

# Aviation Week & Space Technology

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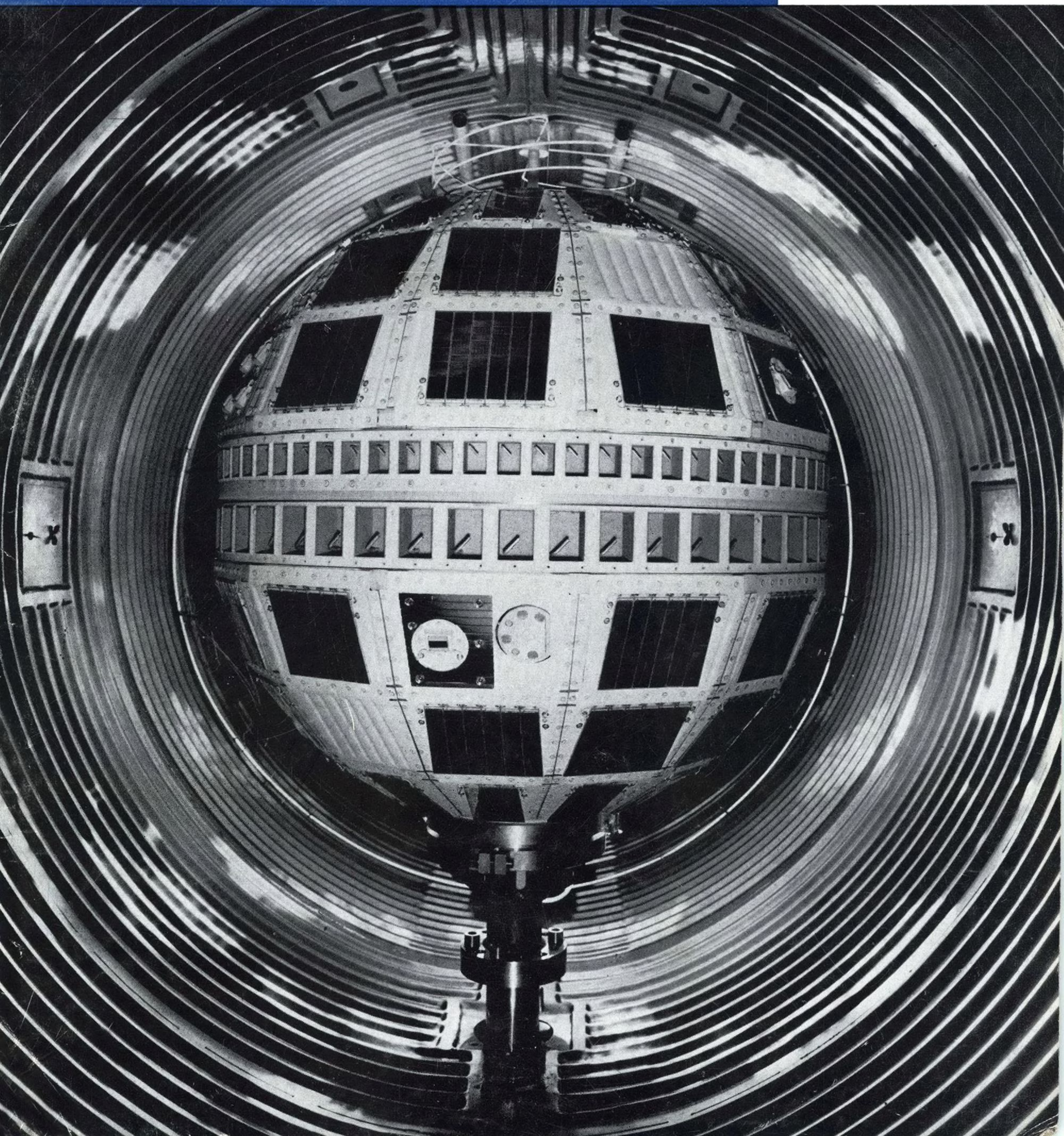
A McGraw-Hill Publication

November 19, 1962

SPECIAL REPORT:

## MMRBM Guidance Techniques

Telstar 2 During  
Environmental Test





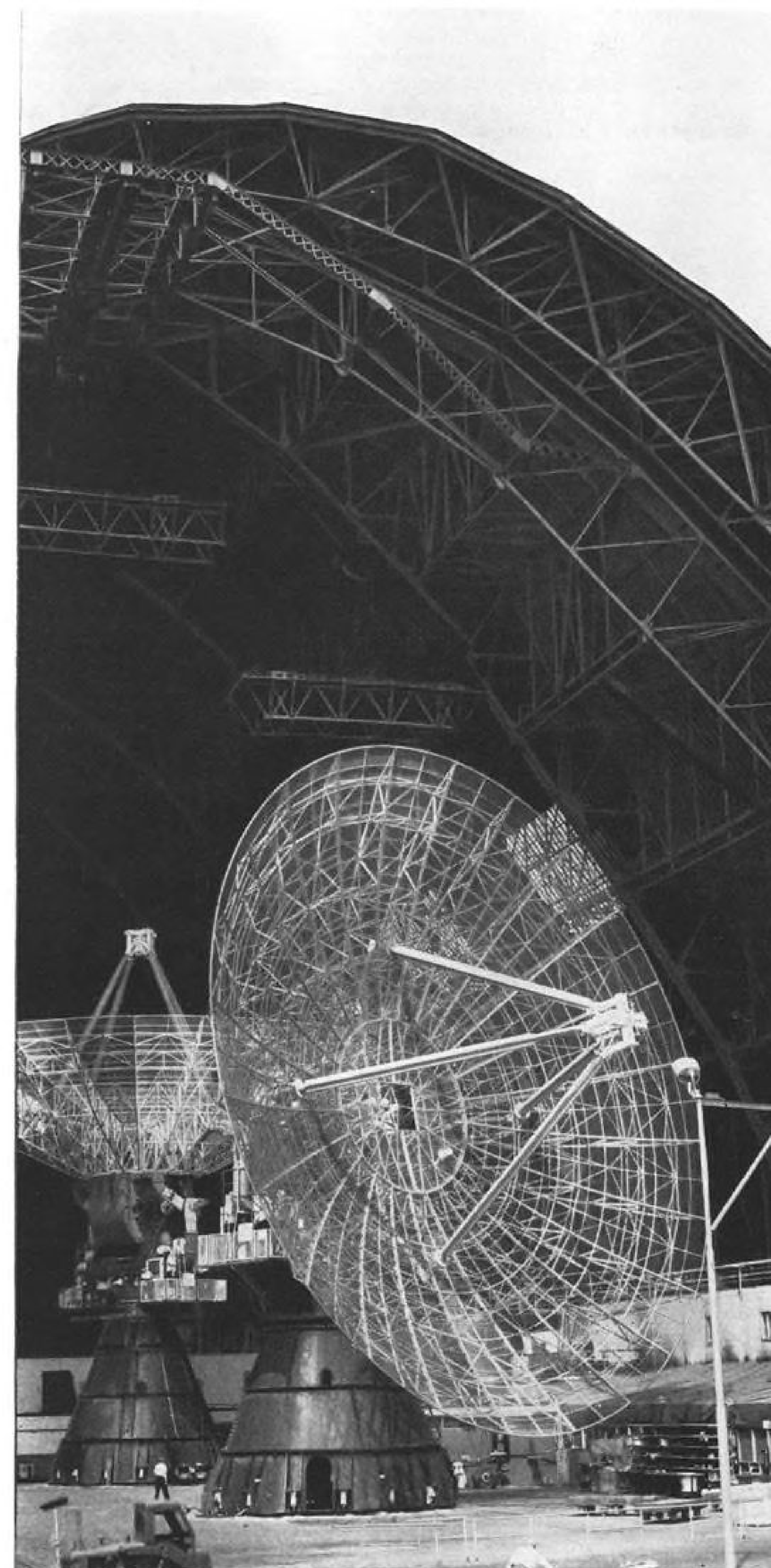
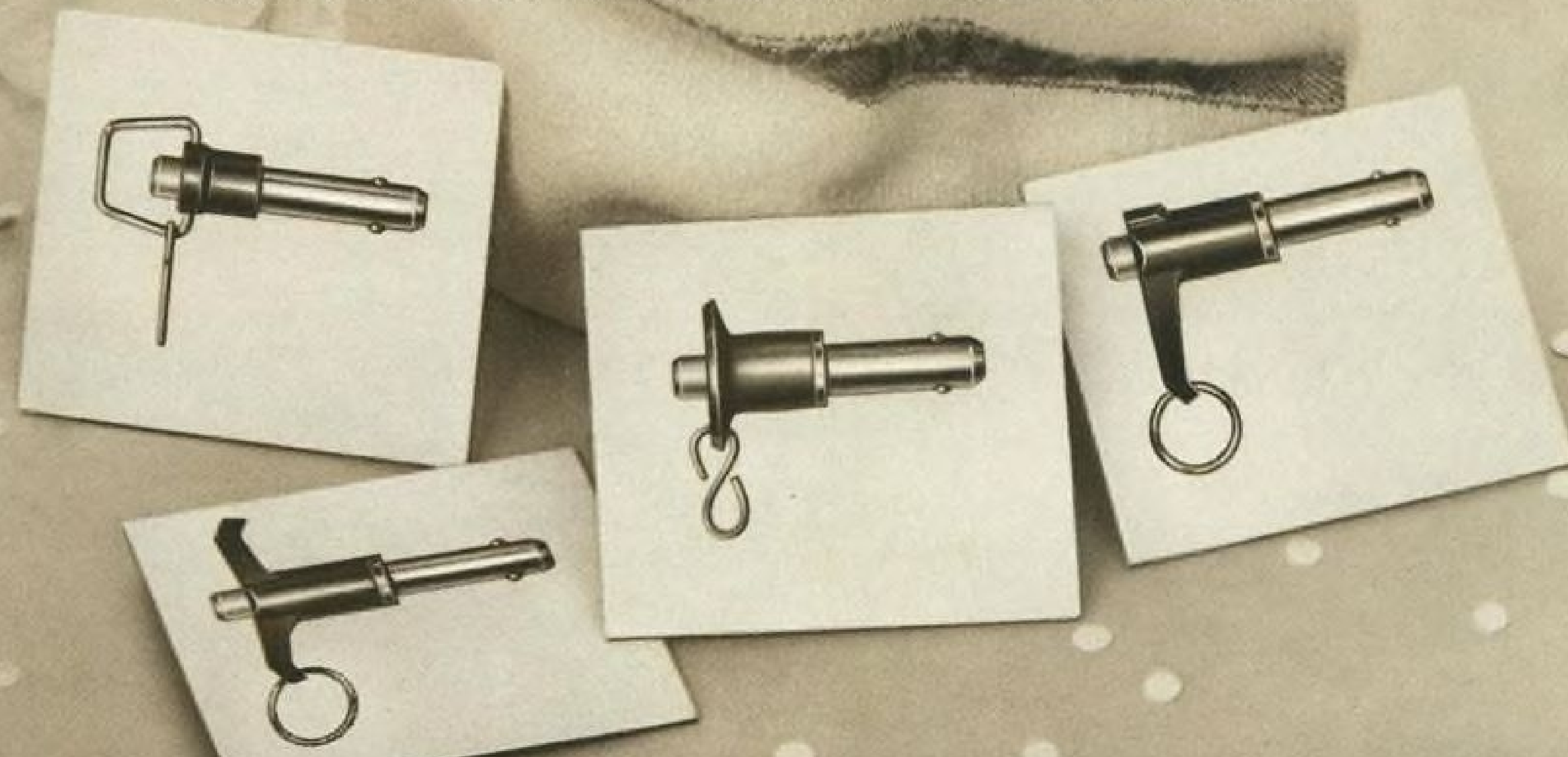
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We've also built and erected radomes for BMEWS, Nike-Zeus and other systems.

If you need help with a radar system . . . or any part of it . . . GAC can provide it. And we can also help you with advanced systems and technology—aerospace support equipment—electronic subsystems—lightweight structures—or missile requirements. Write Goodyear Aircraft Corporation, Dept. 914AW, Akron 15, Ohio, or Litchfield Park, Arizona.

◀ Containing 50,000,000 cubic feet of space without a supporting column, this 18-story-high GAC airdock is big enough to house complete BMEWS antennas.

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Flanged extrusion of 5A12½Sn Titanium alloy measures 51" by 36½", has 1½" wall with machined weight of 745 pounds. A 76" deep case for this application is under development.

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## AEROSPACE CALENDAR

- Nov. 26-27—Western States Section Meeting, The Combustion Institute, Aerojet-General Corp., Sacramento, Calif.  
Nov. 26-29—Annual Coordinated Meetings: American Nuclear Society, Atomic Industrial Forum, and joint AtomFair, Sheraton-Park and Shoreham Hotels, Washington, D. C.  
Nov. 27-29—40th Meeting, Aviation Distributors and Manufacturers Assn., The Kenilworth, Miami Beach, Fla.  
Nov. 27-29—Fall Meeting, Radio Technical Commission for Aeronautics, Marriott Motor Hotel, Washington, D. C.  
Nov. 28-30—1962 Ultrasonics Symposium, Institute of Radio Engineers, Columbia University, New York, N. Y.  
Dec. 2-6—15th Annual International Air Safety Seminar, Flight Safety Foundation, Williamsburg, Va. (FSF members and by invitation.)  
Dec. 4-6—Fall Joint Computer Conference, Sheraton Hotel, Philadelphia, Pa. Sponsors: American Federation of Information Processing Societies; IRE.  
Dec. 4-6—1962 Convention, National Aviation Trades Assn., Flamingo Hotel, Las Vegas, Nev.  
Dec. 5—12th Annual National Air Taxi Conference, Flamingo Hotel, Las Vegas, Nev.  
Dec. 5—Annual Dinner Meeting, Strategic Industries Assn., Statler-Hilton Hotel, Los Angeles, Calif. Speaker: Gen. Mark E. Bradley, Jr.  
Dec. 6-7—Vehicular Communications Con-

(Continued on page 7)

## AVIATION WEEK and Space Technology



November 19, 1962  
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AVIATION WEEK and SPACE TECHNOLOGY, November 19, 1962

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In avionics, the more space and weight you can save in the control package, the more you can pack in the pay load. Ergo, the *Miniature* Agastat time/delay/relay.

Weighs only 15 oz. Less than 2 in. square. Just short of 5 in. tall. Meets the environmental specs of MIL-E-5272 A. Adjustable for time delays from 0.03 to 180 seconds. Operation is *electro-pneumatic*—recycling, virtually instantaneous.

Over the years, Agastats have built an enviable record for reliability and accuracy in many critical applications. These new products of Agastat research are no exception, and they will perform under extreme environmental conditions to the most exacting standards.

