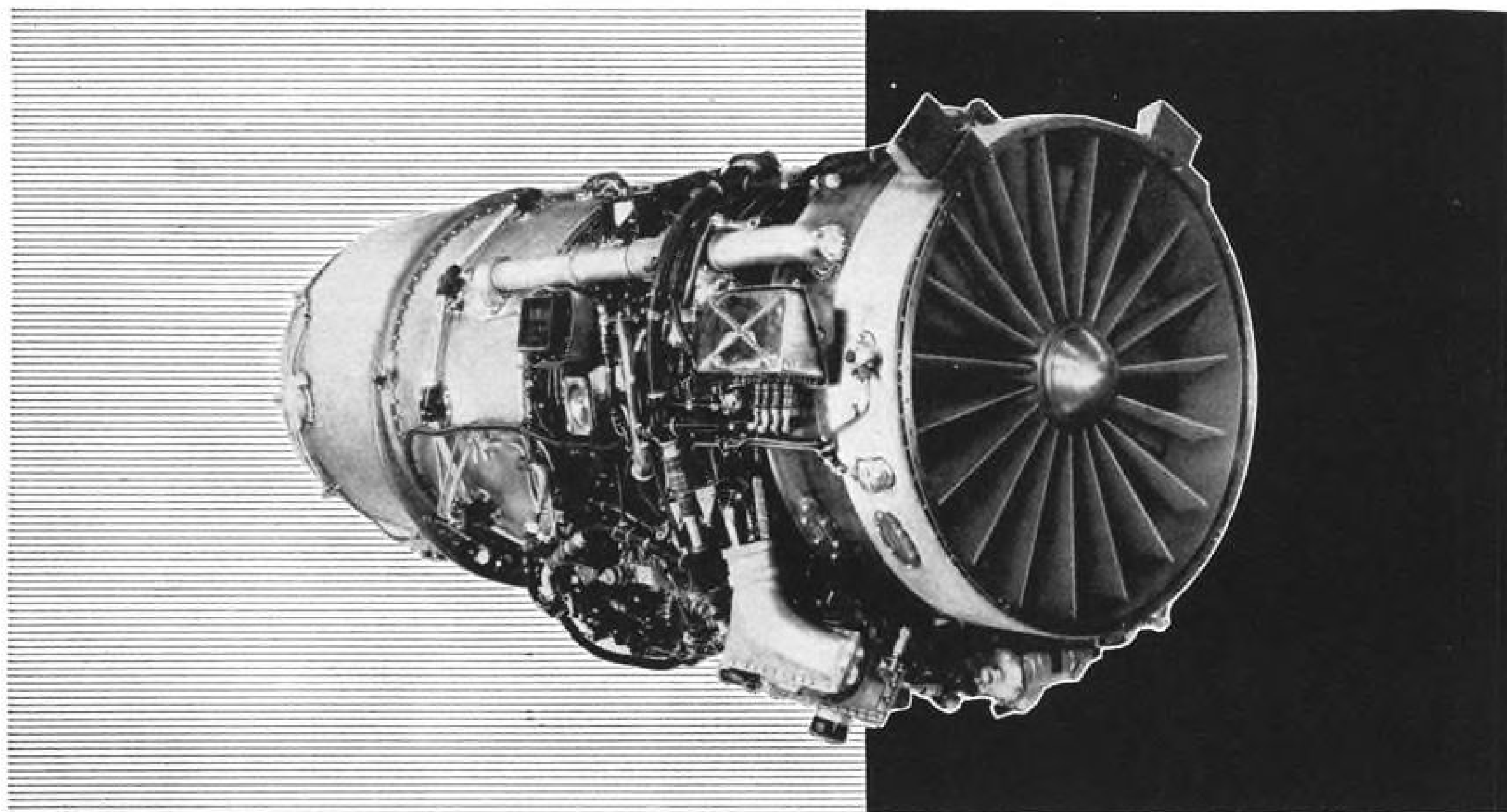
Insofar as possible, the techniques employed in the satellite radar are to be unclassified, NASA says. If it proves necessary to use classified techniques, NASA says it will arrange for the use of such information by the contractor and will respect the classification of these parts of the work.

NASA suggests the use of X-band (3.2 cm.) for the satellite radar in preference to lower frequencies because of the problems of obtaining desired reso-



Scientists Study Entry into Venus' Atmosphere

Blunt nose shape is placed at end of 40-ft. shock tube in Lockheed Missiles and Space Division's Scientific Research Laboratory in a study of the problem of entry into the atmosphere of Venus. Studies by scientists K. K. Chan (left) and Richard W. Rutowski (right) show problem is 50% greater for Venus than it would be for a return to earth.



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The Rolls-Royce Conway by-pass turbo jet is in production for the Handley Page Victor B.Mk.2, the Boeing 707-420 and the Douglas DC-8, and will power the Vickers VC.10.

The by-pass or ducted fan principle which Rolls-Royce have proved in the Conway is now accepted as the correct formula for all jet transport and for certain military applications. The new RB.141 family of by-pass jet engines is based on 7 years' development experience of the by-pass principle and on 6 years operation of other gas turbines in airline service. The first of this series of engines has already been chosen to power the new British European Airways medium range jet airliner.

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lution with reasonable size antennas. However, it does not rule out the use of other frequencies.

In the ultimate operational meteorological satellite, a tremendous amount of radar data will be collected. Present plans are to store the data aboard the satellite on a tape recorder, then transmit it down when the satellite passes over a ground radio station.

The contractor selected to study and develop the satellite radar need not concern himself with the design of the data storage, communications and primary power source except as the latter affects the radar design, according to NASA.

Companies that would like to bid on the satellite weather radar program may obtain copies of the specifications and other details by contacting: Director of Procurement and Supply Division, NASA, 1520 H St. N. W., Washington, D. C.

Soviets Measure Geomagnetic Field

Moscow—Soviet Union has disclosed some of the results of its satellite and rocket program to scientists at the International Cosmic Ray Conference here. A report on the results of Soviet space research that was delivered last March to the USSR Academy of Sciences by its president Alexander Nesmeyanov has been published in summary in recent Soviet newspapers.

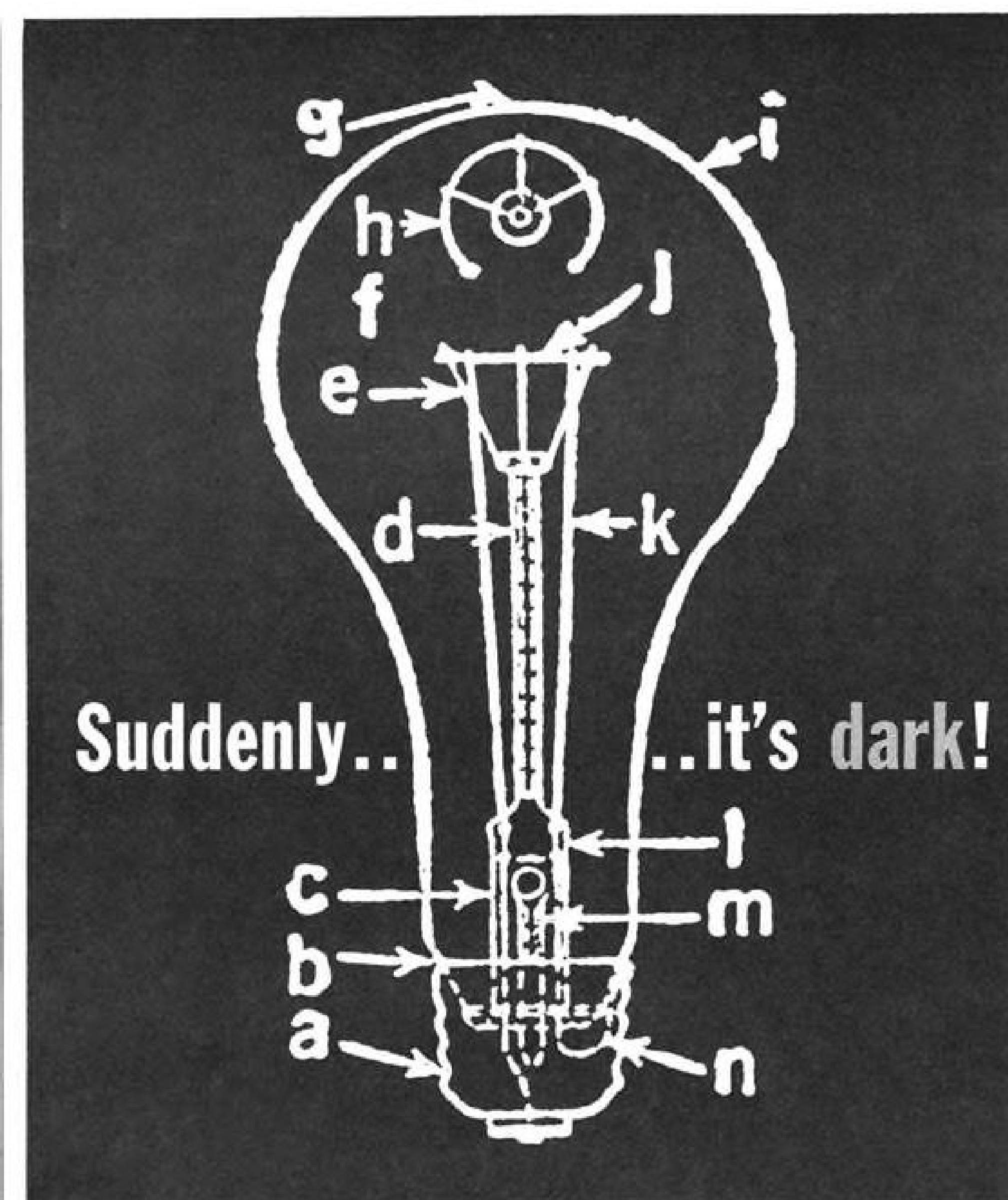
The report states that Soviet research has established that ions with a mass number of 16 predominate at heights from 226 to 1,000 km., with atomic oxygen constituting the basic gaseous component from a height of 226 km. to at least 500 km. Atomic nitrogen ions also have been detected as well as heavy particles with molecular weights of 28 and 30, Nesmeyanov said.

"With further investigation [this detection] can be instrumental in solving the ionization balance problem of the upper atmosphere," he said. The report noted that atomic nitrogen content in relation to atomic oxygen ranges from 1% to 10% depending on height and geographic latitude and varies with lapse of time. "Definite dependence of all discovered components of the ionosphere on geographic latitude has been determined," the report continued.

Nesmeyanov said "extremely important results were obtained in measurement of the geomagnetic field with the help of Soviet space rockets."

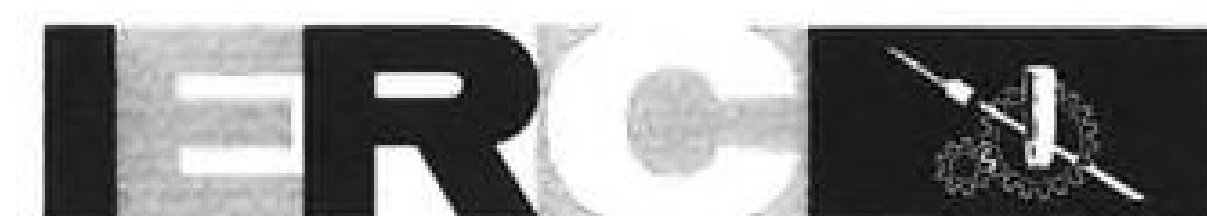
"It has been established" he said, "that the difference between theoretical and factual values becomes noticeable at a distance of approximately two terrestrial radii from the center of the earth and then increases sharply."