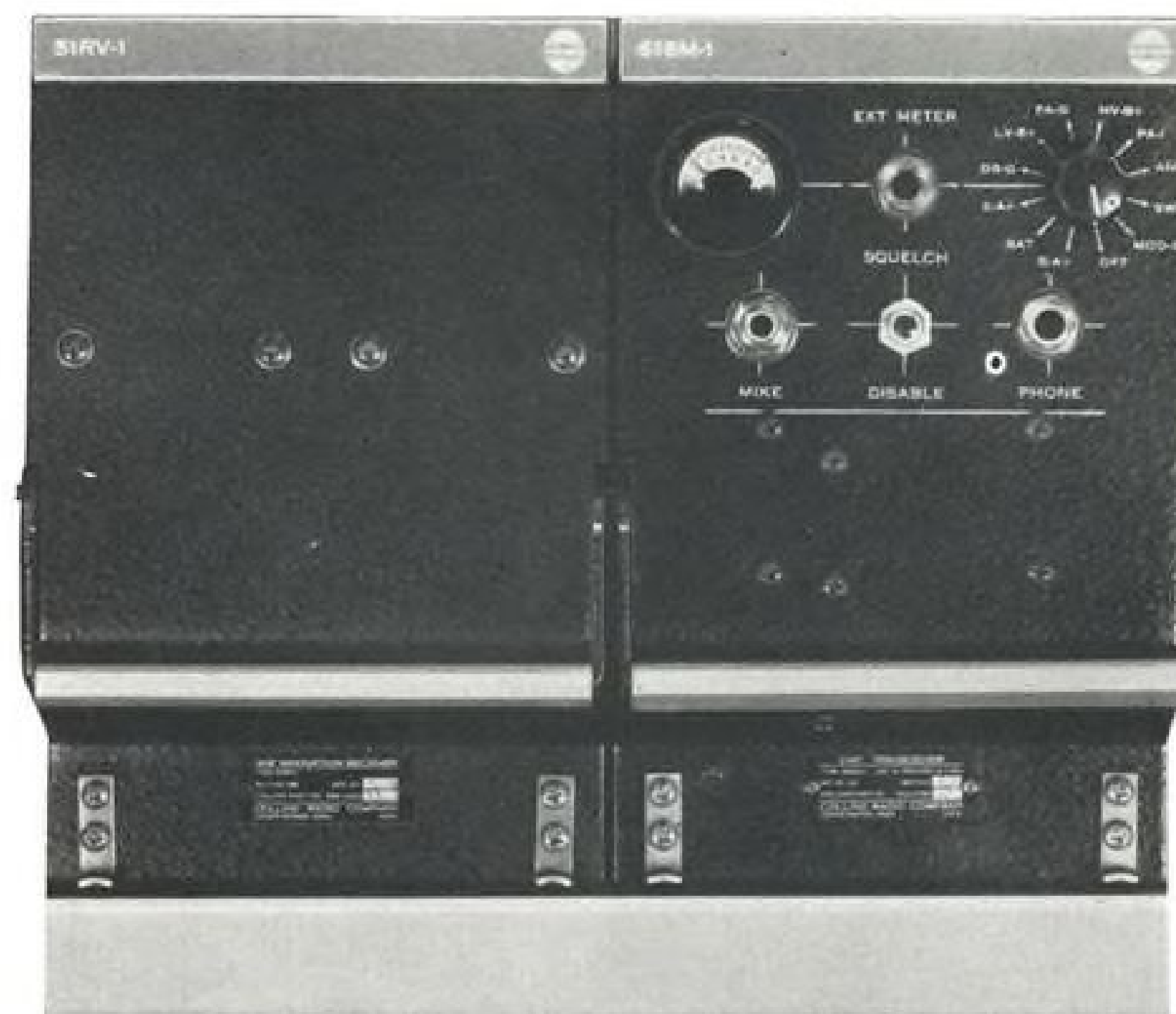
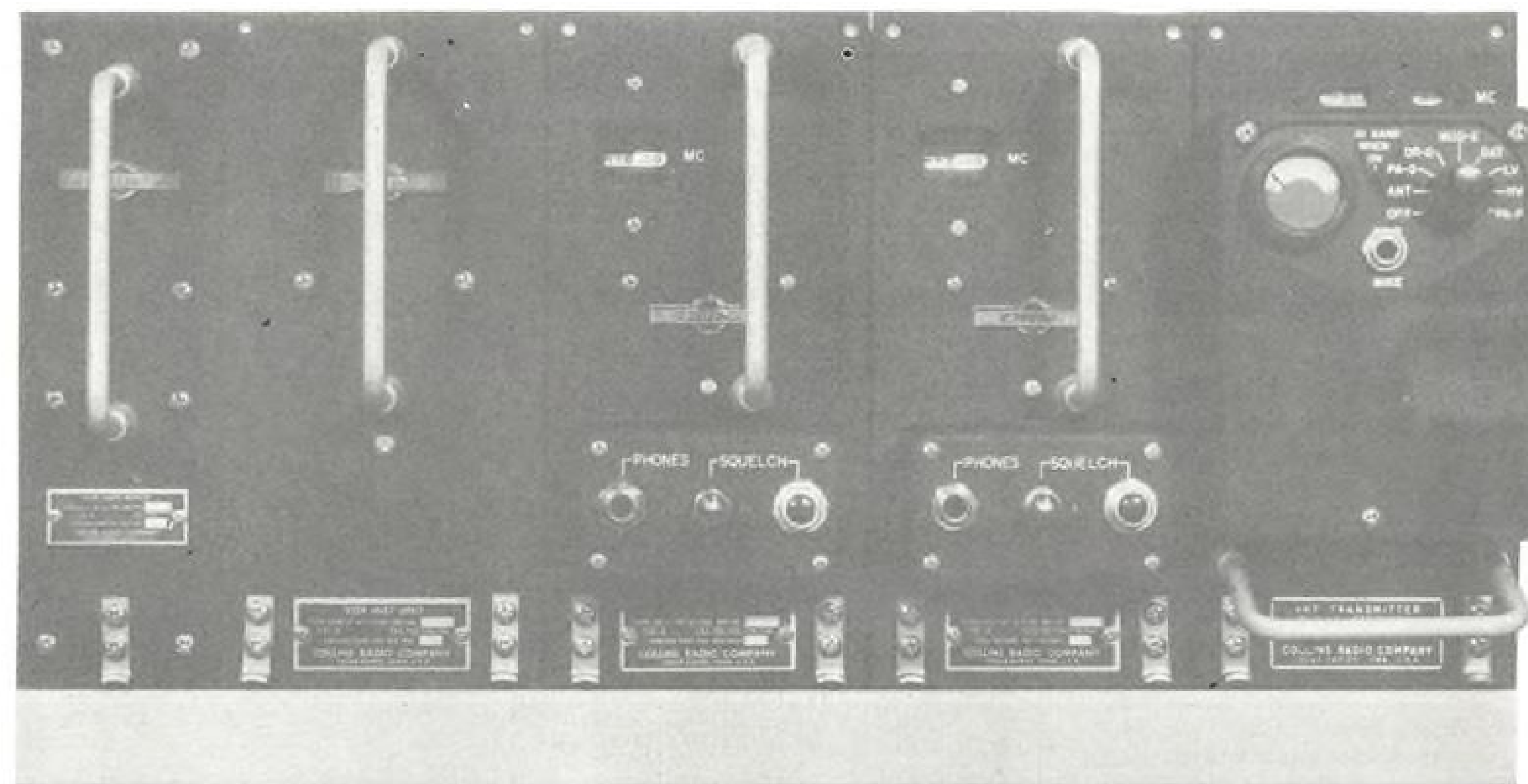
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## AEROSPACE CALENDAR

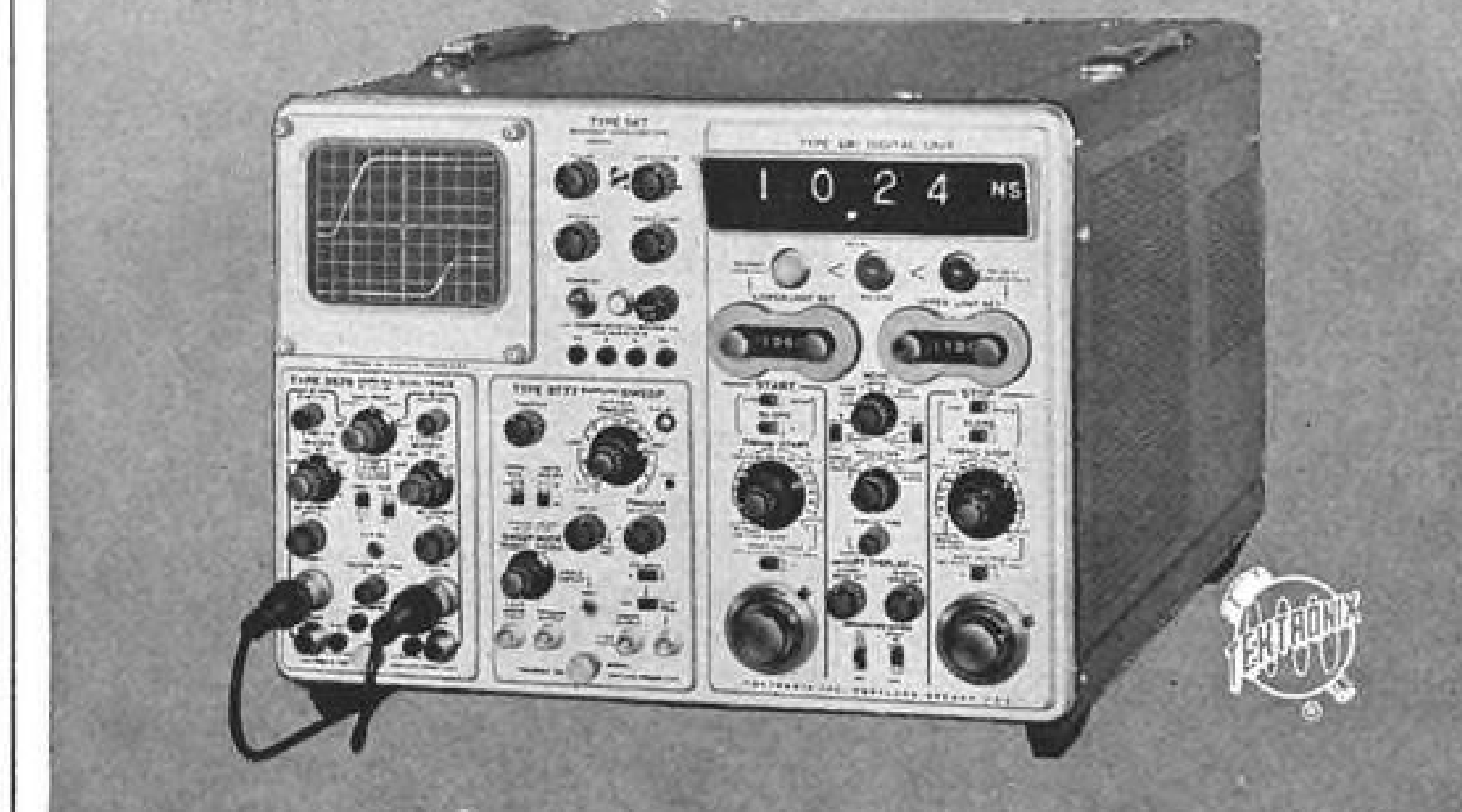
(Continued from page 5)

- ference, IRE, Disneyland Motel, Los Angeles.
- Dec. 10-11—First Annual Symposium on Unconventional Inertial Sensors (classified), Republic's Paul Moore Research & Development Center, Farmingdale, N. Y. Co-sponsors: Bureau of Naval Weapons & Republic Aviation Corp., in cooperation with AFSC Scientific and Technical Liaison Office.
- Dec. 10-12—Conference on VTOL Aircraft, New York Academy of Sciences, Henry Hudson Hotel, New York, N. Y.
- Dec. 26-31—Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science, Philadelphia, Pa.
- Dec. 27—American Astronautical Society Symposium on Scientific Satellites-Mission and Design, Franklin Hall, Philadelphia.
- Jan. 7-10—Millimeter and Submillimeter Conference, Institute of Radio Engineers, Cherry Plaza Hotel, Orlando, Fla.
- Jan. 13-16—15th Annual Convention, Helicopter Assn. of America, Cabana Motor Hotel, Palo Alto, Calif.
- Jan. 14-18—Automotive Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.
- Jan. 21-23—31st Annual Meeting (including Wright Brothers Lecture), Institute of the Aerospace Sciences, Hotel Astor, New York, N. Y.
- Jan. 21-24—43rd Annual Meeting, American Meteorological Society, New York, N. Y.
- Jan. 22-24—Ninth National Symposium on Reliability and Quality Control, Sheraton-Palace Hotel, San Francisco, Calif.
- Jan. 28—Fifth Annual Army Aviation Contract Services Symposium, International Inn, Washington, D. C. Sponsor: National Aeronautical Services Assn.
- Jan. 30-Feb. 1—Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and The Franklin Institute, Philadelphia.
- Jan. 30-Feb. 1—National Winter Convention on Military Electronics, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.
- Feb. 5-6—Symposium on Engineering for Major Scientific Programs, Georgia Institute of Technology, Atlanta, Ga.
- Feb. 11-15—Third International Symposium on Quantum Electronics, UNESCO Building, Paris, France. Sponsors: International Scientific Radio Union; Office of Naval Research; La Federation Nationale Des Industries Electroniques.
- Feb. 12-13—Space Vehicle Thermal and Atmosphere Control Symposium, conducted by the Aeronautical Systems Division, Engineers Club, Dayton, Ohio. Sponsor: ASD's Flight Accessories Laboratory.
- Feb. 20-22—1963 International Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.
- Mar. 7-8—Propulsion Meeting, Institute of the Aerospace Sciences, Cleveland, Ohio.
- Mar. 11-13—Electric Propulsion Conference, American Rocket Society, Broadmoor Hotel, Colorado Springs, Colo.

(Continued on page 9)

## DIGITAL READOUT

of pulse amplitudes *as small as* 2 millivolts peak-to-peak.  
of pulse risetimes *as fast as* 0.4 nanosecond.  
of time differences *as small as* 50 picoseconds up to 100 microseconds.



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With this new Tektronix Readout Oscilloscope you can measure pulse amplitudes and time increments faster and easier. For, after selecting measurement points on the displayed waveform *once* for all successive similar measurements, you make the tests and read the digital data directly. Indicators light to designate the readout status—whether *in* the preset-limit range, *below* it, or *above* it.

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Also, the Tektronix Readout Oscilloscope—with digital and sampling plug-in units—can be externally programmed for automatic sequential operation.

On a production line, in a laboratory, or for sustained testing programs, the digital convenience of this Tektronix Readout Oscilloscope can speed up and simplify your measurement applications.

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Type 567 Readout Oscilloscope (without plug-ins) . . . . . \$ 700  
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Type 6R1 Digital Unit . . . . . \$2500  
Type 3S76 Sampling Dual-Trace Unit . . . \$1100  
Type 3T77 Sampling Sweep Unit . . . . \$ 650  
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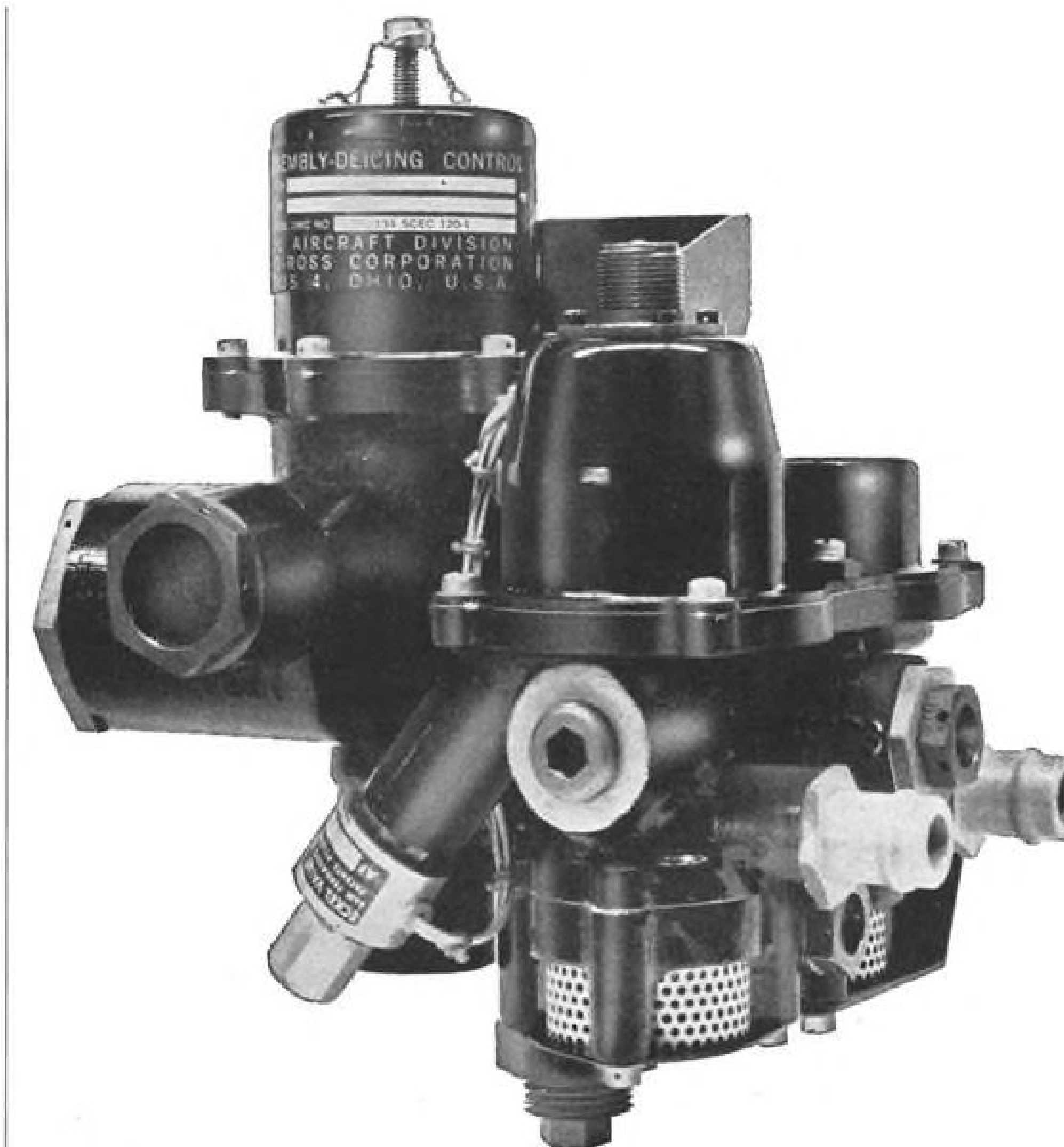


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## AEROSPACE CALENDAR

(Continued from page 7)

- Mar. 18-20—Space Flight Testing Conference, American Rocket Society and Institute of the Aerospace Sciences, Cocoa Beach, Fla.
- Mar. 18-21—1963 Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
- Mar. 19-21—Second Air Force-sponsored Symposium on Bionics, Biltmore Hotel, Dayton, Ohio.
- Mar. 25-28—International Convention, Institute of Radio Engineers, Waldorf-Astoria and Coliseum, New York, N. Y.
- Apr. 1-3—Fourth Annual Structures and Materials Conference, American Rocket Society and Institute of the Aerospace Sciences, El Mirado Hotel, Palm Springs.
- Apr. 2-3—Eighth Annual Business Aircraft Safety Seminar, Flight Safety Foundation, Barbizon Plaza, New York, N. Y.
- Apr. 2-5—Spring Conference, Airport Operators Council, Shoreham Hotel, Washington, D. C.
- Apr. 10-11—Fourth Symposium on Engineering Aspects of Magnetohydrodynamics, University of California, Berkeley.
- Apr. 15-17—Hypersonic Ramjets Conference, American Rocket Society and American Society of Mechanical Engineers, Naval Ordnance Laboratory, White Oak, Md.
- Apr. 17-19—International Nonlinear Magnetism Conference, Shoreham Hotel, Washington, D. C. Sponsors: American Institute of Electrical Engineers; IRE.
- Apr. 17-19—Southwestern Conference and Electronic Show, Institute of Radio Engineers, Dallas Memorial Auditorium, Dallas, Tex.
- Apr. 17-19—Technical Meeting: Nuclear Materials for Space Applications, American Nuclear Society, Netherland Hilton Hotel, Cincinnati, Ohio.
- Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D. C.
- May 2—Bioastronautics Conference, American Rocket Society and Aerospace Medical Assn., Los Angeles, Calif.
- May 2-3—Fourth National Symposium on Human Factors in Electronics, Institute of Radio Engineers, Marriott Twin Bridges Motel, Washington, D. C.
- May 7-9—Electronic Components Conference, Institute of Radio Engineers, Marriott Twin Bridges Motel, Washington.
- May 13-15—National Aerospace Electronics Conference, Institute of Radio Engineers, Dayton, Ohio.
- May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.
- May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Radio Engineers, Miramar Hotel, Santa Monica, Calif.
- May 20-22—National Telemetry Conference, Hilton Hotel, Albuquerque, N. M.
- May 21-23—National Telemetry Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.
- June 6-16—25th French International Air Show, Le Bourget, Paris, France.



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Next time you tackle an air regulating problem—actuation, tank pressurization, de-icing, air conditioning, or what have you—on aircraft, missiles, or ground support equipment, call Janitrol. We got a head start years ago in designing valves for combustion equipment, are now making valves in quantity with some of the most advanced production equipment in the business.

The valve illustrated is a good example of Janitrol's ability to combine several functions in a single unit (this one valve does the work that used to take seven) and thus bring about important weight savings.

We have solid experience in delivering hot valves as well as cryogenic hardware. We also invite inquiries on high performance duct couplings, supports, and heat exchangers.

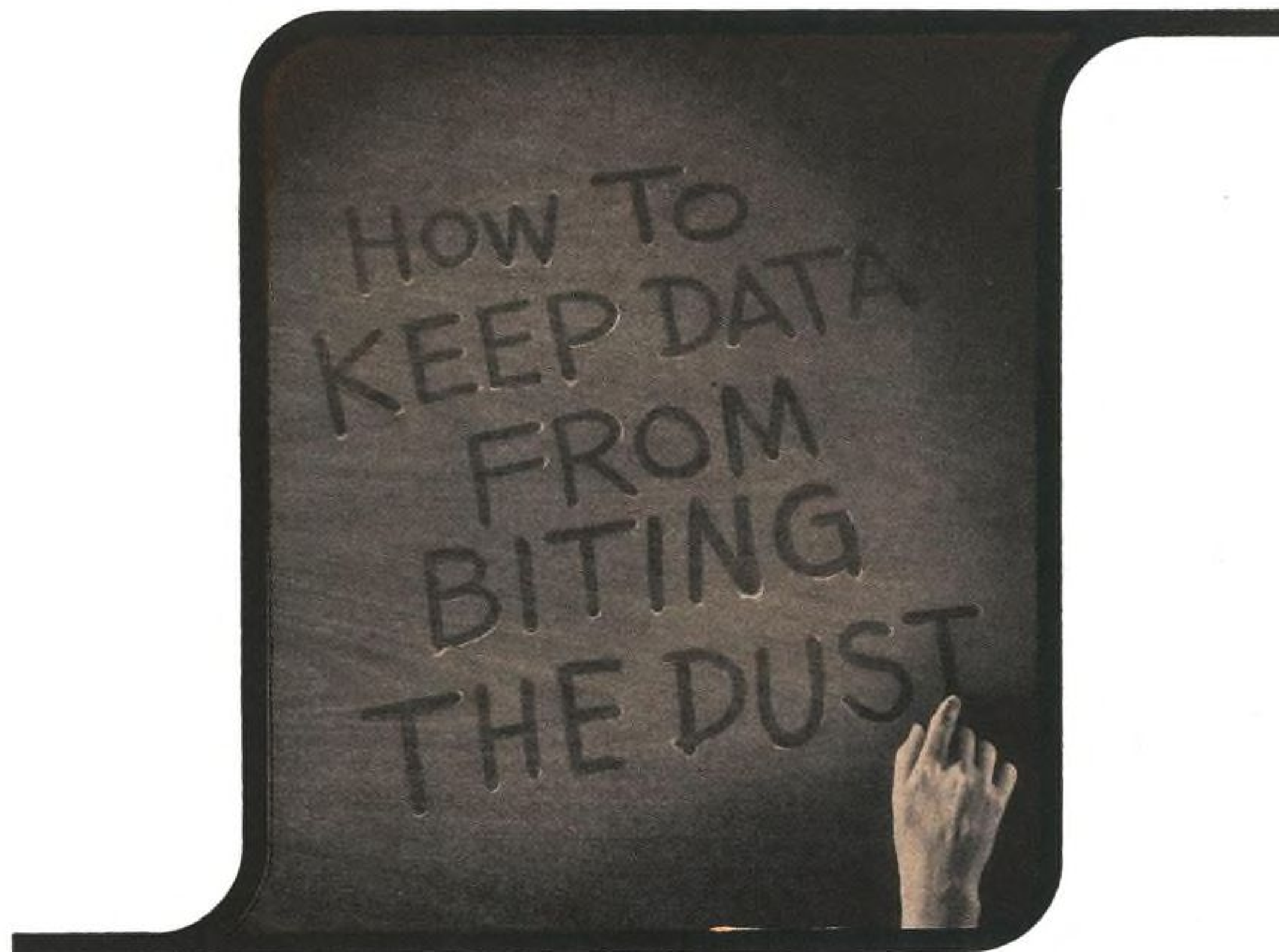
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Airborne dust can be a king-size problem when it separates magnetic tape from signal, *you* from accurately recorded data. That danger mounts as today's higher tape speeds and tensions generate more and more dust-attracting static electricity. That's *one reason* why high-speed recorders need "SCOTCH" BRAND Heavy Duty Instrumentation Tapes... they provide 1000 times greater conductivity than ordinary tapes, drain off static charges before they cause trouble!

Electrical resistance of the heavy duty oxide coating is

only 100 megohms per square or less. Static is readily dissipated to keep tape clean, prevent such other static problems as tape drag and skewing, as well as noise induced by arcing.

"SCOTCH" Heavy Duty Tapes outwear conventional tapes at least 15 times. Special binder and high-potency oxide formulation defeats head-heat buildup, withstands temperatures from -40°F to as high as 250°F! Silicone lubrication protects recorder heads and tape against wear.

16 different "SCOTCH" Heavy Duty Instrumentation Tapes offer a variety of backing and coating thicknesses, provide constructions for all high-speed applications, even for extreme high frequencies, critical short wavelength requirements. For details, call the 3M representative, or write Magnetic Products Division, Dept. MCJ-112, 3M Company, St. Paul 19, Minn.



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## Structures from Avco Corporation for the C-130E

**Eight years ago** when work began on the first production model of the C-130 transport for the U. S. Air Force, the Lockheed-Georgia Company, a division of Lockheed Aircraft Corporation, selected Avco's Aerospace Structures Division as its subcontractor to build tail assemblies for the aircraft.

**This was the beginning** of one of the longest and most successful relationships between a prime and a subcontractor in the aerospace industry.

**Today, Avco/Aerospace Structures** is working on tail assemblies for the newest C-130's, the C-130E *Hercules*, which can span the Atlantic nonstop, or airbridge the Pacific in one stop, carrying payloads of 13 to 16 tons.

**Avco's** long association with the C-130 project attests to its competence and skill in the field of lightweight, high-strength structures. Other important projects on which it is working include: upper aft fuselage section for the RS-70 bomber produced by North American Aviation, Inc.; components for NASA's Saturn booster; FPS-26 height-finder radar reflectors for Avco's Electronics Division.

**Because of the skills** it has established in working on twenty-four different aerospace

structures programs since 1940, as well as its new and unusual low-cost tooling techniques, Avco ranks among the best when it comes to structures for the aerospace age.

**For complete information** on how Avco can solve problems that require structures with high strength, yet are light in weight, write: General Manager—Structures Marketing, Aerospace Structures Division, Avco Corporation, Nashville 1, Tennessee.