Variations in the magnetic field



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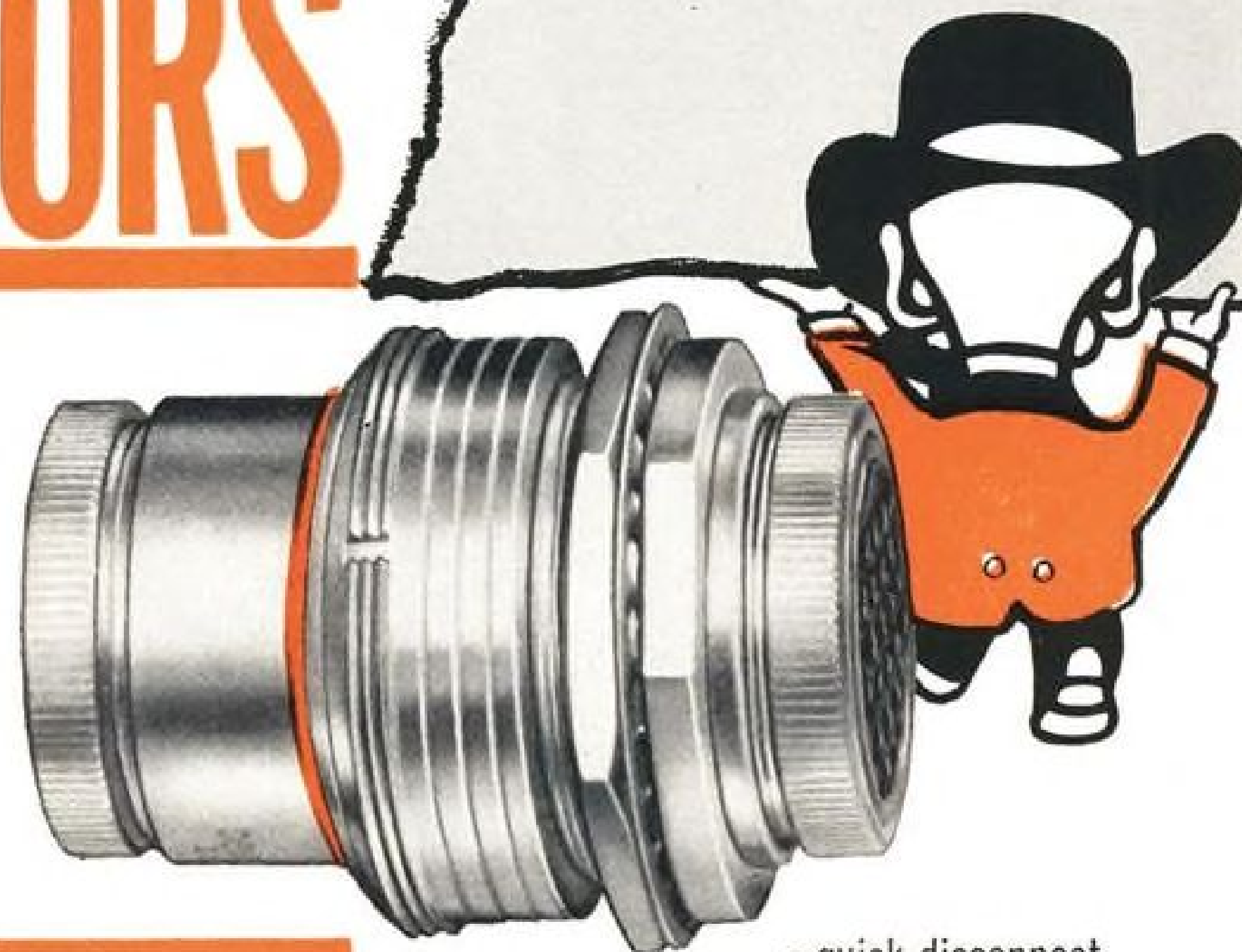


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of the earth can only be explained by supposition that at a height of 21,000 km. the rocket crossed a current-conducting layer, according to the report. Thus, information sent by the rocket indicates the existence of a current-conducting system outside the ionosphere. It was stressed that this fact is of fundamental importance for the theory of magnetic storms and aurorae and specifically for critical reappraisal of current explanations of these phenomena.

Rehashing previously published information, Nesmeyanov said Sputnik III and space rocket observations showed that danger of meteors and micrometeors is negligible in outer space. He said a particle with a mass about one thousand millionth of a gram is likely to be encountered by a space rocket only once in several hours.

In reviewing what had been published on radiation, Nesmeyanov said the outer zone has been "spatialized" with accuracy and further data has been obtained on the composition of charged particles in that zone by analysis of readings of space rocket instruments.

Electron energy within the maximum radiation band is about 25 and on the zone boundary about 50 kev.

The scientist's only published allusion to Project Argus (AWW Mar. 30, p. 26) was a statement that "fallout from high altitude atomic explosions can produce intense streams of charged particles at those altitudes." He said these particles will be locked in a magnetic trap since they have low energy.

Soviet scientists consider that atomic explosions can thus have the effect of "polluting" near earth's reaches of space. He also claimed that Soviet research has shown basic physiological functions of test animals do not alter appreciably in conditions close to that of space flight, noting that "one of the highly important findings of the second Soviet Sputnik was the fact that the state of zero gravity does not appear to have any unfavorable effect on vegetative functions of organism."

"It is advisable to create spatially oriented artificial satellites for a number of lines of solar research," he added. "It is desirable for satellites be oriented on the sun."

"In another instance satellites will have to be oriented so as to have one of their axes directed towards earth and other coinciding with their orbital path. Astrophysical research requires satellites to remain static in relation to fixed stars," Nesmeyanov said.

A manned trip to the moon with a landing and return to earth can be expected to take place in what may well be in the not so distant future," he said. Exploration of Venus and Mars was of "particular interest," he concluded.



How **Quaker** Thermoid made ground-refueling hose to meet toughest government specifications

1. Developed a tube compound that can carry all aircraft fuels without showing appreciable signs of swelling or loss of adhesion to the carcass. A tube that withstands constant bending, twisting, and flexing without ply separation. Performs well in the range -40°F to +130°F.

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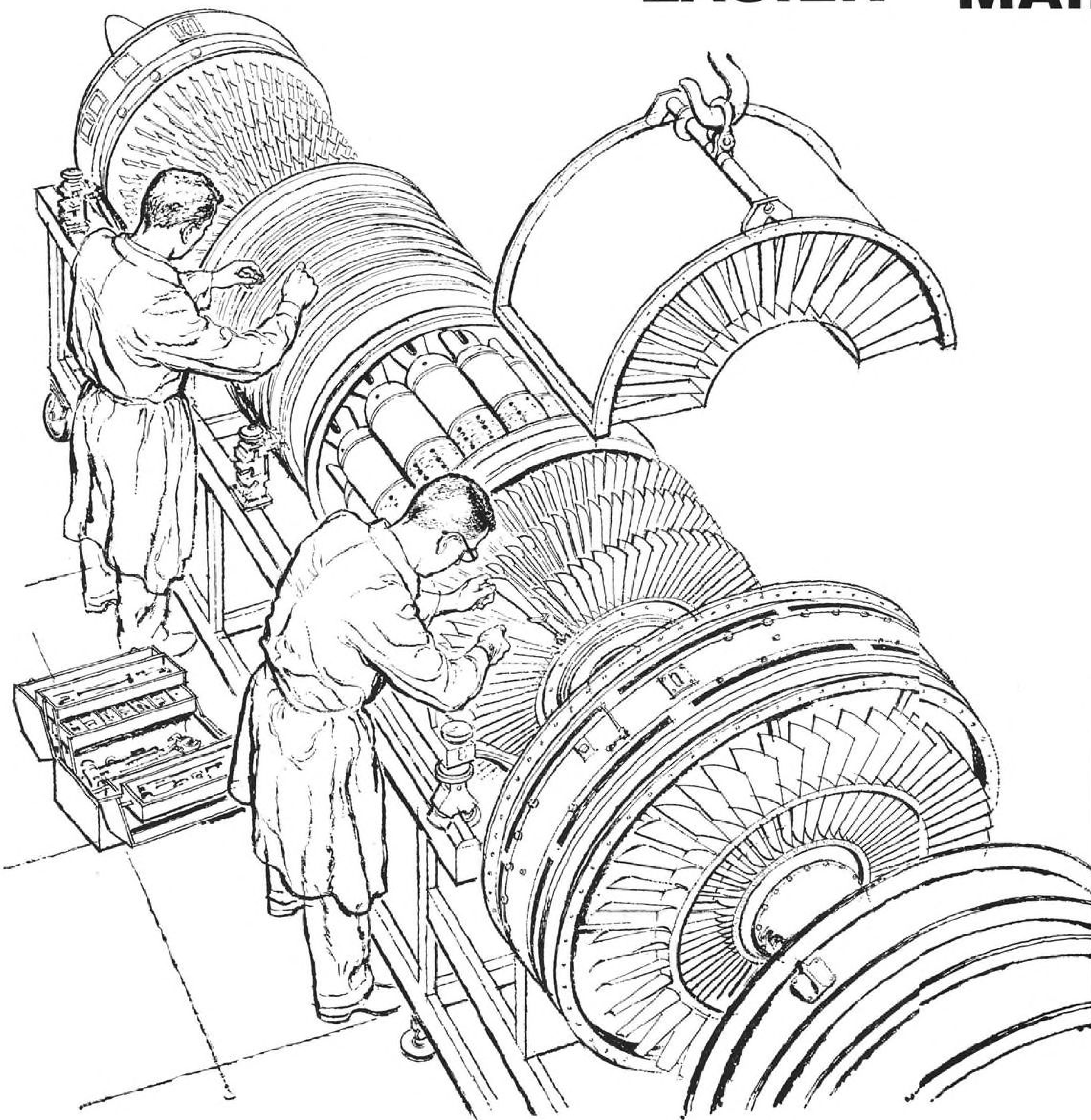
4. Completely bonded all component parts by an exclusive process of curing and manufacturing to provide a ground-refueling hose that is not only strong and easy to handle, but the safest ever built.

Get complete information on Thermoid-Quaker ground-refueling hose from your local Thermoid industrial distributor, or write *Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.*