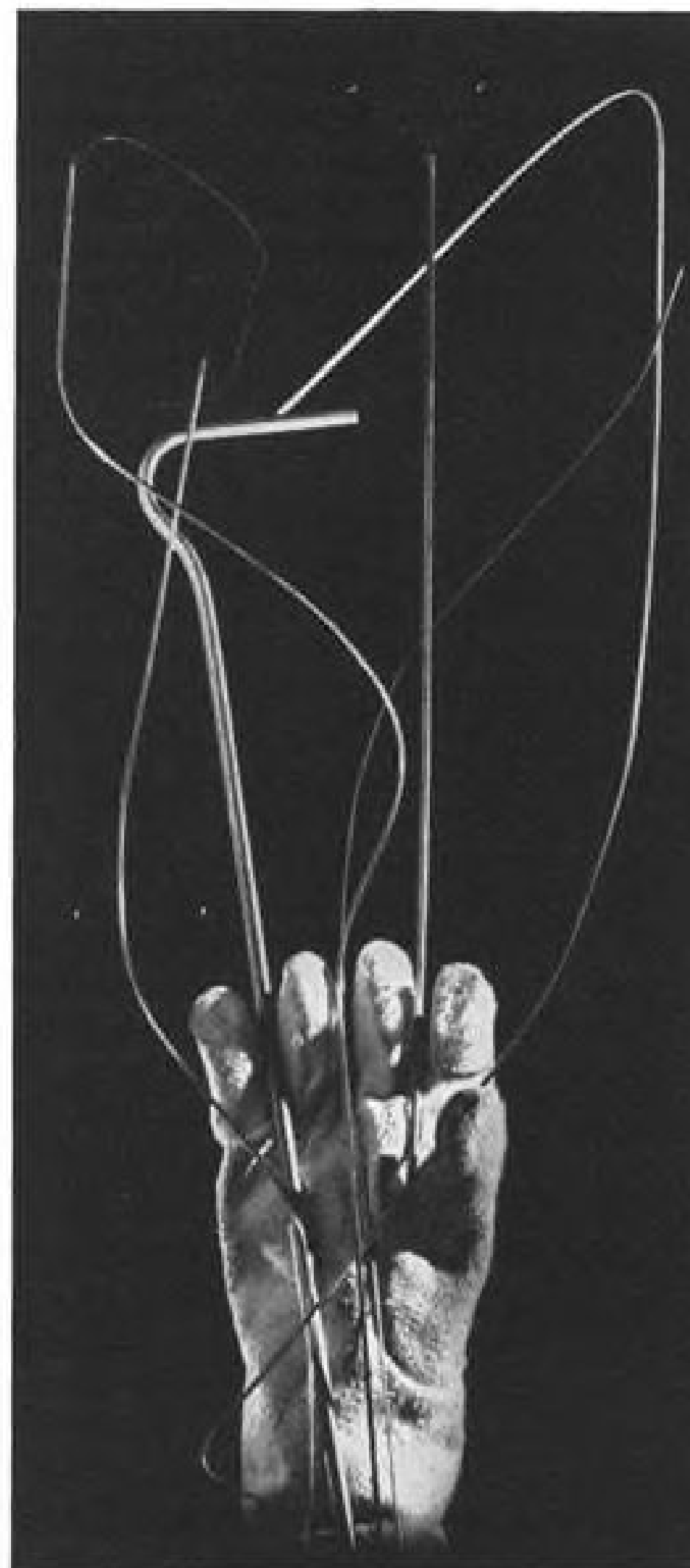
Lockheed C-130E has tail assembly built by Avco



# MegopaK Exotic?

Only by association. Because of their speedy response and flexibility, **MegopaK** temperature sensors are being used in some of the most advanced scientific projects of our time. Modern industry, research, space age and atomic projects are using **MegopaK** sensors, and using them! To meet the demand, we now offer some 76,000 different combinations of **MegopaK** components from factory stock.

You see, a **MegopaK** unit is a very precise and practical thermocouple, consisting of mineral-insulated thermocouple wires, solidly compacted within a corrosion-resistant metal sheath. It has exactly what it takes to sense reaction and process temperatures: high response speed, simplicity of construction, long useful life, small diameter (1/16" and even smaller on special order) and measurement ranges up to 3000°F. It can be had in lengths up to 50 feet. One of its greatest advantages is flexibility; it can be bent on the job to measure in spots that bulkier and rigidly-mounted sensors couldn't begin to reach.



A **MegopaK** thermocouple is in a class by itself. For instance, the original sensor in an atomic reactor gave so much trouble that the user determined to replace it with the very best temperature measuring device that money could buy. After exhaustive consideration of everything available, he selected a **MegopaK** assembly, and reports complete

satisfaction now that it's at work.

Again, a leading builder of spacecraft considers **MegopaK** thermocouples "most important" (his words) to the success of this highly critical application.

The **MegopaK** assembly is a typical Honeywell "family" achievement. Developed at our Corporate Research Center at Hopkins,

Minn., it received the early attention of some of the world's leading authorities in thermocouple metallurgy and insulating materials. It is manufactured under spick-and-span conditions at a new facility in Philadelphia. Strictly controlled processing and specially-designed equipment make it possible to compact the assembly tightly with no unevenness in resistance or distortion of the wires. Finally, the completed **MegopaK** unit is 100% inspected at 500 V d.c. to make sure that every inch meets the highest possible standards.

Naturally, all this attention to detail is reflected in the price. You could probably find something that looks like a **MegopaK** sensor for considerably less money. It all depends on how much reliability and precision you're willing to pay for.

Whether you are interested in measurement across the entire temperature spectrum, or only a narrow segment of it, you'll find that the best-known name in temperature measurement and control can be of distinct help to you. We'll gladly put our long and varied experience at your disposal in selecting sensors, instruments and data handling equipment. If you like, we'll install them for you, and guarantee they'll work. Talk over your needs with your nearest Honeywell field engineer, or write A. E. Finn, MINNEAPOLIS-HONEYWELL, Wayne & Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ont.

**Honeywell**  
First in Control

HONEYWELL INTERNATIONAL Sales and service offices in principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.



## Scott put the **LIFEGUARD** on the launch pad



Scott standard Air-Pak model 6000A2MST. Scottoramic Mask offers complete protection to eyes and face and provides unlimited vision in all directions for maximum safety.

Scott "Air-Paks" are protecting lives in many of the branches of the Department of Defense. In NASA, crewmen safely perform the hazardous job of fueling missiles and rockets with highly toxic propellants. Air-Paks deliver pure, fresh air "on demand", effortlessly, even under exertion.

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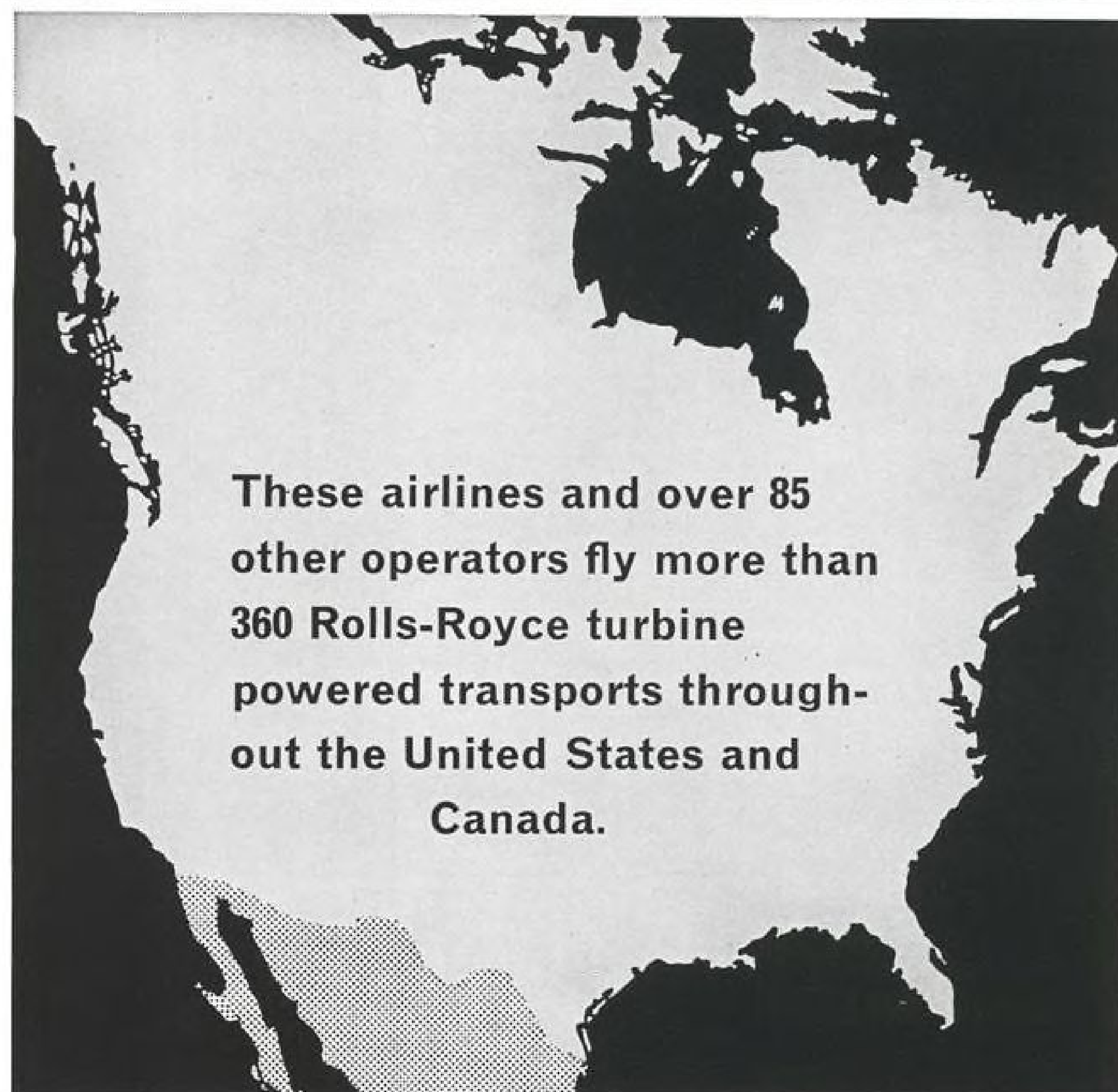
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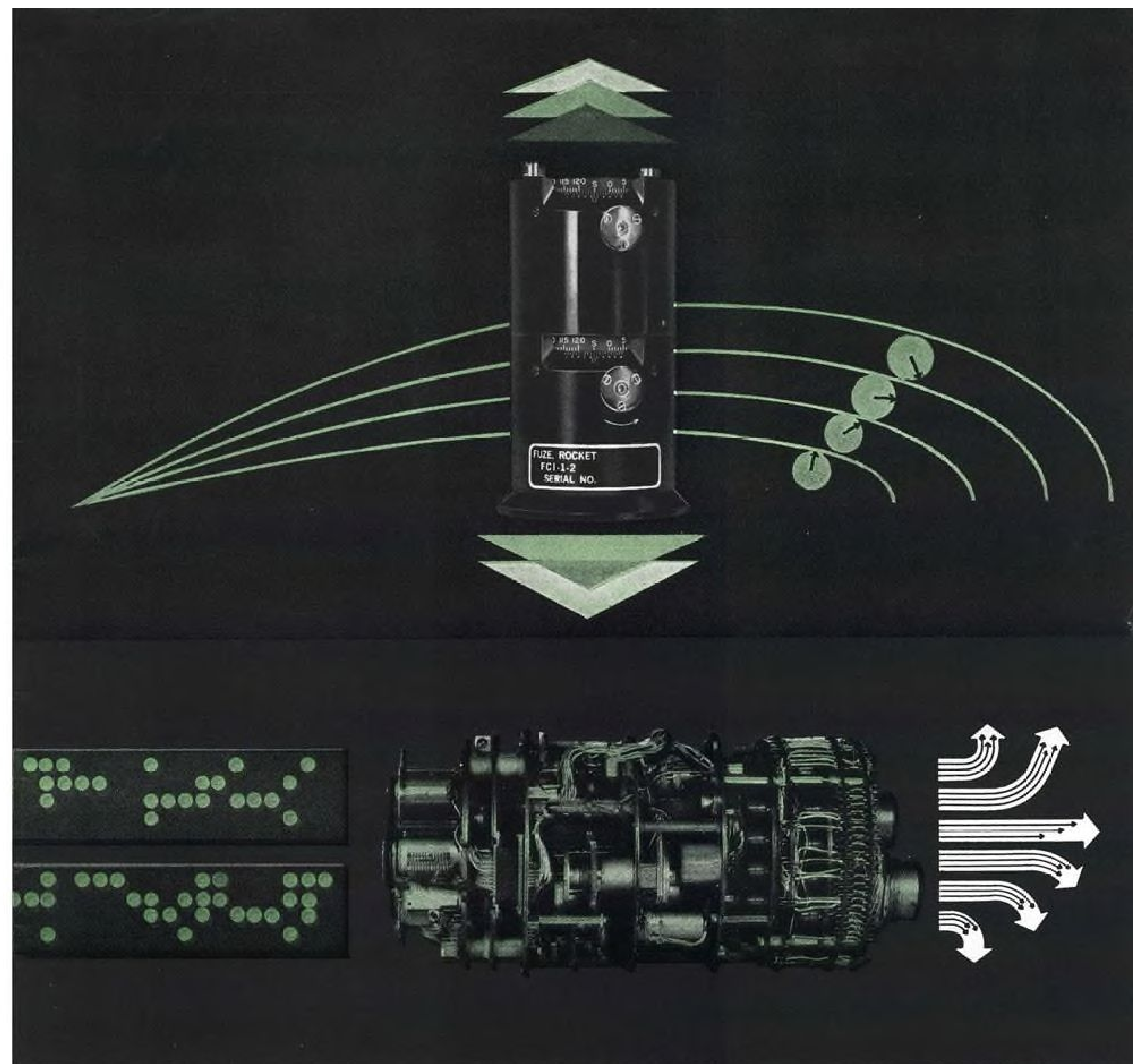
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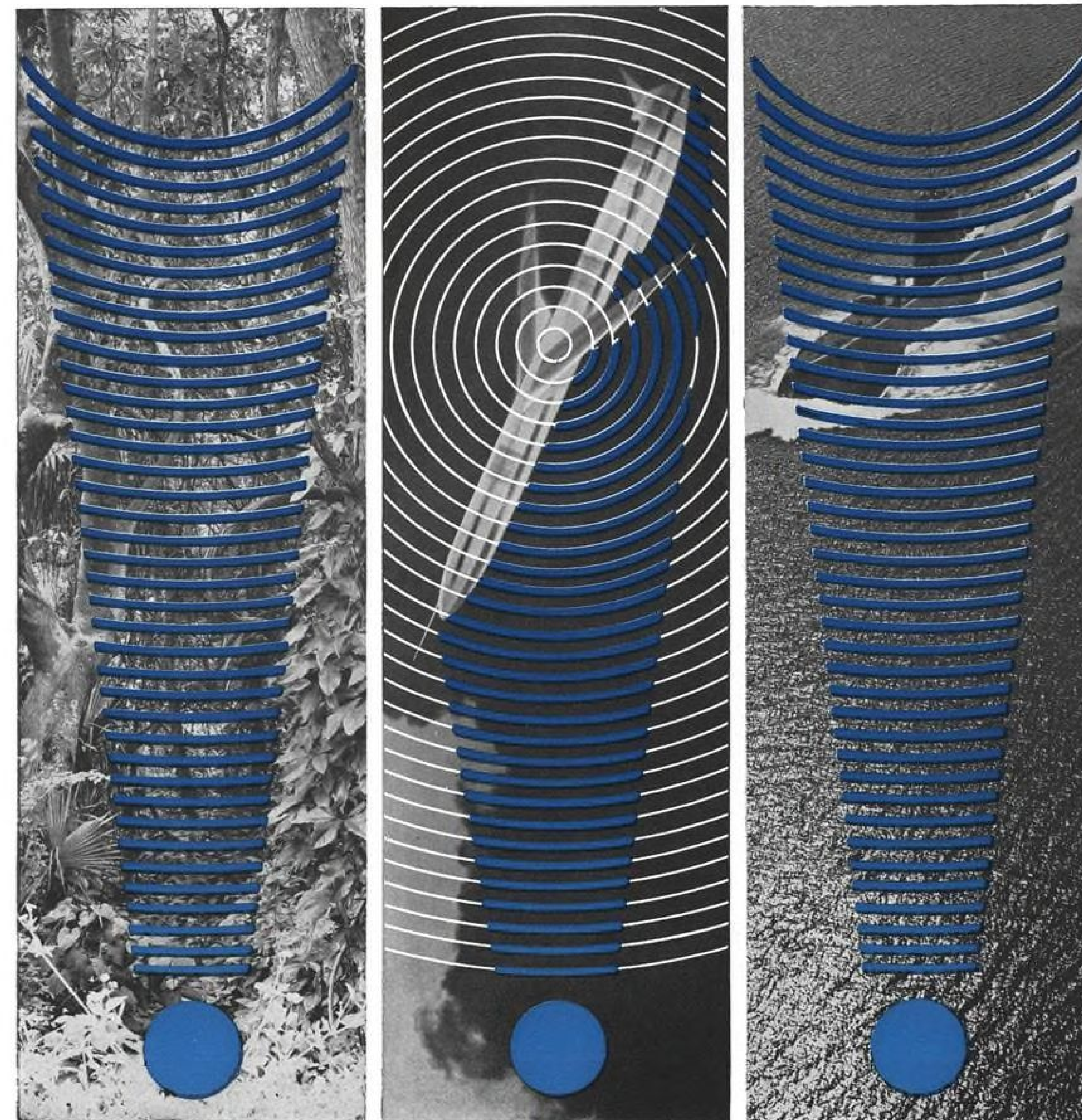
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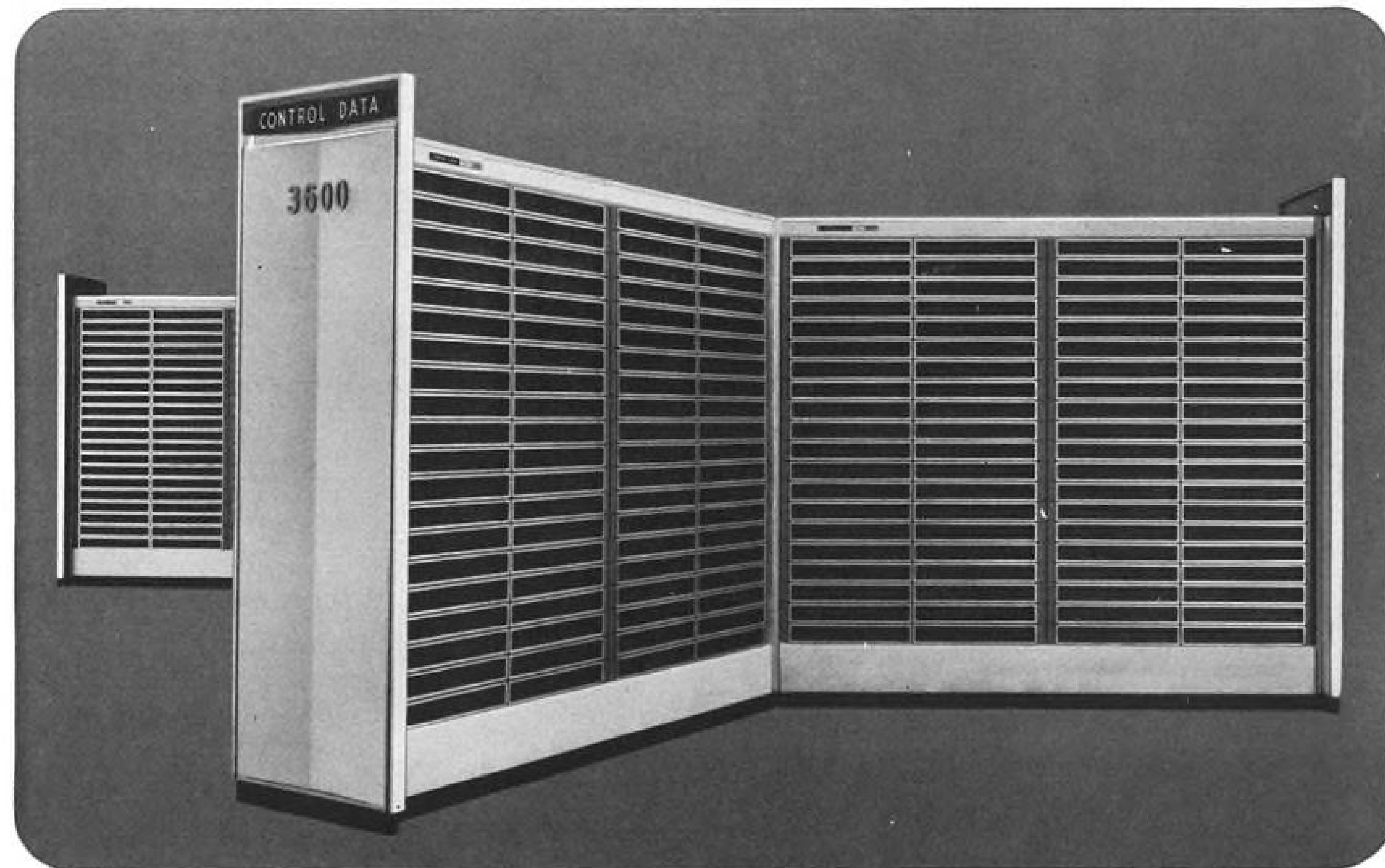
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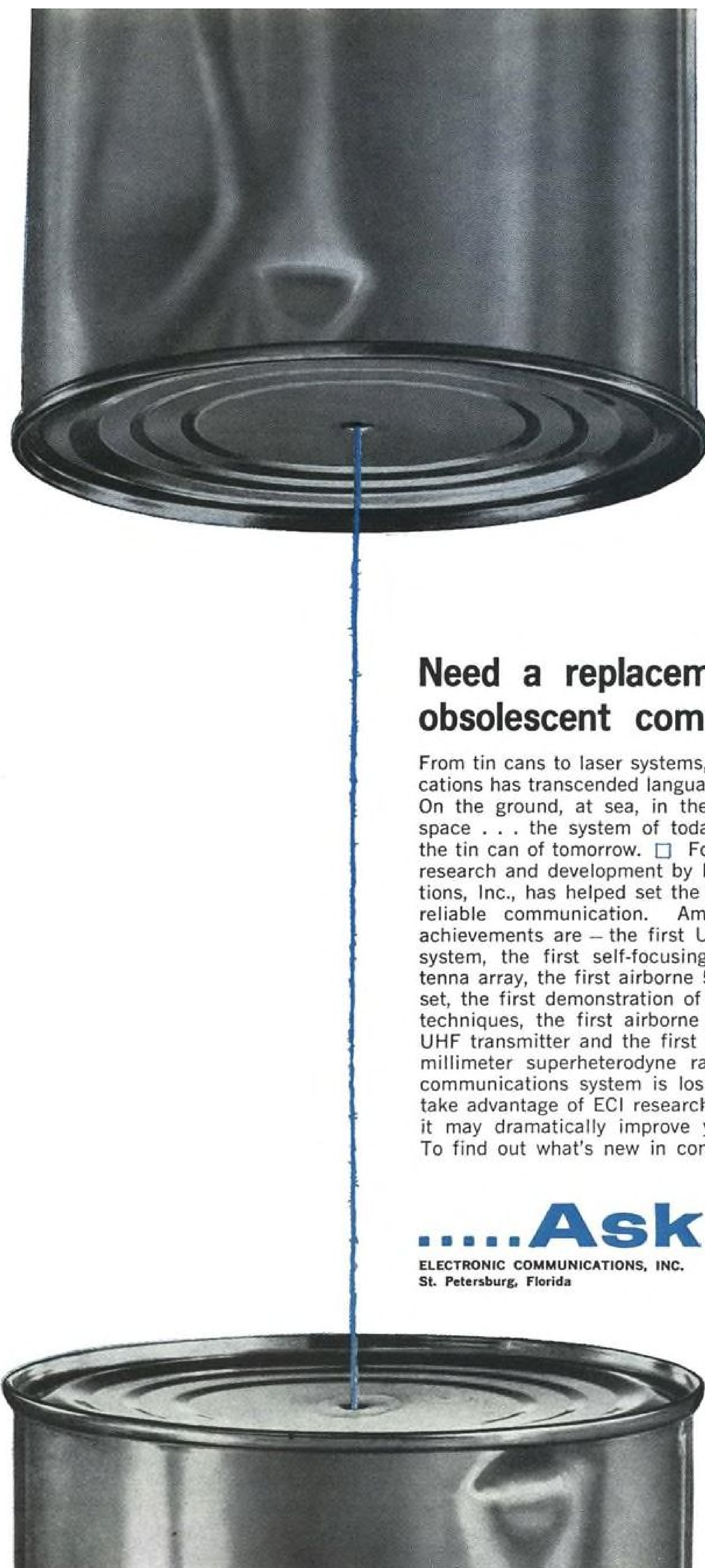
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COVER: Bell Telephone's Telstar 2 is prepared for environmental testing in company's space chamber. Photo was taken before closing of access door on one end of the cylindrical chamber. Three solar lamps behind satellite direct light arcs into chamber through Pyrex windows, producing visible and invisible radiation simulating outer space sunlight. National Carbon Co. furnished the arc carbons. During test, Telstar was suspended from flange.

#### PICTURE CREDITS

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## EDITORIAL

### NASA Growing Pains

The National Aeronautics and Space Administration shows signs of suffering from acute growing pains as the Fiscal 1964 budgeting season begins. There are solid indications that the Apollo manned lunar landing program is already beginning to slip due to financial strain (AW Nov. 12, p. 27), and further significant slippage may be expected unless its funding is increased. Already, other aspects of NASA's rightfully broad space exploration program are being pared to provide funds for the Apollo program, and the strain in these areas will grow acute if present funding plans don't change.

It is not unusual that an organization that has grown as fast as NASA during the past two years should be suffering from growing pains and budgetitis. Almost from its inception, NASA has shown a trend toward consistently underestimating the cost requirements of its major technical programs. For example, the cost of the Mercury manned orbital space flight program has quadrupled over the original cost estimates made by NASA. One major phase of Mercury actually cost 10 times the original price tag. The Apollo program and many other key NASA ventures are already showing signs of climbing this same curve of rising costs. This is naturally disturbing to the program managers who are charged with pushing on toward their technical goals at full speed; to the NASA administrators who assured Congress that their funding budget scope was sufficient to achieve desired goals within minimum time spans; and to the congressmen who have supported NASA programs and budgets because of the assurance that they met the high priority goals established by President Kennedy some 18 months ago. But it is really an inevitable by-product of any major effort to push hard along a major technological frontier and gain basic new knowledge.

#### Funding Needs Misunderstood

It is also one of the tragedies of our time that the vital funding requirements of major research and development efforts are so poorly understood by the fiscal officers who control the budgetary process. As a nation, we have wasted far more money in the unskillful funding techniques used to support research and development than we have through the rising costs of these programs as they reach the pay-off stage. These short-sighted policies, based on short-term financing techniques, have developed far more drag on the long-term goals of research progress than any technical obstacle. They have been particularly acute in the development of new military weapon systems during the past decade and they now threaten to develop the same bureaucratic fiscal drag on the national space program.

When a nation sets its technical sights as far out as we have in our entire space technology program, and particularly in the manned lunar landing program, it is impossible to estimate accurately the eventual cost of this effort at its inception. No blame should attach to anyone or any agency for the failure to do so, although

it won't be long before the General Accounting Office and the Renegotiation Board, with their 20-20 hindsight, will begin to castigate someone on this score.

The real problem presented by the growing pains of the space agency as it approaches its Fiscal 1964 budgeting process is whether it is going to stick to the technical performance goals and timetable it set for the Apollo program and other key space exploration efforts and ask for the resources necessary to do the job, or whether it is going to begin the process of tailoring its technical goals to fit a budget ceiling. There is no doubt that if President Kennedy is still serious about boosting this nation into pre-eminence in space technology, and beating the Soviets to the moon as the first tangible proof of this leadership, there will be rising resource requirements as the Apollo program progresses. It is also equally clear that if funding limitations are to be imposed below the rate that maximum technical progress requires, there can be little hope of achieving this leadership.

#### Space Program Definition

The real essence of the debate that is certain to ensue over NASA's Fiscal 1964 budget level is what kind of a space program the nation really wants. Does it want a maximum effort to beat the Soviets to a manned lunar landing and establish U.S. leadership in space technology, and is it willing to pay for a well-managed effort toward this goal? Or does it want a more moderately paced effort, geared to budget ceilings rather than technical progress, and is it willing to sacrifice the chance to achieve international leadership to gain at least the illusion of financial stability and orderly bookkeeping?

We think that the Kennedy Administration, the Congress and the American people will have to make that decision when they handle the Fiscal 1964 budget for NASA. In making this choice it is important that all of the facts involved are developed in the debate that looms ahead. It will serve no useful national purpose to try to conceal the fiscal realities of a strong space program that can push forward as fast as its technical progress allows. And it will serve no useful purpose for NASA officials to issue soothing assurances that they are getting all the money that can be "usefully spent" when the technical people at the working levels are being decelerated by fiscal brakes.

After the manner in which the news of the Cuban missile crisis was crudely controlled to produce a calculated political effect, all agencies of the government necessarily must be suspect of managing the news to suit their current purposes. Industry, Congress and the American people should be particularly alert to the unfolding of the national space policy debate, and expend extra effort to ensure that the issues are candidly presented and the alternatives clearly outlined so that an intelligent decision can be made.

—Robert Hotz



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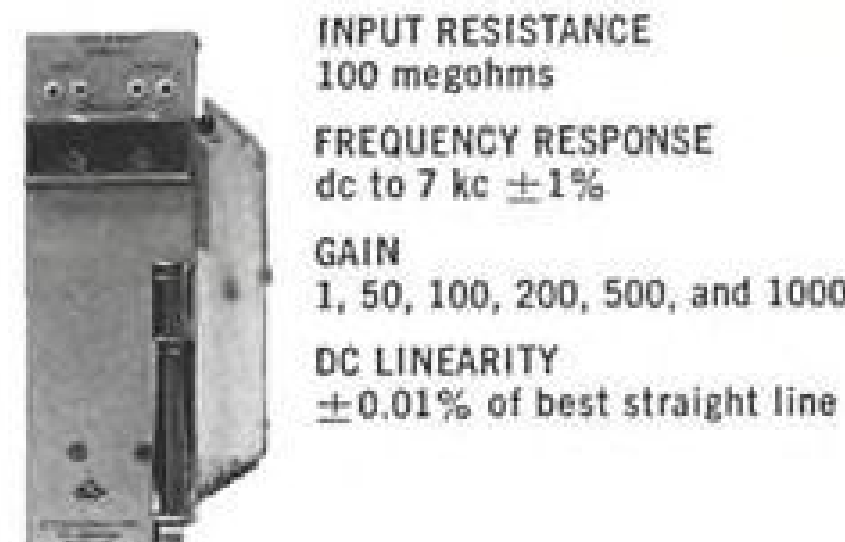
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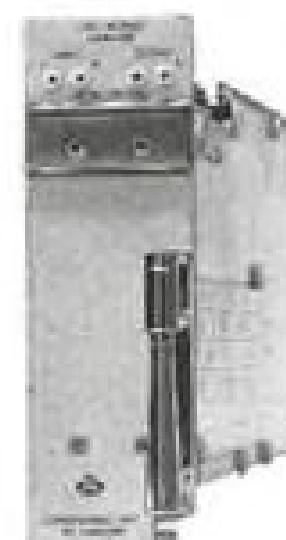
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## WHO'S WHERE

### In the Front Office

James S. Lee, sales manager, Pratt & Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn., succeeding the late C. T. McKinnie. Robert Baer succeeds Mr. Lee as president of United Aircraft International, a subsidiary of UAC. Also: Robert M. Etherington, executive vice president, and George Estes, a vice president of United Aircraft International.