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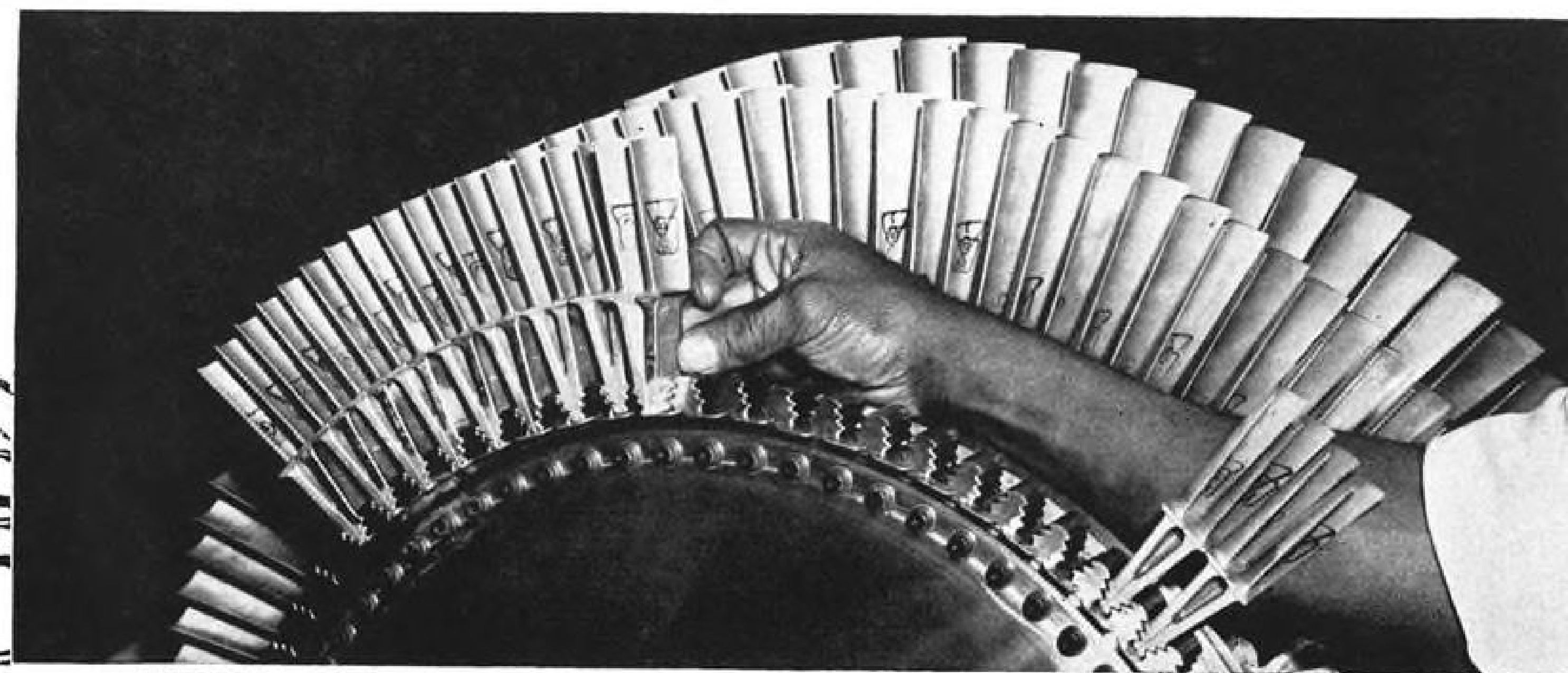
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At General Electric, field maintainability ranks with high performance, light weight and durability as prime considerations in engine design. Compare the maintenance and overhaul features of G-E aft fan engines with those of any other turbofan. General Electric Company, Cincinnati 15, Ohio.

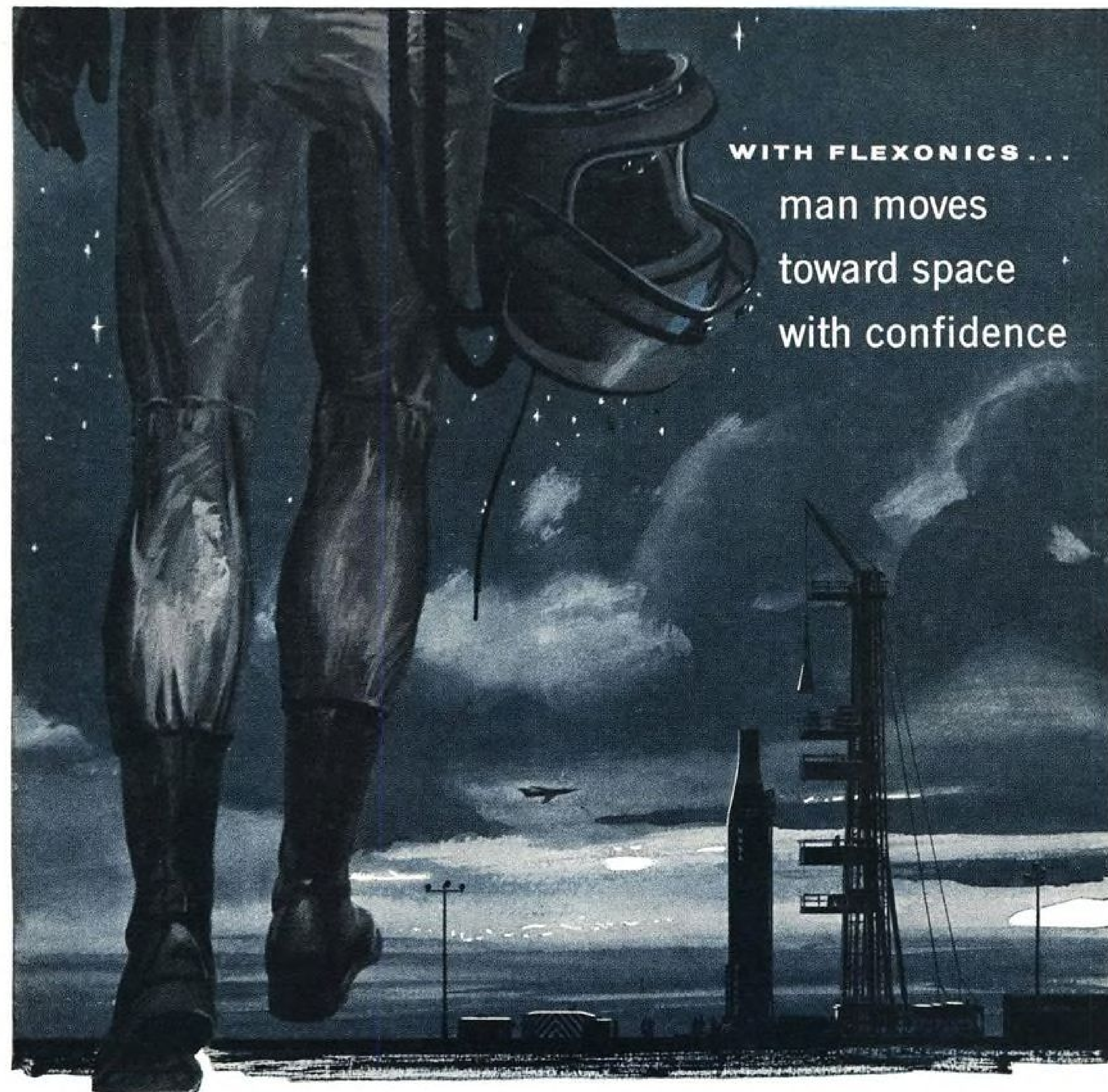
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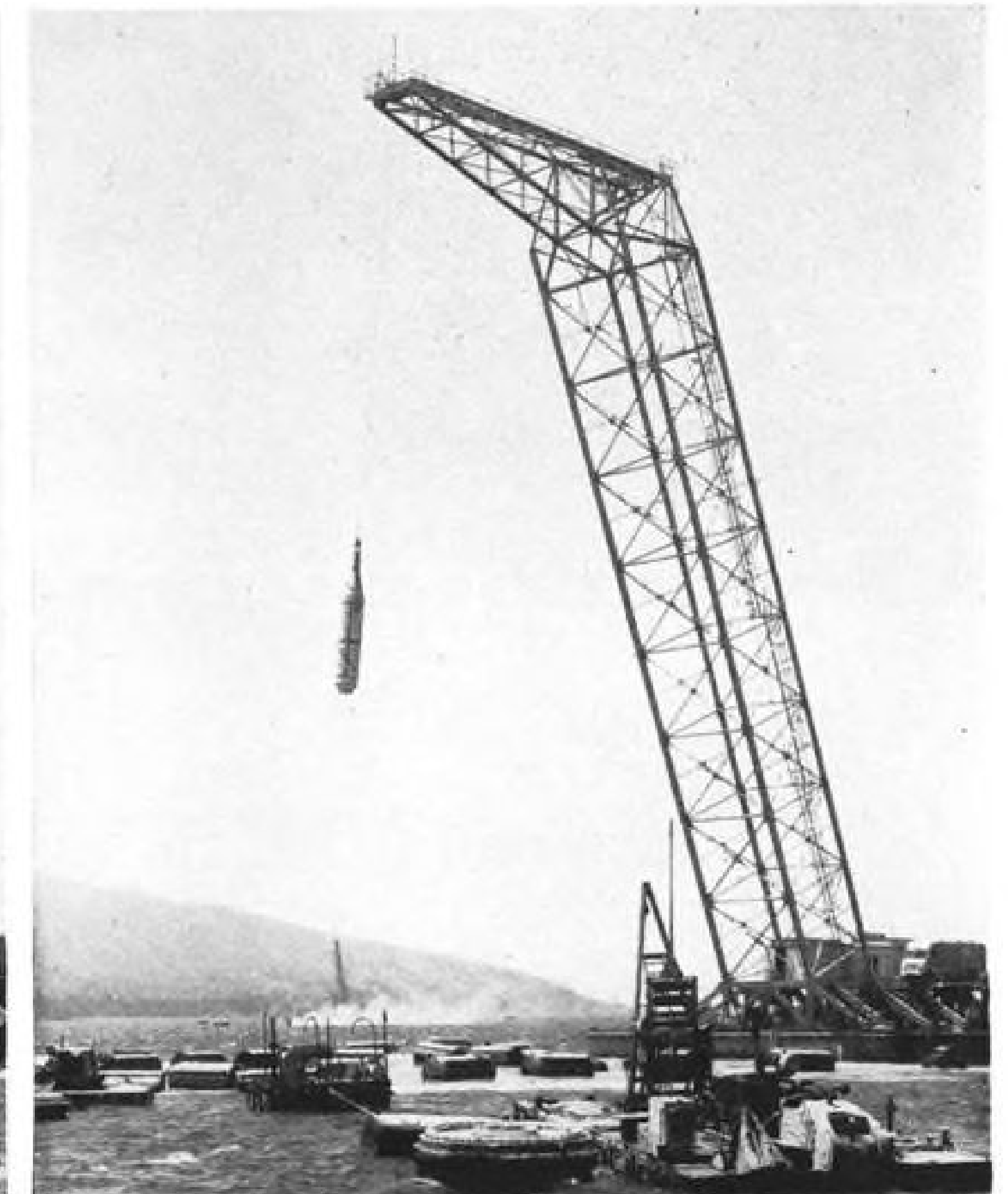
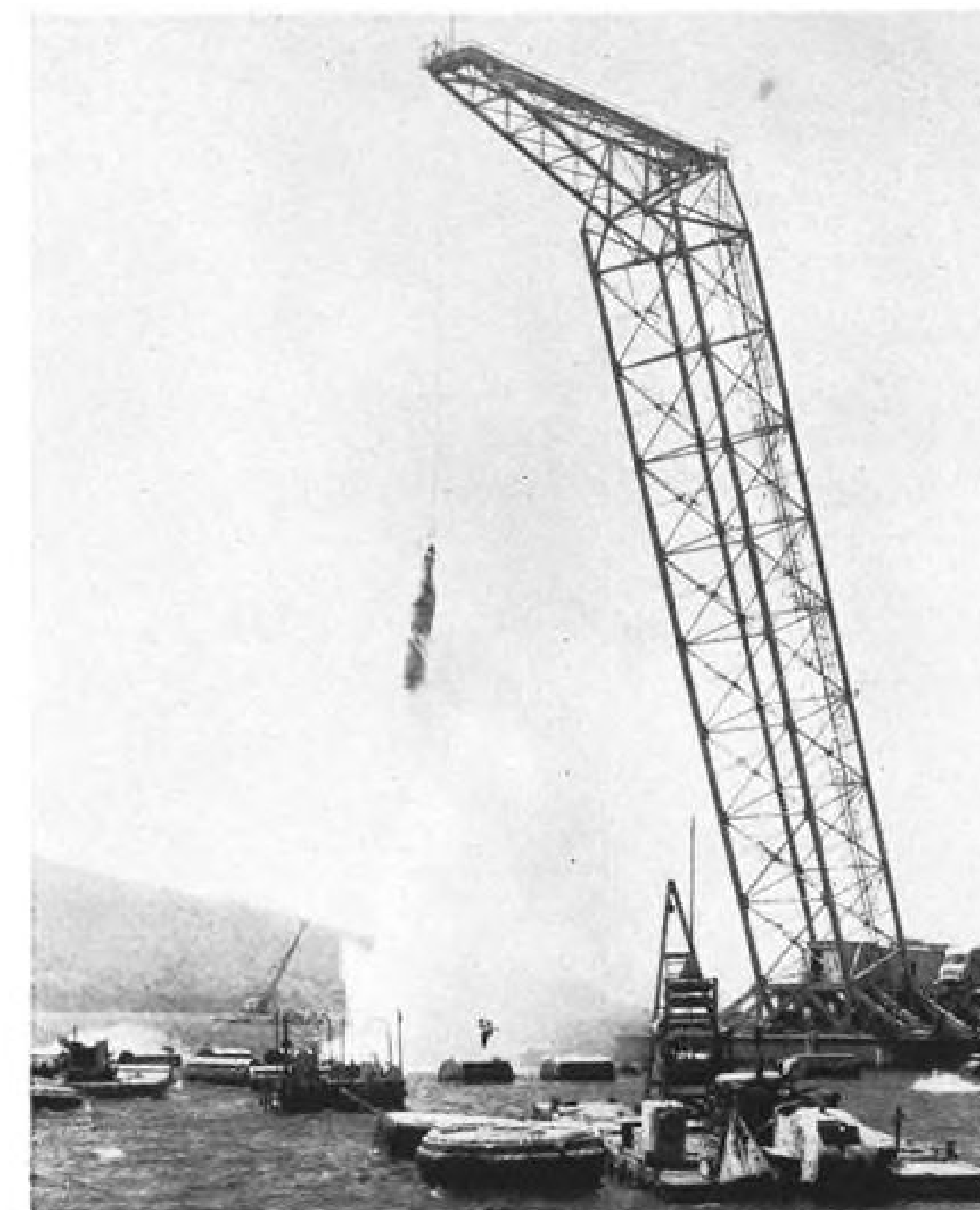
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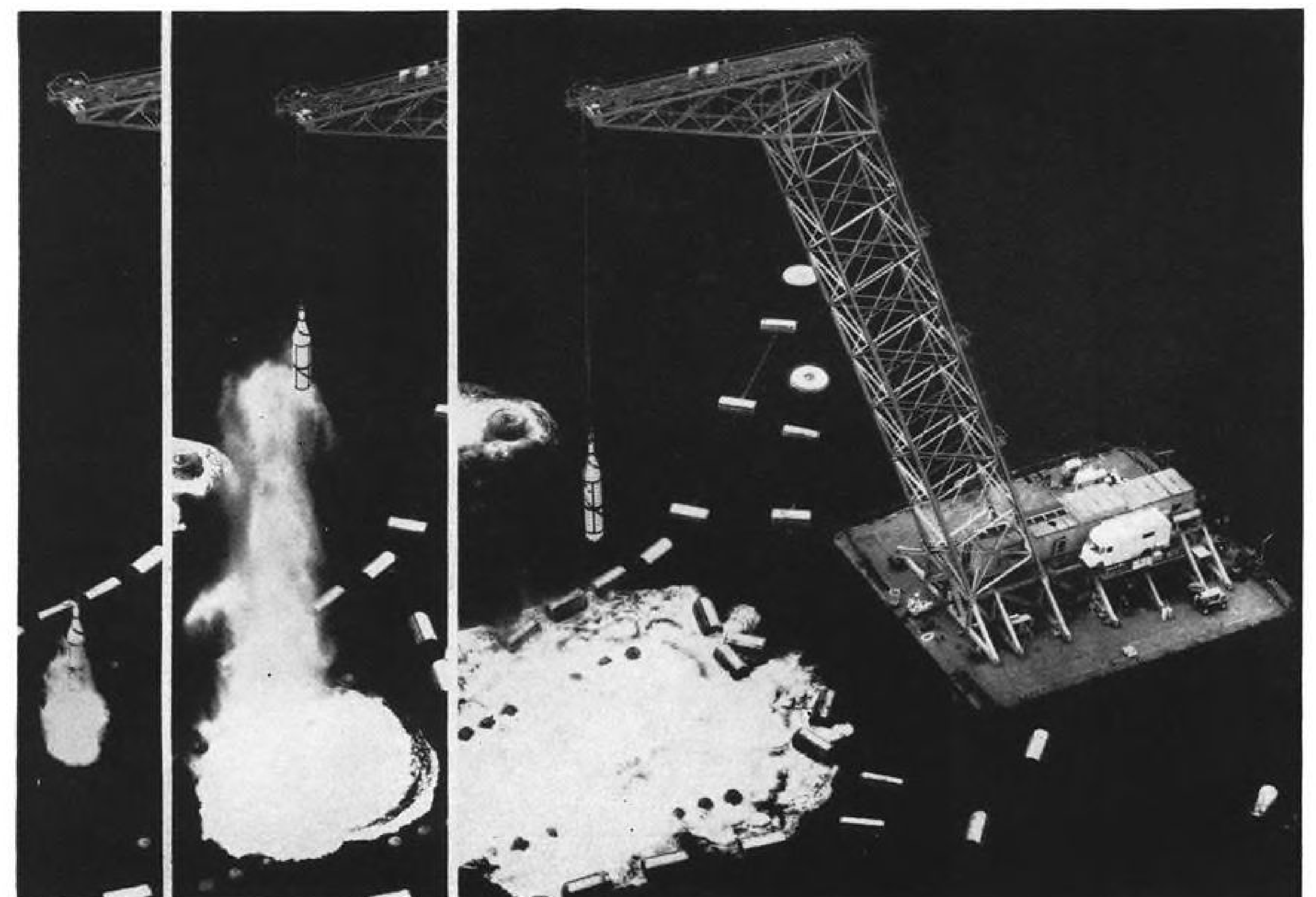
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Crane, Hydraulic Ram Retrieves Polaris Dummy In San Clemente Tests

Lockheed Missile and Space Division and Westinghouse Electric have developed Operation Fishhook to retrieve dummy Polaris missile shapes after firing from an underwater launching tube. Missile is reeled in by cable operated from the 186 ft. high crane; hydraulic ram-type piston braking is used to keep the Polaris from falling back into the sea. Fishhook is in operation at San Clemente Island sea range of U. S. Naval Ordnance Test Station, China Lake, Calif. Earlier recovery method involved use of modified carrier aircraft arresting gear (AW May 25, p. 69).



Honeywell puts man in space —at zero altitude

**Advanced space environment simulator will isolate
two men in Honeywell-controlled space flight
environment during unprecedented 30-day test**

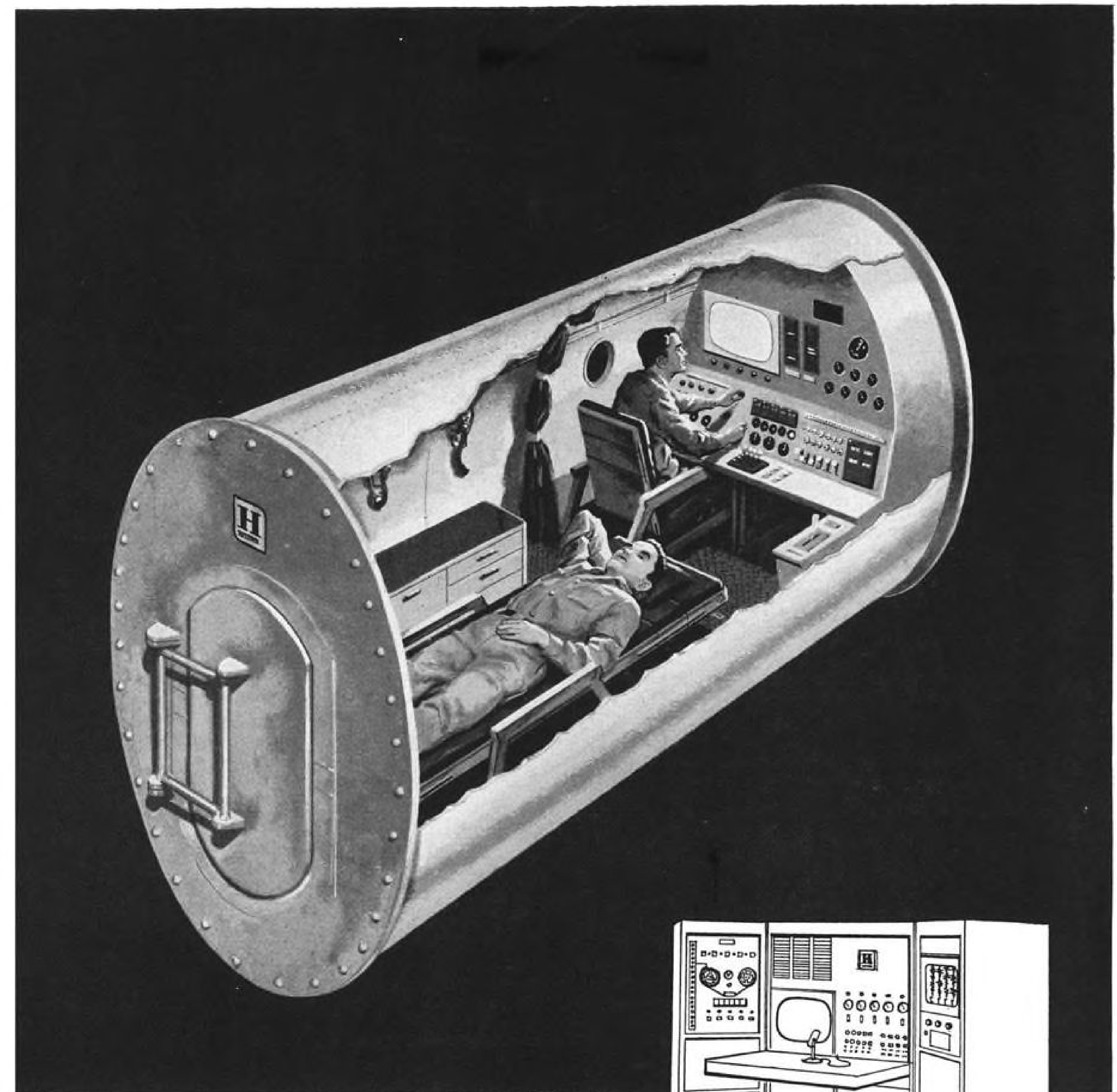
AS ANOTHER step toward man's conquest of space, Honeywell will provide the USAF School of Aviation Medicine with an environment simulator for use in researching human reaction to isolation in space. The test capsule developed by Honeywell will hold two men and all the life-sustaining materials they need for 720 hours. It provides a completely self-sufficient environment contained in a 12- x 6- x 5-foot package. When man travels space, the air he breathes, the food he eats, temperature control, waste disposal, and all other basic elements must be precisely planned and controlled. This poses intricate problems involving toxic gas, filtration, oxygen, lighting, and many others. In solving them Honeywell utilizes advanced engineering techniques developed during more than 70 years of leadership in environmental control.