Eugene A. Holmes, III, vice president and general manager, Semiconductor Division of Hoffman Electronics Corp., Los Angeles, Calif., succeeding Vice President Theodore S. Hoffman, now operations manager.

Richard A. Wilson, vice president and general manager, General Dynamics/Electronics, Rochester, N. Y.

Space Technology Laboratories, Inc., a subsidiary of Thompson Ramo Wooldridge, Inc., Redondo Beach, Calif., has elected the following as vice presidents: Dr. Robert Bromberg, director, Mechanics Division; Dr. Richard D. DeLaurer, associate director, Ballistic Missile Program Management and director of STL's Titan Weapon Program office; Edward M. Foley, STL treasurer and director of corporate planning and control; Dr. George E. Solomon, director, Systems Research and Analysis Division.

The Secretary of Defense has announced the following assignments to the Defense Communications Agency: Maj. Gen. John B. Bestic, USAF, Deputy Director, National Military Command System; Rear Adm. Frank Virden, USN, Deputy Director, Communications Satellite Project Office; Brig. Gen. George P. Sampson, USA, Deputy Director, Defense Communications System (AW Oct. 29, p. 25).

### Changes

Dr. Edgar A. Sack, Jr., engineering manager, Westinghouse Molecular Electronics Division, Pittsburgh, Pa.

Dr. Robert H. Bragg and Dr. Thomas E. Tietz have been named senior members of Lockheed Missiles & Space Co.'s Materials Sciences Laboratory, Palo Alto, Calif.

Dr. Harry J. Watters, chief defense engineer, Defense Engineering, RCA Defense Electronic Products, Radio Corp. of America, Camden, N. J.

Robert G. Brown, director-Titan 2 Program, AC Spark Plug Division of General Motors, Milwaukee, Wis., succeeding Paul O. Larson, now director-Titan 3 Program.

O. E. Bottorff, manager-administration, Douglas Space Systems Center, Huntington Beach, Calif.

Ed C. Nikkel, manager of contract administration, Beech Aircraft Corp., Wichita, Kan., and also Weapons system manager for Beech's subcontract program on the McDonnell Phantom II.

Leon H. Tanguay, director, Bureau of Safety, Civil Aeronautics Board, Washington, D. C., and Bobbie R. Allen, deputy director. Also: Warren J. Vibbard, executive assistant to the director.

Jack B. Hippler, manager-aerospace development sales, Lockheed-Georgia Co., Marietta, Ga., a division of Lockheed Aircraft.

(Continued on Page 143)

## INDUSTRY OBSERVER

► Aerojet-General's XM-86 solid-propellant rocket motor, being developed under contract with Edwards AFB's 6593rd Test Group (development), incorporates beryllium powder to increase specific impulse and control burning rate. Data from firing of small-scale spherical motor have indicated that total impulse of about 160,000 lb./sec. could be available in the full-scale motor. Full-size motor could be top stage for USAF's four-stage Blue Scout booster—it would use a glass-fiber case and measure 18 in. dia. by about 42 in. long.

► First fine-grained infrared measurements of the earth and its atmosphere from a satellite, recently accomplished by Air Force Cambridge Research Laboratory scientists using an Air Force Discoverer satellite, are expected to provide badly needed data to ease problems with the Midas early-warning satellite (AW Sept. 24, p. 54). Measurements were made over broad spectrum of 1.8 to 16 microns using an ultra-sensitive interferometer-type spectrometer weighing six pounds and developed by Block Associates, Cambridge, Mass.

► Aerojet-General Corp. and United Technology Corp., each working under subcontract to Radio Corp. of America, will soon demonstrate the characteristics of 2,200-lb.-thrust ablative thrust-chamber designs in the USAF Arnold Engineering Development Center facilities. Both chamber designs feature glass-fiber wrap reinforcement. North American's Rocketdyne Division is pushing company-funded ablative chamber development in 7,500-lb.-thrust-class, also featuring external wrap for reinforcement.

► Boeing Co. is expected to request proposals for special stage-separation retrorockets for the S-1C cluster of five Rocketdyne F-1 liquid-propellant rocket engines comprising the first stage of NASA's Saturn C-5 booster. No motors now are available to fit the requirement. S-1C is a joint design effort of Boeing and Marshall Space Flight Center (AW Aug. 13, p. 52), will measure 33 ft. dia. by 138 ft. long, have a dry weight of about 280,000 lb. and carry 4.4 million lb. of propellant. Boeing is scheduled to produce 24 S-1C units at Michoud.

► Developments in side-looking radar antenna design point to major reductions in over-all length of the next round of systems. Current side-looking antenna on the Grumman Mohawk is about 17 ft. long. At least one company is planning on a one-foot-length antenna for its next installation.

► Air Force Office of Aerospace Research's Program 35, administered by Space Systems Division of USAF Systems Command, is scheduled to launch the next Blue Scout from Pt. Arguello, Calif., to put a payload into an elliptical polar orbit. Program 35 encompasses both deep-space probes and orbital missions, accommodates either 100-lb. or 240-lb. payloads, which are specified to launch crews only a relatively short time before firing date.

► Aerodynamic fairings have been designed for the Vought-Hiller-Ryan XC-142 VTOL tri-service transport (AW Sept. 3, p. 24) to smooth the flow around the landing gear housings and in the volume between the vertical tail and fuselage. Wind-tunnel tests showed some flow breakaway, necessitating the fairings to maintain attached flow and minimize drag.

► National Aeronautics and Space Administration will not require Martin Co. and General Dynamics/Astronautics to submit results of their Nova boost-vehicle configuration and payload studies until April, although original target date was this month. Boeing Co.'s study, already submitted and under review by NASA propulsion personnel, indicates preference for 260-in. and larger solids, a timely choice in view of the decision by NASA and Dept. of Defense to proceed with feasibility demonstrations of large solid-propellant motors (AW Nov. 12, p. 38).

► Ryan Aeronautical Co. has proposed a version of its Firebee drone, with supersonic performance, as a weapons system to deliver biological- and chemical-warfare payloads.



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## An Application of Silicone Technology

### A gyro puts a missile on a pinpoint... and a silicone fluid smooths the way

The highly critical area of missile guidance provides an example of how UNION CARBIDE Silicone Fluids can meet your own precise specifications. In the Hawk I ground-to-air missile, flight control depends largely on the miniature rate gyroscopes strapped to the airframe. This location results in a built-in problem of unwanted vibration. And since the targets can be anywhere from treetop height to ten miles up, this problem is complicated by the range of temperatures through which the missile passes.

Since the guidance system must remain stable throughout, the gyros require a torsional vibration damper. Raytheon Company, manufacturer of both the missiles and their gyros, uses UNION CARBIDE's Silicone Fluid L-45, 1415 centistoke. A film of this fluid between the gyro's gimbal and external case prevents excessive resonance at frequencies near the gyro's natural resonant frequency. In this way, the gyro's response characteristic is shaped as desired in the frequency range of interest without affecting static response. And since L-45 maintains its



Target for this missile may be treetop height or ten miles up. Silicone Fluids keep its gyro functioning despite extremes of vibration and temperature.

viscosity over a broad temperature range, it functions with dependable uniformity.

#### FITTING YOUR NEEDS

This excellent viscosity-temperature characteristic of L-45 is a primary reason for its usefulness as a torsional vibration damper in these missiles. For example, it provides these properties:

Coefficient of thermal expansion  
 $9.7 \times 10^{-4}$  cc/cc/°C.

Viscosity-Temperature Coefficient 0.62

$$\left(1 - \frac{V(210^\circ\text{F.})}{V(100^\circ\text{F.})}\right)$$

In addition, it has a flash point over 600°F. and a pour point below -55°F. But this is only one application for silicone fluids, and UNION CARBIDE is capable of supplying formulations that will meet any specifications set for any job where these materials will work. Your own requirements may be just as severe as those involved in missile guidance; if so, you'll do well to talk to UNION CARBIDE.

#### THE KEY: PRECISE FORMULATION

The L-45 series of silicone fluids is available in a wide range of viscosities. Heat exchange devices, electrical systems, hydraulic systems, liquid springs, and other mechanisms are utilizing silicone fluids that are precisely engineered to the task. In their formulation and production, UNION CARBIDE maintains a rigid quality control program to provide the uniform performance properties on which you can depend.

#### SEE YOUR SILICONES MAN

With its pioneering background in silicones technology, UNION CARBIDE is constantly achieving new breakthroughs in these versatile materials. Your UNION CARBIDE Silicones Man, supported by extensive resources of technical capacities, is an authority in his field. Get in touch with him to learn what is being done in silicones today. Or, for further information, send us the coupon below.



## SILICONES

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In Canada: Union Carbide Canada Ltd.,  
Bakelite Division, Toronto 12.

Please send me data on Silicone Fluid L-45.

NAME \_\_\_\_\_  
TITLE \_\_\_\_\_  
COMPANY \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ ZONE \_\_\_\_\_  
STATE \_\_\_\_\_



Precision engineering of Raytheon gyroscopes for guided missiles include a vibration-dampening silicone fluid that retains its fluidity below -55°F.

## Washington Roundup

### Science News Confusion

Confusion over the release of scientific findings concerning the radiation belt created by a nuclear blast last July 9 continues. Dr. Jerome B. Wiesner, who wears four hats including that of presidential science adviser, has "recommended" that National Aeronautics and Space Administration issue no releases until there is agreement on the interpretation of the data on the radiation belt.

Following the recommended bureaucratic procedure, NASA is interpreting this "recommendation" as an order. But both Wiesner's office and NASA deny that Wiesner intends to slow down the quick dissemination of scientific findings that NASA has worked for four years to achieve. Some NASA scientists had interpreted Wiesner's action as a general attitude against quick release of such data.

Some information on the radiation belt was first made public in a scientific journal by two of NASA's Goddard Space Flight Center scientists, some time after a closed meeting between NASA and Defense Dept. was held to discuss the belt.

Dr. James A. Van Allen, whose Injun satellite first detected the belt and who has experiments aboard Explorers 14 and 15, which are exploring it, apparently agrees with Wiesner that information should be conclusive before it is released. But he disagrees that it is still too early to release findings from the two new Explorers. Although NASA has been precluded by its interpretation of Wiesner's "recommendation" from releasing anything on the belt since Oct. 31, Van Allen revealed last week that the intensity and lifetime of the belt will be less than anticipated last August (see p. 26).

### B-70 Flight Delayed

First flight of the USAF-North American B-70 has been delayed from December until next March or April by leaking fuel tanks. The leakage problem is related to the changing temperatures that the Mach 3 bomber will experience. Results of studies by Air Force and by the Joint Chiefs of Staff on the B-70 and its RS-70 reconnaissance strike version have not yet been disclosed by the Defense Dept.

Progress of the British-French supersonic transport program (see p. 41) has prompted Federal Aviation Agency Administrator N. E. Halaby to try to accelerate U.S. supersonic transport plans. Halaby will present recommendations to President Kennedy within a few weeks. They will include cost estimates, basic research and development needs and a time schedule for the proposed program.

### TFX Decision Due

Long-awaited decision on who will build the bi-service tactical fighter (TFX) is due to be announced this week. A last-minute delay occurred last week but Defense Secretary Robert McNamara's office and Air Force and Navy were expected to have the matter settled by Nov. 19. Boeing and a General Dynamics-Grumman team are the finalists. In the aerospace understatement of the year, USAF Asst. Secretary Joseph S. Imire said last week: "When the winner is decided upon, he and the government will know more about the task to be undertaken than in any previous procurement of a complex new system."

Watch for Rep. John Moss, Democratic chairman of the House Government Information Committee, to express his views on the Kennedy Administration's handling of news during the Cuban crisis before the California Press Assn. in San Francisco on Nov. 30. Rep. Moss' committee, which has served as the "watchdog committee" on excessive government secrecy since late 1955, has been far less active since the Democrats took over the executive branch than it was when Republicans were in the White House. But the widespread criticism of the way Cuban news was controlled is expected to result in public hearings early next year (AW Nov. 12, p. 25).

### NASA Information Plan

Plan to make information officers integral parts of NASA's main program offices (AW Mar. 5, p. 17) has finally taken effect, in spite of fear in some quarters that it may produce less information instead of more, since these press officers now will be partly responsible to their technical chiefs. Joe Stein, former deputy public information director, already has moved into the advanced research and nuclear propulsion program office; Paul P. Haney, former news chief, has moved to manned flight. Allan J. Funch has been assigned to the international programs office for several months. Walter A. Pennino, former coordinator of information for international trade fairs at the Commerce Dept., replaces Stein. Pennino will now have a relatively small news room staff to deal directly with the press and public.

France will have nuclear bombs with yields of 60 kilotons by 1964, according to the official French publication *National Defense Review*. Nuclear strike force initially will consist of Dassault Mirage 4 bombers and Dassault Etendard 4 strike fighters.

—Washington Staff



# Webb Minimizes NASA Money Problems

**Other space agency officials admit serious fund shortages; no supplemental appropriation bid is seen.**

By Edward H. Kolcum

Washington—Space program funding problems were minimized last week by space agency chief James E. Webb, but several other key agency managers admit that serious money deficiencies exist. They blame them on poor estimates by themselves and prime contractors.

In a New York City speech, Webb said the space program is "proceeding on schedule," and that the National Aeronautics and Space Administration does not foresee the need for a supplemental budget request during this fiscal year. This is a solid defeat for several of Webb's top associates who have been pressing for supplemental money, which they consider mandatory in order to keep the manned space flight program on schedule.

Congress already has been informed that the manned space program alone faces a deficiency approaching \$300 million (AW Nov. 12, p. 27). This has resulted in slowdown orders from NASA to several prime contractors, which eliminated some overtime in order to stretch available funds through this fiscal year.

Other NASA programs are experiencing deficits, although not to the same degree. Among them are Centaur (AW Sept. 3, p. 16), nuclear propulsion and some scientific satellites.

Defending his program, Webb said: • **Space program** is "not a crash program," but one which is fast-paced, driving, prudently managed and efficiently conducted.

• **Space effort buildup** is slowing down, but the end is not in sight.

• **Current program** is designed to achieve pre-eminence—no national effort except in wartime has had so rapid a buildup.

• **National decisions** are approaching the point where they will relate less to the space race with the Soviet Union, and more to the rate at which the U. S. proceeds after manned exploration of the moon has begun.