Honeywell Capability

Human environment, however, is only one of many fields in which Honeywell can demonstrate space-flight capability. For example: *Guidance and Stabilization* Honeywell's reference system

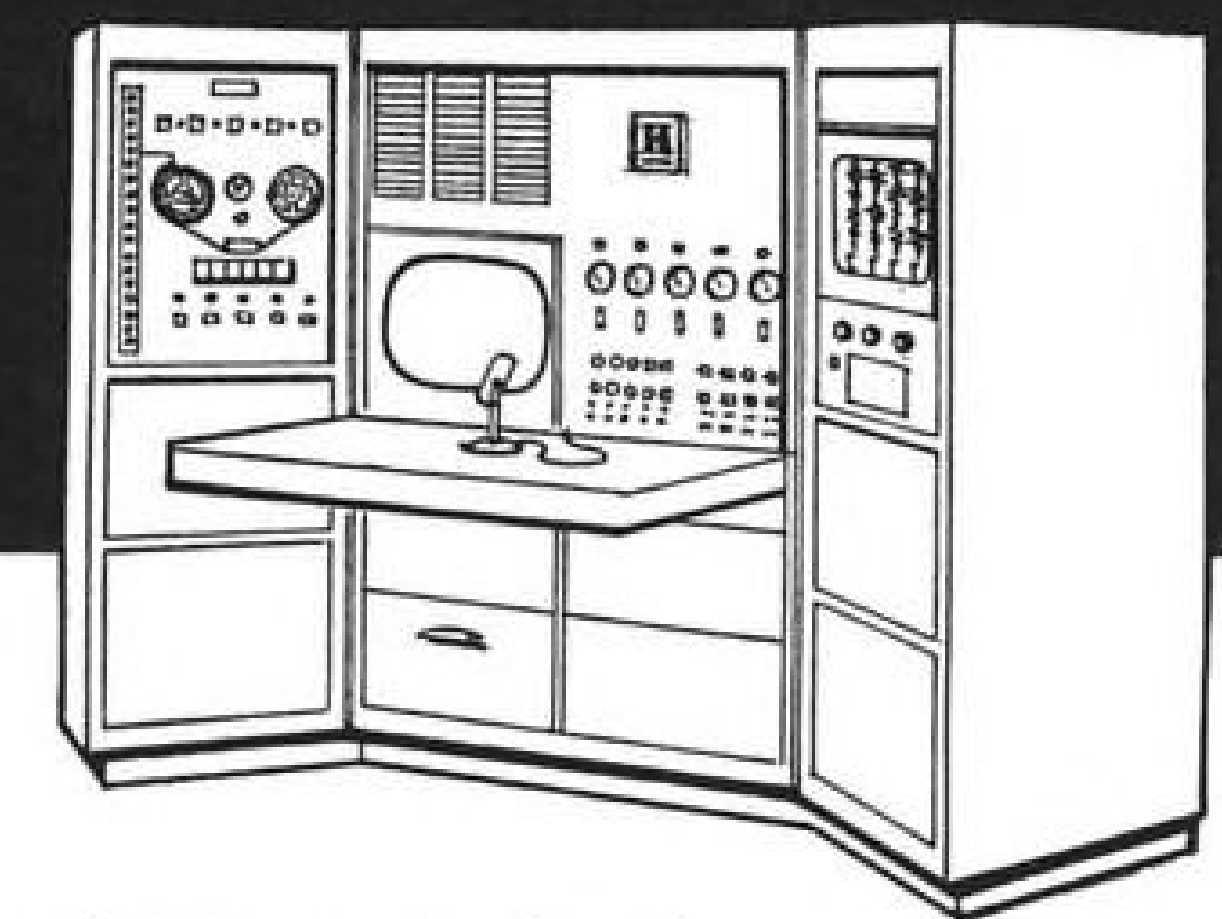
is a remarkably accurate means of missile guidance and control proved in actual applications. *Flight Control.* Honeywell has more experience in the field of flight control than any other company. Proved systems include autopilots, reaction controls, jet vane controls, thrust vector controls and automatic landing systems. *Data Processing.* Honeywell capability includes sensing, recording, transmitting and interpreting. *Ground Handling.* Some of the most extensive and complex work done by Honeywell in the missile field concerns the development and operation of test and checkout equipment. This work includes depot overhaul and maintenance equipment, base level overhaul and maintenance equipment, and launch site checkout equipment. Additional Honeywell experience includes instruments, auxiliary airborne power systems and research into human factors, both biochemical and psychological.

If you have a problem in the design of systems or components in the field of space flight, call or write Honeywell, Military Products Group, 2753 Fourth Ave., South, Minneapolis 8, Minnesota.



Two-man hermetically-sealed space cabin simulator.

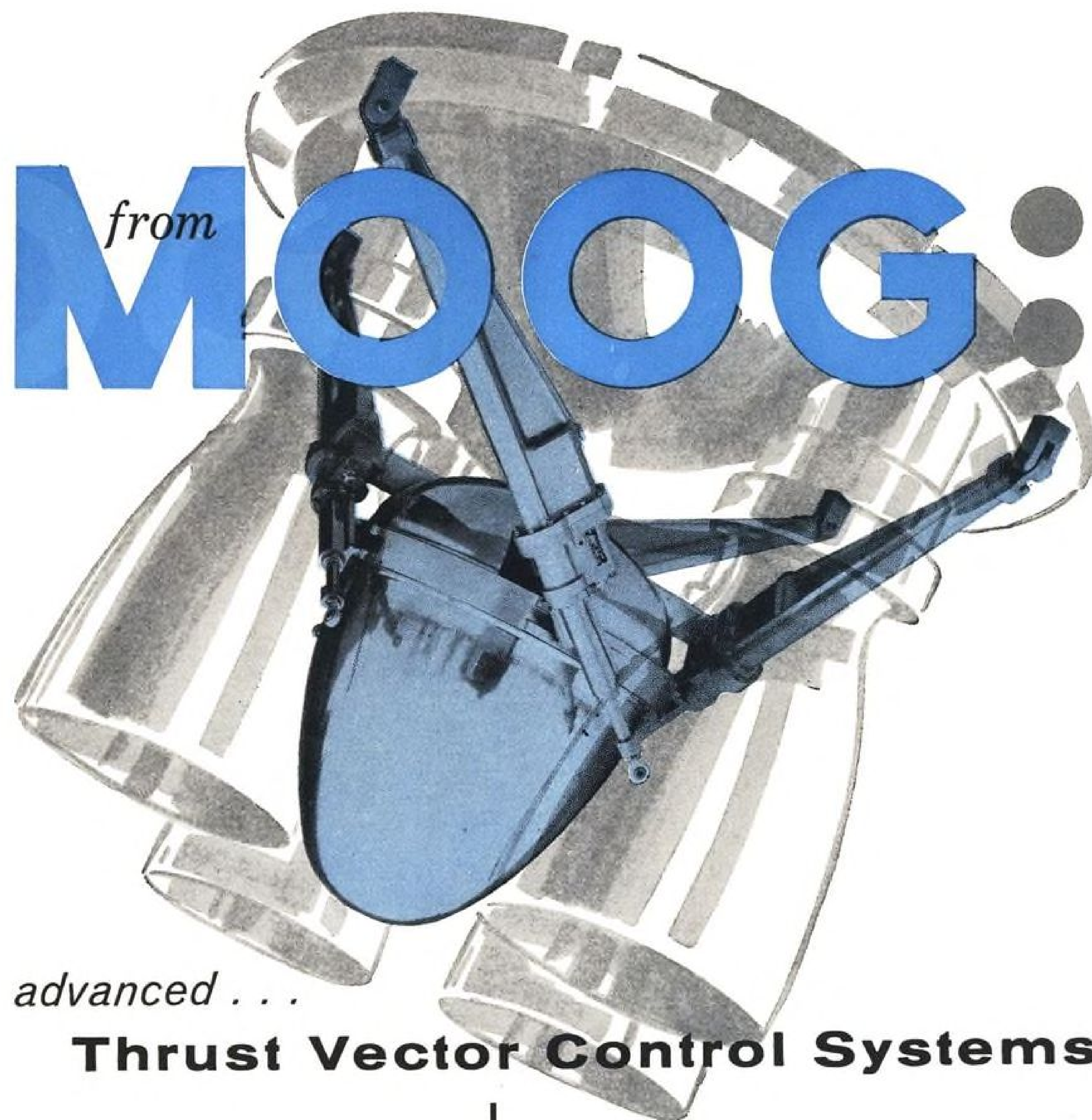
The basic chamber of the simulator will contain equipment that would be found in actual space flight. Oxygen, carbon-dioxide, toxic gases, temperature and humidity are constantly and individually sensed and compared to a set value. When safety limits are exceeded an error signal is amplified and corrective action is automatically begun. A sufficient water supply and facilities to insure personal cleanliness will be provided. Ample storage facilities for nonperishable foodstuffs will be provided for the 30-day isolation.



Exterior console, right, presents and records data concerning conditions inside the capsule. Permanent records will be kept by audio recording, TV kinescopes, and camera equipment.

Honeywell

H Military Products Group



advanced . . .

Thrust Vector Control Systems

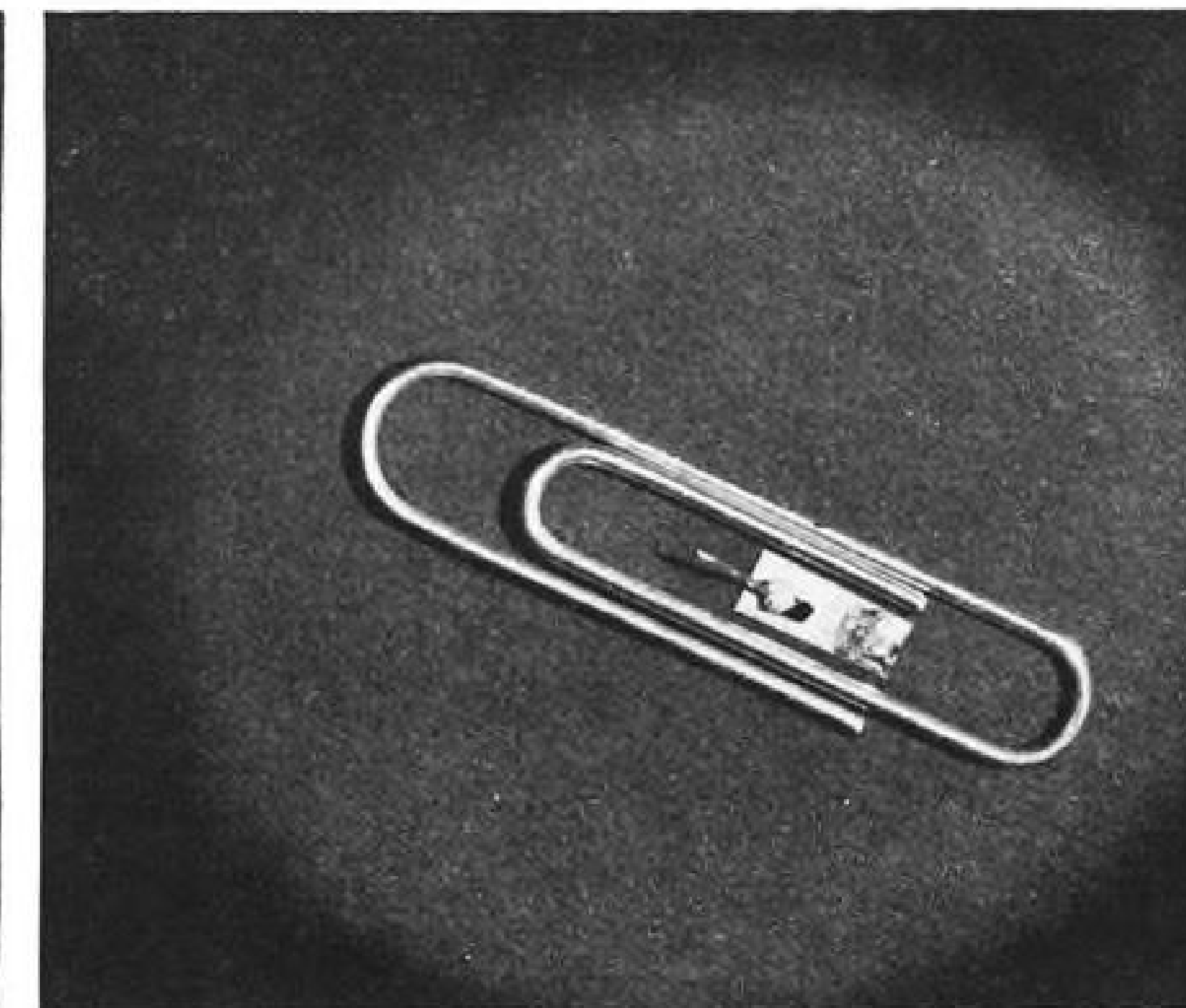
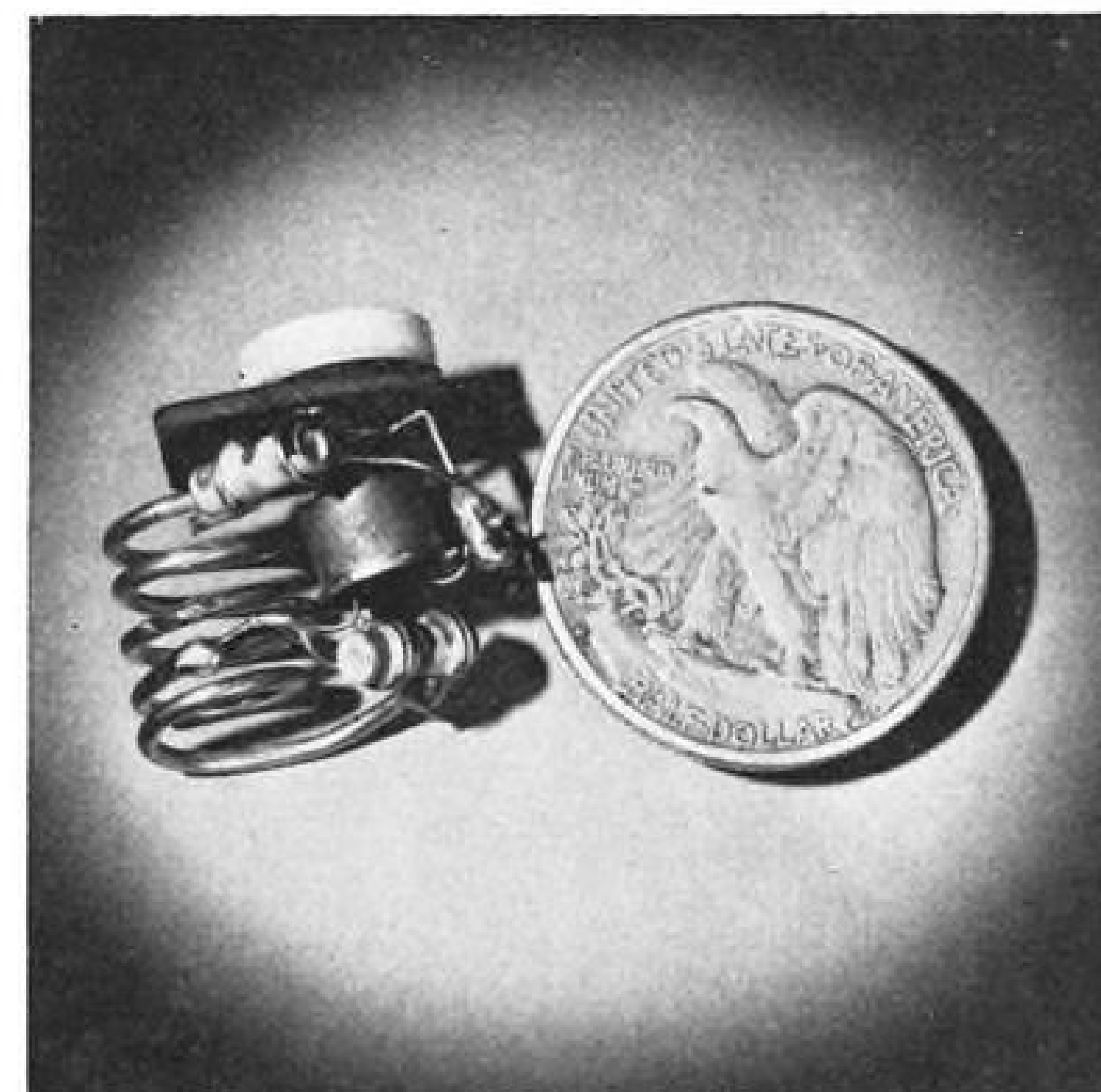
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Moog's integrated hydraulic servosystems are lightweight and compact packages which include auxiliary power units and electrohydraulic servoactuators. The unit above was designed to position ICBM rocket engine nozzles for thrust vector control. A unique mechanical feedback arrangement within the servoactuator eliminates the need for electronic feedback elements. Moog's integral system design provides complete servocontrol packages for reliable, high performance operation.

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AVIONICS



TUNNEL DIODE transmitter (left) consists of one variable and two fixed ceramic capacitors, tuning coil, and the tunnel diode located inside the can. Close-up of a tunnel diode (right) shows the connecting wire leading into an alloy dot which is soldered to a germanium crystal (dark area) which in turn is soldered to a rectangular metal plate that forms the other connection.

Tunnel Diodes May Cut Transistor Costs

By James A. Fusca

New York—Semiconductor researchers are becoming increasingly interested in the promising new device called the "tunnel diode." Latest results to be announced are those of scientists at the General Electric Research Laboratory where tunnel diodes have been incorporated in operating experimental circuits such as an FM transmitter, an FM receiver, and in microwave and crystal-controlled oscillators.

Sample Quantities

Characteristics of the tunnel diode that have attracted interest include the ability to operate at frequencies as high as 10 kilomegacycles, power requirements as low as one millionth of a watt, and an amplification noise figure of about one decibel.

General Electric says that it will be offering tunnel diodes in sample quantities by late September at an approximate price of \$75 per diode. Eventually the company hopes to make available a complete line of different types of tunnel diodes at prices below the cost of the various types of transistors available commercially today.

Tunnel Diode

The tunnel diode takes its name from the quantum-mechanical tunneling phenomenon by which electrical charges move through the device at the speed of light. This high speed makes possible operation at extremely high

frequencies. Oscillators employing tunnel diodes have been operated successfully at frequencies above 2,000 mc., and General Electric says that it expects to obtain operating frequencies above 10,000 mc. in the near future.

Several advantages are claimed for the tunnel diode in comparison with transistors. The tunnel diode is smaller than a conventional transistor and, because of its simpler structure, ultimately should be reduced to a fraction of its present size. It is relatively immune to environmental conditions. Silicon tunnel diodes made by General Electric have been operated at temperatures to 650F. Measurements indicate that the device is 1,000 times better at resisting

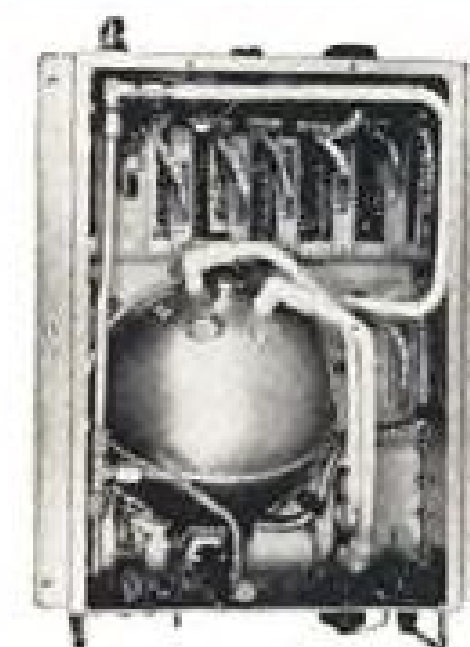
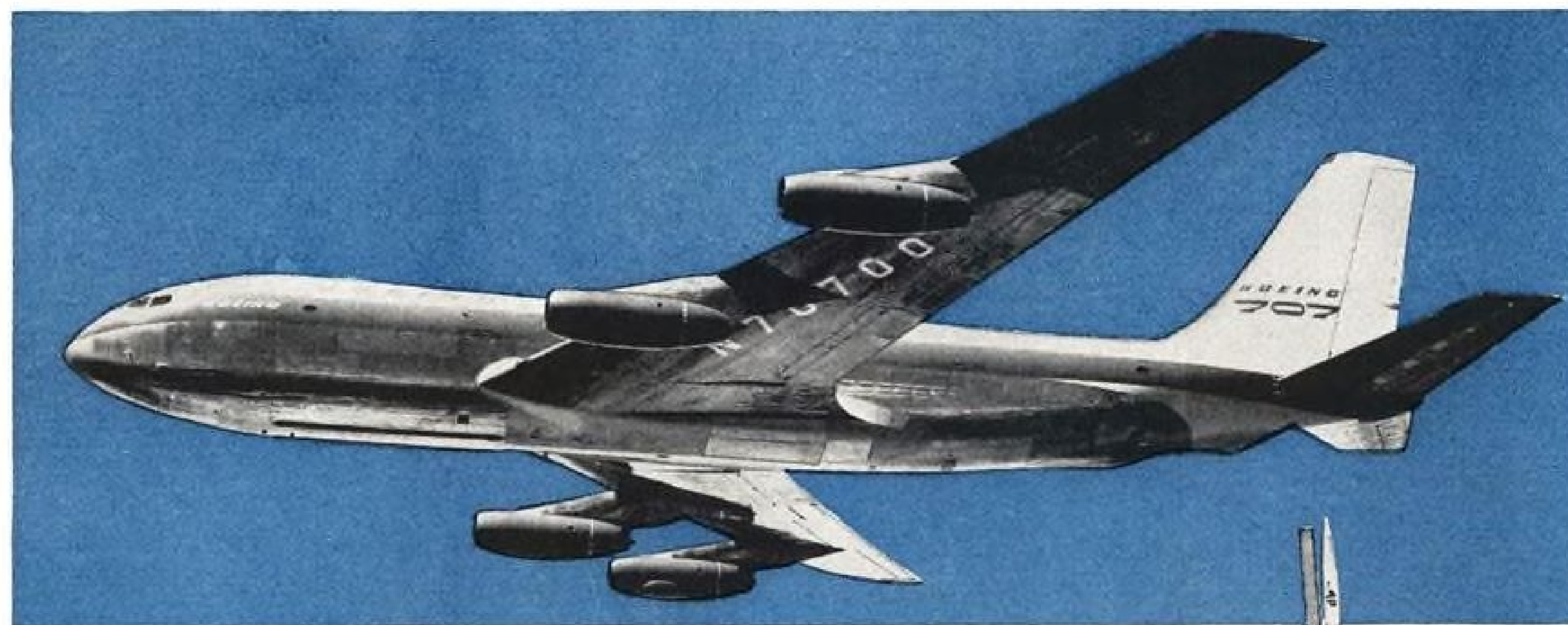
the actual effects of nuclear radiation.

One of the most interesting characteristics of the tunnel diode is that it is a negative resistance device. First reported by Dr. Leo Esaki of Japanese Sony Corp. in early 1958, the device has attracted wide attention in this country. Other research facilities known to be actively investigating tunnel diodes are RCA Laboratories, Bell Telephone Laboratories, and Air Force Cambridge Research Center. Several different materials are being studied, including silicon, germanium, gallium arsenide, gallium antimonide, indium antimonide, and silicon carbide.