NASA believes the funding deficit has been caused by a combination of

low estimates the agency made when it drew up its programs, and similar faulty estimates which contractors made in responding to competitive bids. Although NASA declined to identify those contracts which were underestimated, a spokesman said that the final totals of several were \$70 to \$80 million more than initial estimates.

Probably one of the major reasons that Webb refuses to seek a supplemental appropriation, despite the recommendations of his managers, is the over-all deficit which the U. S. will experience this year (see p. 28), which will total \$7.8 billion, according to current Budget Bureau estimates.

Despite this factor, some members of Congress feel that if NASA needs supplemental funds and does not request them, it may reflect an Administration cooling toward the urgent space program spelled out by President Kennedy shortly after he took office last year.

Because of the decision not to request a supplemental appropriation, unless, according to Webb, "some unforeseen opportunity opens up, or new requirements are established," the funding for the lunar excursion module will be limited to about \$30 million this fiscal year. NASA estimated that the bug contract, won by Grumman Aircraft Engineering Corp. (AW Nov. 12, p. 29), has a value of \$350 million. Money to begin the project came from reprogramming part of the \$115 million in Fiscal 1963 funds earmarked for the lunar landing module, which will not be a part of the Apollo system in the lunar orbit rendezvous configuration.

The lunar logistics system, which some in NASA believe is a mandatory part of the Apollo project, probably will not go beyond the study phase until after Jan. 1. This system is expected to cost at least as much as the bug.

Although Webb said the program is on schedule, NASA had officially set

Maj. Gordon Cooper's Mercury Atlas-9 flight (see box), now set for the first quarter of Calendar 1963, as recently as Sept. 25. NASA said an April launching has been scheduled because of better weather prospects, but some officials at Cape Canaveral say the delay has been caused by a cancellation in overtime.

In his talk, Webb indicated NASA does not plan to award a Nova vehicle contract for another two years because it is not known how fast nuclear power can be developed for space propulsion, or whether solid propellants offer advantages over liquid fuels.

"There are those," Webb said, "who believe we should begin major funding now of programs looking toward manned exploration of Venus and Mars and operations from the surface of the moon." This type of program was outlined by NASA in Chicago Nov. 1 at a university conference (AW Nov. 12, p. 26) by Abraham Hyatt, director of plans and program evaluation, who said the major program limitation is money.

To those who favor such a program, Webb continued, the "decisions we have made to spend two more years in studies, research and technological developments related to the Nova booster are not in the national interest. In the debates which will accompany the decisions on the 1964 budget submissions of the President, I am sure Congress will hear these arguments . . ."

NASA's Fiscal 1964 budget request will be approximately \$6 billion. Although Webb did not announce the budget amount, he said "we have no doubt that the President's budget recommendations to Congress will provide the same strong support which has characterized his actions in the past."

## Van Allen Radiation

Cambridge—Dr. James A. Van Allen revealed last week that the observational data obtained from the Injun satellite and Explorers 14 and 15 (see p. 106), on the artificial radiation belts created by the recent high-altitude nuclear explosions were substantially in agreement with the theoretical pre-blast predictions he made last May.

Intensity and lifetime of belts have been found to be appreciably less than stated in the August report on the tests, which he termed "ill-considered." Van Allen, speaking at the New England regional conference on science, technology and space under the joint auspices of NASA and MIT, said background noise, which had worried radio astronomers, was doubled as a result of the blasts, but has subsided.

## First Details on Pegasus Revealed

Los Angeles—First details of the Martin Pegasus, a three-stage vehicle for space investigations up to altitudes of 3,000 mi., were revealed at the 17th annual meeting of the American Rocket Society here.

Pegasus is based on the Martin Pershing two-stage solid-propellant tactical ballistic missile (AW Apr. 9, p. 80). It uses standard Pershing components for first- and second-stage units, and could be handled on a standard Pershing launcher-transporter.

Martin's aim in proposing the Pegasus was to develop a space probe system that would be low-cost, versatile and mobile. Low cost, the company says, is promised because the research and development expenses already have been absorbed to a large degree in the Pershing program.

Versatility comes from the basic design, which permits either a two-stage or three-stage vehicle, capable of these typical payload-altitude accomplishments:

- As a three-stage vehicle, Pegasus could carry a ton to 153.3 naut. mi.; half a ton to 321.6 naut. mi.; 500 lb. to 601.9 naut. mi.; 100 lb. to 1,824 naut. mi.; or about 50 lb. to 3,000 naut. mi.

- As a two-stage vehicle, it could loft a ton to 105.4 naut. mi.; 1,000 lb. to 175.5 naut. mi.; 500 lb. to 239 naut. mi.; or 100 lb. to 319.7 naut. mi.

Re-entry velocity range varies from 4,700 fps. with a one-ton payload carried by the two-stage vehicle, to 21,140 fps. for the three-stage version carrying a 100-lb. payload.

Mobility is obtained by using the Pershing transporter-launcher unit, designed to be airlifted in a Boeing-Vertol Chinook helicopter. Martin says the vehicle could be launched from any location on earth—presumably within range of the proper ground instrumentation. With its own erector, launch pad, flame deflector, umbilical mast and associated equipment, the booster system can be readied and launched by a dozen people in less than a day's time, the company says.

Side advantage of the mobility, which makes it possible to move the probing vehicle easily to an equatorial or arctic site for launchings requiring such locations, is that crowded ranges and tight schedules need no longer present a problem. Martin shows one picture of the Pegasus set up on a launch site near the long line of Atlas and Titan launch complexes at Cape Canaveral. The implication is that Pegasus could be set up and fired without intruding on either the existing sites or schedules.

Martin says that all required components and subsystems are ready for production; some are already in production for the Army Pershing. Deliveries of the Pegasus can begin within six to 12 months from the date of contract, Martin says.

## ARS-IAS Merger Approval Near, But Individual Doubts Still Remain

By David A. Anderton

Los Angeles—Approval of the proposed merger of the American Rocket Society and the Institute of the Aerospace Sciences appeared certain last week from early returns of the membership vote.

To approve the merger, a majority of both societies must vote, and of that majority, two-thirds must favor the merger. By last Tuesday, about 40% of the ARS ballots had been returned, and about 85% of these favored the merger. Similar results were reported from IAS returns, with about 44% voting so far, and 95% of those favoring merger. Ballots were mailed to the membership of both societies at the end of last month.

Either Dr. W. H. Pickering, outgoing president of ARS, or Dr. Martin Summerfield, president-elect of the society, was expected to announce at the honors night dinner that approval of the merger was an accomplished fact.

But individual reservations still exist within both societies and within the board of the American Rocket Society. These will not be resolved until the combined organization has been operating for some time.

Summerfield, speaking at a luncheon during the 17th annual meeting of the ARS here, said two major hurdles remain ahead of the combined groups. First of these is financial. "Although we cannot guarantee the future solvency of the American Institute of Aeronautics and Astronautics," Summerfield said, "there is a good chance that we can make ends meet without raising the dues, but don't take this to be a promise."

One example of increased costs cited by Summerfield—"The staff of the AIAA will be 2.4 times as costly as the ARS staff. Only Mr. Parkinson [C. Northcote Parkinson, author of Parkinson's Law, which defines the growth of organizations] can explain how the merging of two societies of equal size

results in a staff cost that is 2.4 times that of the ARS alone," Summerfield said.

"This matter of staff costs and expenses in general is one that has concerned those government officials whose agencies grant us funds to support our scientific publications. One tends to draw the conclusion that the funds received with one hand to support our journals serve merely to permit us to release other funds to support our over-sized staffs," he added.

"This view may be too extreme, but I am sure there is an element of truth in it. I think we will have to take steps in the new AIAA to bring down the overhead costs at least to ARS levels or we will surely have to raise the dues and cut back on our publishing program," Summerfield noted.

Second major hurdle is the thinking of the AIAA board, Summerfield said. "To some of the new board members, these ideas on society government [election by direct ballot, nomination by petition] may seem strange. Will they accept them? I do not know. Further and most important, will the new AIAA board give the same strong support to the field of astronautics that the ARS board gave, that is, the kind of enthusiasm that led to the meteoric rise of the ARS? I do not know."

Question of protective legislation proved to be the main stumbling block during the year of negotiation, according to Summerfield. The purpose of the legislation was to accomplish three goals—guarantee direct balloting and the right of nomination by petition, maintain control by technical committees over the time and content of technical meetings, and define the publications policy of the AIAA.

"We wanted the AIAA to have a democratic election process, to allow its members to vote by direct ballot for its officers and its board, and we wanted to guarantee to the members the right of nomination by petition in case the nomination machinery should ever be captured by an inside clique. This is the system we have in the ARS, but it was firmly opposed at first by the IAS council . . . This issue was resolved ultimately to conform to ARS practice," Summerfield said.

"In the AIAA, according to the merger agreement, the technical committees will have complete authority, subject to policy directives of the board, over the calling of national technical meetings and the acceptance of papers for such meetings, just as in the ARS."

Finally, the question of publication policy was resolved in the manner ARS had requested. Two periodicals will be published—AIAA Journal, and Astronautics and Aeronautics. Both will be sent to all members, with subscription fees covered by their dues.





### UH-1B Research Helicopter Exceeds 175 mph.

Extensively modified Bell UH-1B Iroquois is carrying out a U.S. Army Transportation Research Command program studying the possibilities of significant performance improvements on existing and future helicopters using state-of-the-art knowledge. Turbine-powered research UH-1B has extensive fairings installed on aft-cabin section and around rotor pylon, skid landing gear has been streamlined and other protuberances deleted or faired over to reduce drag of conventional configuration. Rotor pylon also can be tilted to maintain level fuselage attitude during forward flight, reducing drag and loads on rotor system. This configuration, which is part of a continuing study on increasing speed and range without boosting power, has attained top speeds exceeding 175 mph., which is 40 mph. greater than top speed of standard tactical UH-1B and about 25 mph. greater than the existing world record set by this class helicopter.

### Budget Bureau Sees Deficit of \$7.8 Billion

Washington—Kennedy Administration now expects to end this fiscal year on July 1 with a \$7.8-billion deficit, rather than the \$463 million surplus predicted last January when the President submitted his budget to Congress.

Budget Bureau blamed the deficit largely on the failure of the national economy to gain as much as expected, but also cited tax concessions which cost the government money, including reduction of the air transportation tax from 10% to 5% effective Nov. 16.

Although the Bureau still expects the Defense Dept. to spend \$48.3 billion this fiscal year, as predicted in January, the Administration said it will ask Congress next year for \$410 million in supplemental funds to cover costs of the Cuban crisis and other emergency expenditures.

The Bureau also predicted the National Aeronautics and Space Administration would spend in Fiscal 1963 the \$2.4 billion forecast in January. Although the Bureau did not announce any intention to ask for supplemental funds, NASA will need extra money or risk the type of slippage in its programs revealed last week by AVIATION WEEK (AW Nov. 12, p. 27). The space agency last week confirmed it is short of funds and that its lunar landing

program is behind schedule (see p. 26).

Last January, the Budget Bureau predicted the government would take in \$93 billion and spend \$92.5 billion, but in its fall review last week changed these predictions to receipts of \$85.9 billion and expenditures of \$93.7 billion, or a deficit of \$8.3 billion.

### GE Begins Forming Apollo Support Unit

Washington—General Electric has started organizing its Apollo Support Dept., which is eventually to include several thousand persons with headquarters in Daytona Beach, Fla., and branches at Cape Canaveral, Manned Spacecraft Center, Houston, Tex., and Marshall Space Flight Center, Huntsville, Ala.

Early this year, the company was awarded a National Aeronautics and Space Administration contract for integration analysis, over-all reliability and development and operation of a vehicle checkout for the entire Apollo system (AW Feb. 19, p. 26). For the past six months, General Electric has been conducting a detailed study and planning analysis, and the contract now moves into its implementation phase. There have been estimates that the award will become one of the largest single contracts in GE history.

Richard L. Shetler, general manager

of the company's Command Systems Division, of which the Apollo Support Dept. is a unit, will head the new group, with John K. Records as program director.

The company expects to have several hundred employees at its Daytona Beach facility before the end of this year. In addition to Shetler and Records, key assignments at this facility are Robert S. Grisetti, from head of advanced engineering for the Atlas guidance project to program manager of reliability assessment; Dr. Lindon E. Saline, from manager of the GE Specialty Devices Operation to checkout program manager; Robert G. Henry, from Defense Systems Dept. marketing manager to program operations manager; Robert D. Featherstone, from Defense Systems Dept. finance manager to department finance manager, and Walter B. Booth, Defense Systems employee relations manager, to the same job at Daytona Beach.

L. W. Warzecha becomes manager of support operations at Manned Spacecraft Center from the Missile and Space Division. James E. Keister will manage the southeast support operation at Cape Canaveral after managing engineering for the company's electronic components advanced products planning. E. A. Wright, formerly Malta Rocket Test Station manager, will manage support operations at Marshall Space Flight Center.

## Guantanamo Bolstered by Massive Airlift

By Larry Booda

**Guantanamo Bay**—In a period of 78 hr. beginning at 5:27 a.m. on Oct. 21—more than a day and a half before the U.S. announced its arms blockade of Cuba—sailors and airmen unloaded and serviced 187 military transport and cargo aircraft at the Leeward Point jet airstrip here.

This massive airlift of men, equipment and supplies was done with Douglas C-124, Lockheed C-130, Boeing C-135, Fairchild C-119, Douglas C-118 and Lockheed C-121 aircraft.

The tension that marked this period lessened but a sense of urgency persists.

The augmented Marine force, aided by two Seabee battalions and the naval base public works center, is constructing a main line of resistance (MLR) among the cactus and scrub-covered hills on the eastern part of the reservation.

Navy-Lockheed P2V-7 patrol planes and Grumman S2F-1 anti-submarine aircraft take off at frequent intervals to cover the sea lanes to the north, the Windward Passage between Cuba and Haiti—and the area to the south near Jamaica.

The lineup of aircraft at Leeward

Point, whose 8,000-ft. runway runs east and west at the west side of the harbor entrance, and at McCalla Field, with its 4,850-ft. runways hugging the cliffs on the other side, is not impressive. There are Marine-Vought F8U-1 fighters, Douglas A4D-2 attack aircraft, Sikorsky HUS-1 helicopters and Navy-Douglas AD-1s. This force could take care of a ground attack and to some extent an air threat. But it is the high degree of activity of the Grumman TF-1 carrier-on-board delivery (COD) aircraft, which disappear for 8 to 10 hr. at a time, that indicates the presence over the horizon of aircraft carriers and their hundreds of aircraft.

The high degree of military readiness has resulted in many hours of operational flight experience, including:

- **Detection and tracking of submarines.** Both the P2V and S2F aircraft have flown thousands of hours in sea searches far out into the Atlantic and Caribbean. At first they were principally concerned with locating and reporting Soviet ships proceeding toward Cuba, but submarine detection gear is operating full time.