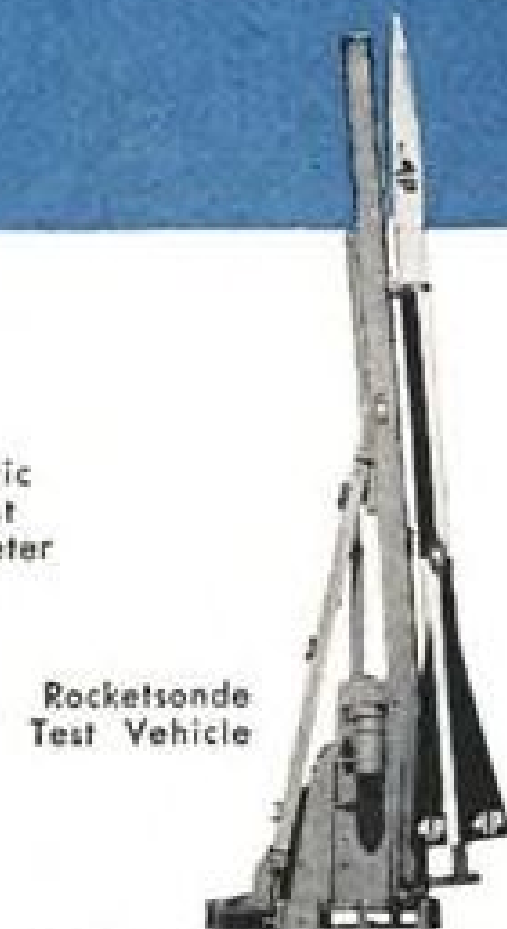
In quantum-mechanical tunneling, an electron, or a hole, disappears from one

Comparison of Tunnel Diode Characteristics

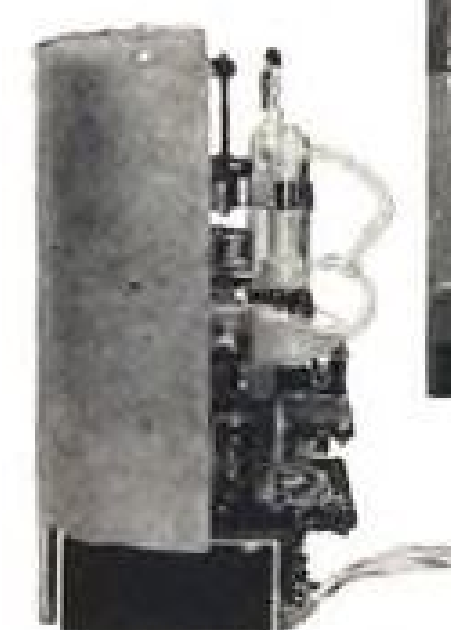
	Maximum Frequency Of Operation (in kmc.)	Minimum Power Requirements (watts)	Low Noise Amplification (Noise Temperature at 1,000 mc.)
Tunnel Diode	2-10	0.000001	100-300K
Transistor	2	0.001	3,000K
Vacuum Triode	10	0.1	900K
Parametric Amplifier	6	10	35K (at room temp.)
Traveling Wave Tube	60	10	300K
Maser	10	400	20K



Automatic Dewpoint Hygrometer



Rocketsonde Test Vehicle



Ozone Sensor



Sensor and Computer Airborne Control Console



Aircraft Installation for Transonic Sande Ejection

AN/AMQ-15

... concept to reality in one year

Just one year ago, the Air Force Global Weather Reconnaissance Program was only a system concept. Today, the feasibility of this advanced airborne system has been demonstrated at realistic speeds and altitudes.

The Bendix AN/AMQ-15 system includes advanced aircraft sensors for measuring thirteen geophysical parameters along the flight path, and advanced drop-sonde and rocketsonde sensors for measuring eight parameters in a vertical profile from sea level to 150,000 feet. Other subsystems are storm radar, cloud top and base radar, air sampling, airborne digital data processing and display, and ground data handling.

For flight demonstrations up to altitudes of 45,000 feet, the Boeing Airplane Company has installed AN/AMQ-15 subsystems in their prototype 707 jet

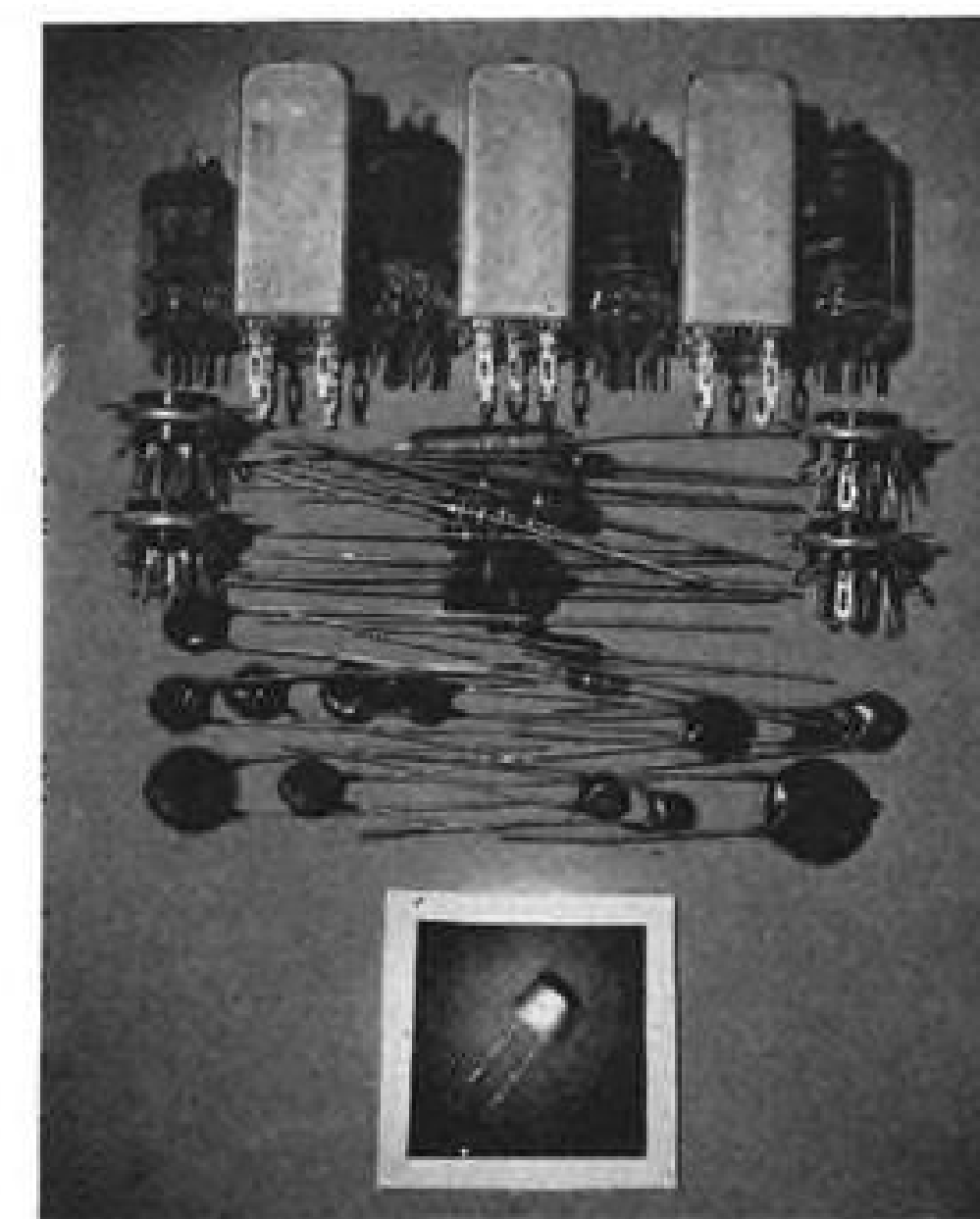
transport. In addition, Bendix has conducted firings of rocket test vehicles at Holloman Air Force Base.

In reporting this achievement of a major system design and implementation, Bendix is very proud of the contributions of its own divisions, and is most appreciative of the cooperative teamwork provided by the Air Force, Boeing, and other subcontractors. The result is a flexible and modular system which can be used in various sized packages for all types of aircraft ranging from strategic bombers to interceptors, and for civilian transport aircraft.

The AN/AMQ-15 is typical of the hard-hitting programs being carried out by Bendix Systems. Better engineers and scientists interested in pioneering systems of the future are invited to join this growing team.

Bendix Systems Division

ANN ARBOR, MICHIGAN



TUNNEL DIODE, shown in can at bottom, is capable of the functions necessary for an FM receiver: amplification, oscillation, conversion, limiting, detection, and automatic frequency control. An FM receiver built using a tunnel diode, the conventional components shown at the top could be omitted, with some sacrifices in performance.

side of a potential barrier and instantaneously reappears on the other side, although it does not have enough energy to surmount the barrier. In the case of the tunnel diode, the barrier is the space charge depletion region of a p-n junction. This is the same barrier which prevents current from flowing in the reverse direction in an ordinary rectifier diode.

This barrier is made extremely thin in the tunnel diode—less than one millionth of an inch—so that penetration by the tunnel effect is possible.

This gives rise to an additional current in the diode at very small forward bias which disappears when the bias is increased.

It is this additional current that produces the negative resistance in the device.

Free Carriers

The origin of this additional current can be understood by considering the changes in the characteristics of a conventional p-n junction diode as higher concentrations of free carriers are added in a semiconductor crystal.

As the density of charge carriers is increased, the reverse breakdown voltage decreases.

This reverse breakdown voltage, however, does not reach a limit at zero. The lower limit is determined by the solubility of the impurities which determine the carrier concentrations. Experiments have shown that many semiconductor materials can be doped heavily enough so that the diode can still be in the reverse breakdown condition at a small forward bias.

When a larger forward bias is applied, the diode goes out of the reverse breakdown condition and the current falls to a small level. The reverse breakdown current that flows with a forward applied bias establishes the negative resistance of the device.

Diode Advantages

In competition with conventional tubes, transistors, and other electronic devices, General Electric believes tunnel diodes have the following advantages.

- For communications applications, tunnel diodes compete with transistors, parametric amplifiers, vacuum triodes, magnetrons and klystrons, traveling wave tubes, and masers. Tunnel diode characteristics to be compared are their high oscillation frequency, microwatt power requirements, and very low noise amplification (noise figure of about one decibel).

- In computer applications, tunnel diodes will compete with transistors. The diode is at least 100 times faster than present day transistors, according to General Electric, and can be made to consume only about 100th of the power. Tunnel diodes also are relatively insensitive to temperature changes, which may permit circuit simplification without sacrificing reliability.



Electrostatic Gyro

Highly accurate electrostatic gyro whose spinning rotor is suspended in a vacuum by electric fields instead of by conventional bearings is shown here. Extremely low-drift gyro, developed by Minneapolis-Honeywell, uses spherical rotor made of beryllium and machined to tolerances of 15/millionth inch. Honeywell began this research under Navy Bureau of Ordnance sponsorship, and recently received USAF contract to study airborne application. Glass tube atop gyro case is a gage to measure internal vacuum. General Electric also is developing electrostatic gyro suspension.

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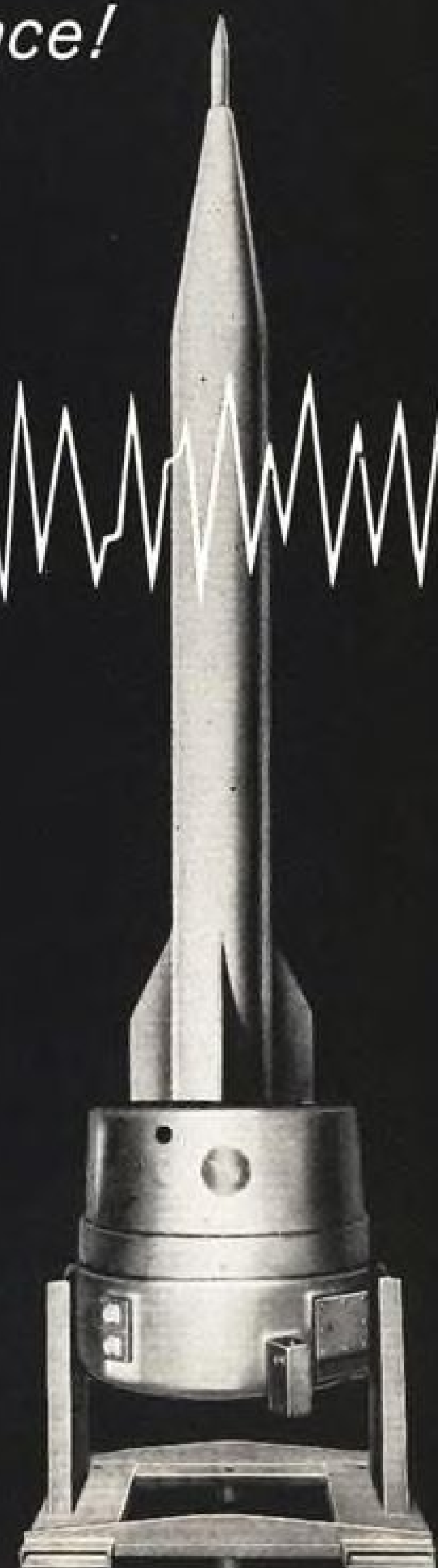
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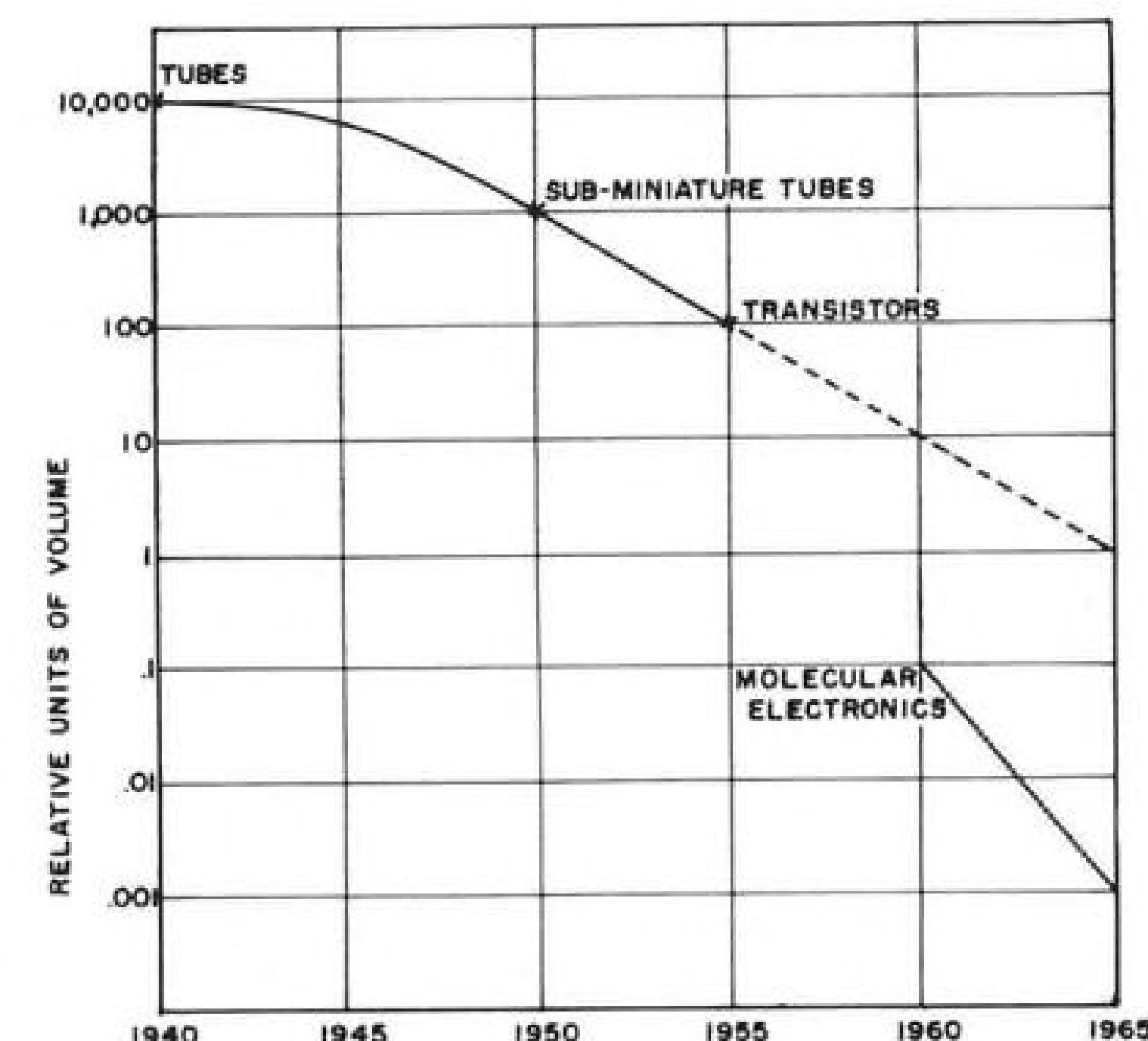
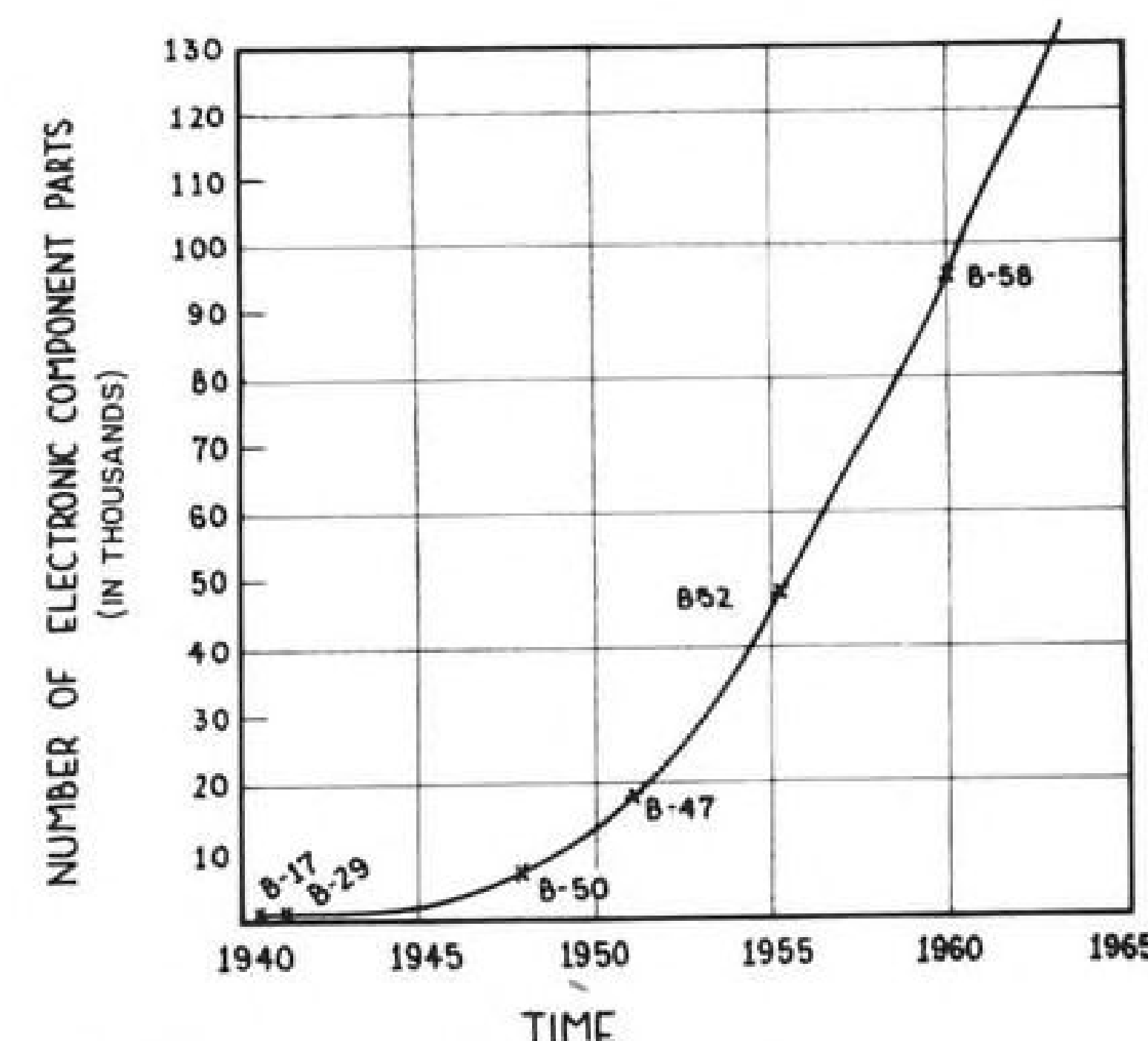
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GROWING COMPLEXITY of avionic equipment carried aboard bomber aircraft is shown at left in terms of the approximate number of components, each a potential source of equipment failure. Miniaturization gains achieved in the last two decades through the use of smaller components, tubes and transistors, are compared at right with the results expected from the Air Force's new molelectronics program.

USAF Investigates Basic Molelectronics

Dayton—During the past decade, Air Force weapon systems have become increasingly complex in order to accomplish their increasingly difficult mission assignments. One vivid example is in the number of electronic components required. Whereas the Boeing B-17 and B-29 avionic equipment used only a couple thousand components, the B-47 has an estimated 20,000 and the B-52 approximately 50,000. The total for the Convair B-58 is around 95,000 and the North American B-70 will show a corresponding increase.

Design Problems Created

This trend has created a number of major problems for the air/space vehicle designer, including size, weight and electric power requirements. Perhaps the most critical is the lesser reliability which results from the irrevocable law of nature that the reliability of a system is equal to the product of the reliabilities of each of its individual components. In addition to the components themselves, there usually are two soldered connections for every component—each another potential source of failure.

The electronics industry has not been standing still during the last few years. It has improved the performance of components and has made significant reductions in their size. However, the curve reveals that the reduction in size has been approximately a straight-line function for the past several years. This is not adequate to meet the greatly increased complexity of weapon systems and the demands for small size, weight and power of air and space vehicles.

Furthermore, it appears that a continuation of this evolutionary change cannot meet our needs. We need a new concept, or breakthrough, in the electronic components field.

Several years ago this situation was discussed with a number of representatives from industry and contracts were placed with hopes that breakthroughs would be achieved.

From a contractual standpoint, these programs were relatively successful, but we learned that one cannot contract for a breakthrough.

At that time we were thinking of functional components which were defined as single items that could replace a tube or transistor and its family of supporting passive components. These functional components were to amplify, switch, oscillate or perform one of the many other functions normally found in avionic equipment. We were even so visionary as to think of a complete communications or radar receiver that would be so simple as to have input, output and power leads only, with the innards being a solid material instead of an assembly of hundreds of components.

The term "molecular electronics"

Current Air Force philosophy and research effort in molecular electronics (molelectronics) is described in this article prepared for Aviation Week by H. V. Noble and Robert D. Larson. Mr. Noble is technical director of the Wright Air Development Center Electronic Technology Laboratory. Mr. Larson is chief of the laboratory's Advanced Solid State Section.

has been used by the Air Force to describe this technology for which we were searching. Molecular electronics has been defined as the synthesis of matter with predetermined electronic properties so that under a particular stimuli, the matter exhibits complex and complete electronic functions that previously were performed by distinctive combination of active and passive components.

A molecular electronic item that performs such a function has been named a "functional electronic block," or FEB (pronounced "Feeb") for short. A FEB might, for example, be a band-pass amplifier having a gain of 40 db. at 455 kc. with a 10 kc. bandwidth and an output of 100 microwatts.

Research Program

Because the previous contractual effort was not completely successful, it was felt that the next best thing would be to create a research program whose output would be an environment conducive to revolutionary advancements or even breakthroughs.

To accelerate a scientific revolution in this field through application of molecular electronics required new knowledge and tools which could only be obtained through intensive and exhaustive research programs. The success of the molecular electronics approach is highly dependent upon the revelation of basic information locked in the confines of atoms, molecules and crystals of matter, and on the development and application of new and novel concepts and approaches to the design of useful systems.

Full advantage had to be taken of