- Although no HSS-1 and HSS-2 ASW helicopters are flying from the fields here, they have participated in the sub-

marine tracking operations, flying from ASW carriers. One patrol plane reported a submarine snorkel contact about midnight two weeks ago, calling it a "positive" contact. At dawn a helicopter and a destroyer were ready to close in on the target. Soon the helicopter radioed: "Cancel submarine contact." The patrol plane commander broke in, "I don't believe you." The helicopter replied: "Come and see for yourself." The "snorkel" turned out to be a palm tree floating vertically with its branches out of the water.

- **Fighter and attack aircraft.** The F8U, A4D and AD aircraft are mainly standing by in an alert status. Flight operations consist of on-station airborne alert and daily flights involving the dropping of small practice bombs on the salt flats in the northwestern section of the naval base. These flats can be seen from the town of Caimanera, half a mile north of the reservation line.

- **Helicopter operations.** Marine HUS-1 helicopters maintain continuous patrols along the fence line during daylight hours. The helicopters are also running shuttle flights between McCalla Field and Leeward Point, eliminating the boat ride across the harbor mouth.

By coincidence, the emergency condition here began during a regular naval emergency ground defense exercise which had started the morning of Oct. 20. These exercises were held every six weeks for the last two years. During the exercise most of the sailors manned emplacements in the hills to the east, augmenting regular Marine force. Sailors reporting for duty spend two weeks in "Division X," learning to operate seven weapons.

Shortly after midnight on Oct. 21, the message announcing the beginning of the airlift arrived. Every vehicle that could be pressed into service was sent into the field to pick up sailors. By dawn most of them were back and had a shower and breakfast.

A message was sent to all commands involved in the airlift to fuel planes sufficiently to permit them to return to a U.S. mainland airport without refueling here, but many were already on the way. The first day's activity therefore involved not only unloading aircraft but servicing them.

The force of about 400 sailors was augmented by 110 Air Force airmen late that day. Cargo was loaded aboard trucks which were taken across the harbor mouth in two automobile ferries. Small boats also were pressed into service. During the 78 hr. period, as many as eight planes were being unloaded on the ramp at one time. Leeward Point consists only of the runway and taxiway which is next to the hardstand.

### Il-28s, Inspection Still Bar Cuba Settlement

Washington—Soviet Union's apparent removal of 42 medium-range ballistic missiles from Cuba aboard eight Russian ships (p. 30-33) had not resolved the Cuban crisis by late last week. The U.S. still insisted on removal of Il-28 bombers and on-site inspection, while Russia and Cuba stood by Premier Fidel Castro's five counter-demands, which include U.S. withdrawal from the Guantanamo Naval Base.

The U.S. arms blockade and aerial surveillance continued, and Deputy Defense Secretary Roswell L. Gilpatric said the U.S. would never "bargain away" its right to air reconnaissance, which is "part of our right of self-defense."

U.S. officials at the United Nations continued talks with UN, Russian and Cuban delegates over a Soviet-Cuban proposal aimed at settling the situation. Details of the proposal remained secret but there were other indications that Russia was supporting Castro—at least for bargaining purposes—in his insistence that the U.S. leave Guantanamo, end its blockade and aerial surveillance, guarantee against invasion by U.S. or Cuban refugee groups and end economic sanctions (AW Nov. 5, p. 37).

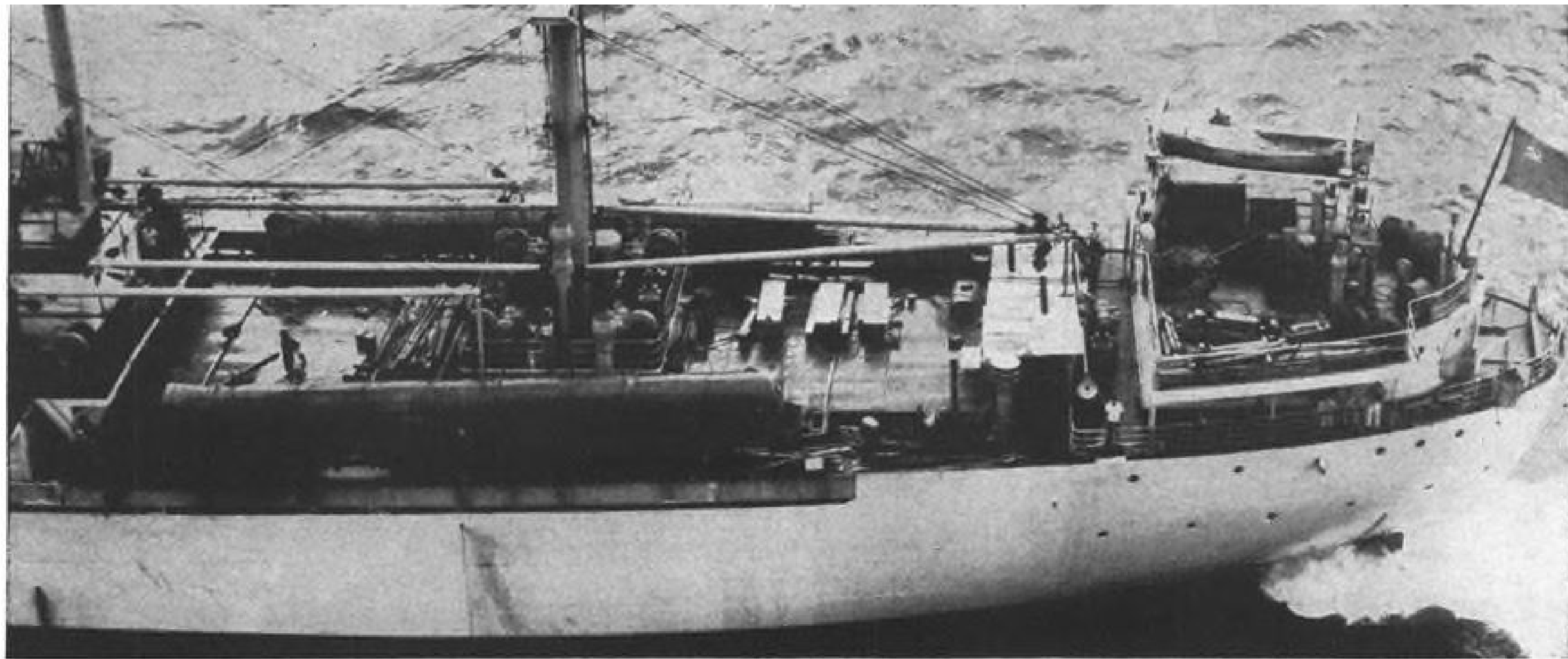
Negotiations to have International Committee of the Red Cross handle inspections at sea of ships bound for Cuba (AW Nov. 12, p. 34) also appeared to be getting nowhere.

Using ships, aircraft and helicopters, U.S. blockade forces photographed and "inspected" these Soviet ships on Nov. 9, 10 and 11—the Komsomol and the Anosov, with eight missiles each on their decks; the Labinsk and the Bratsk with two each; the Volgoles with seven; the Kurchatov with six; the Polzonov with five and the Dvinogorsk with four. Tarpaulins were pulled back in some cases but the missiles still were covered with waterproof casings. All inspections were made from alongside.

Gilpatric said on Nov. 11 that "we could never be sure that 42 was the maximum number" of missiles Russia sent to Cuba "until we have so-called on-site inspection of the island." Administration spokesmen stuck to this position throughout the week. There were unconfirmed reports that a blockade of oil and gasoline might be enforced if Russia and Cuba continued to refuse to remove the Il-28s, which Soviet sources at the UN have said are now the property of the Cuban air force.

At Shannon Airport in Ireland, the Eire Ordnance Corps was using a Geiger counter to search Cuban and Czechoslovakian aircraft (AW Nov. 12, p. 34). First aircraft searched was a CSA Bristol Britannia flying from Prague to Havana with 77 Cuban, Czech and East German passengers. No military equipment was found.



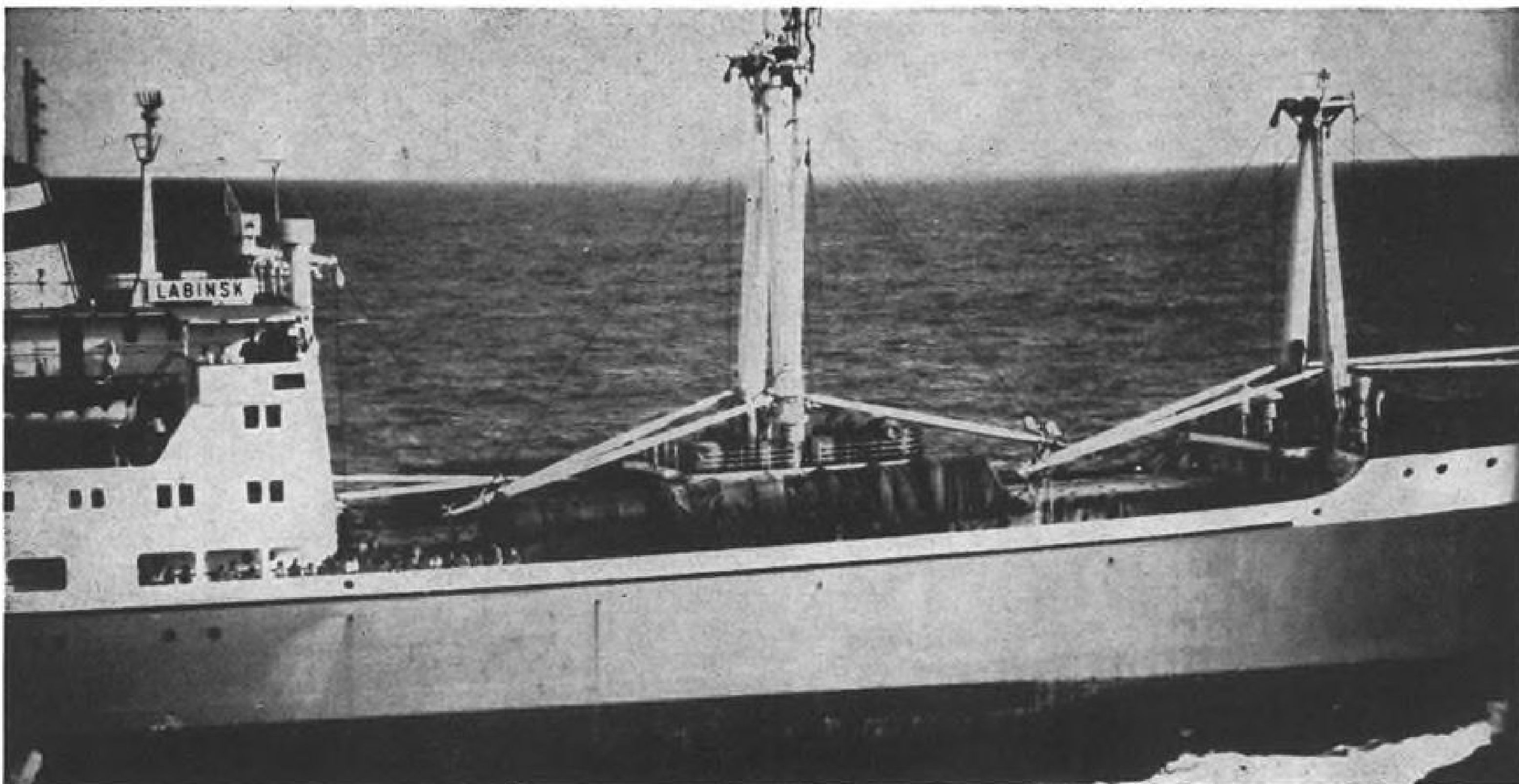


Removal of canvas covers from two Russian medium-range ballistic missiles on deck of the Soviet ship Bratsk shows similarity of configuration to the latest version of the Shyster MRBM (below), photographed at the Nov. 7 Bolshevik parade in Moscow. Although skin-tight anti-corrosion casing remains, slightly flared skirt is visible. With nose cone, Shyster shown below measures about 80 ft. long. Without the 15 ft. nose cone, as on the ship, dimensions correspond closely with those in U.S. photo reconnaissance pictures of Cuban MRBM sites (AW Oct. 29, p. 30).

## U.S. Monitors Ships Returning Red MRBMs From Cuba



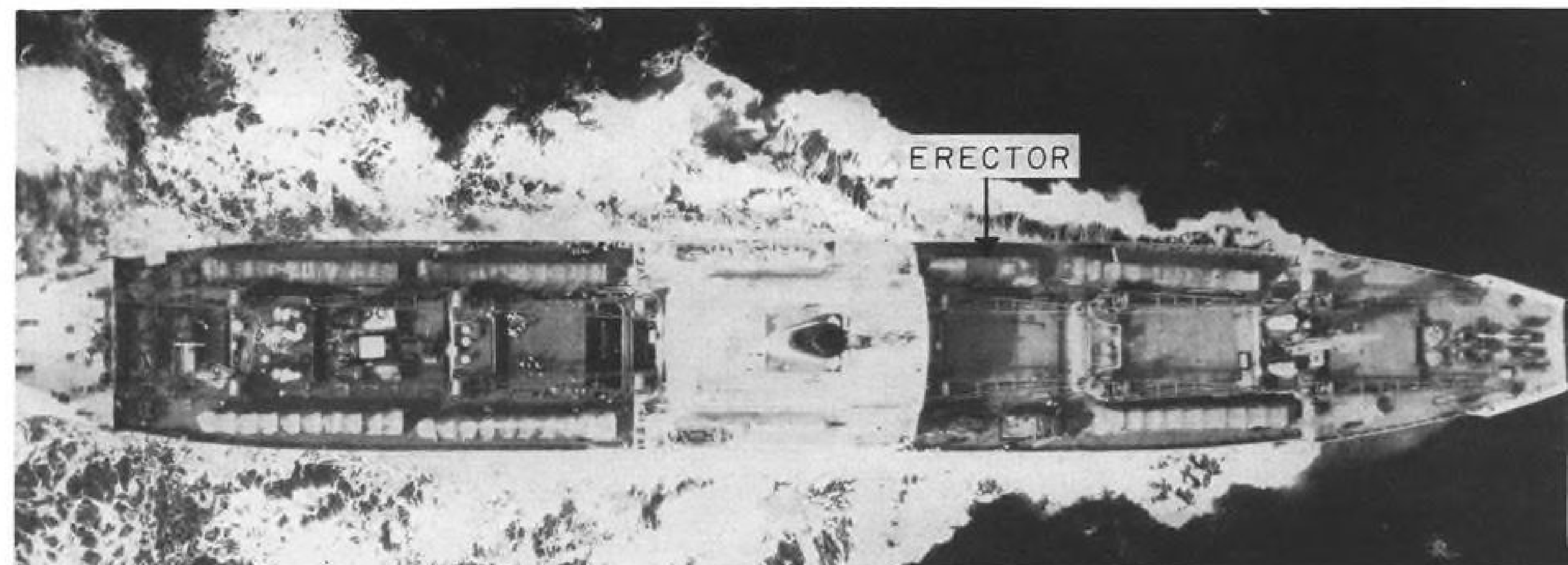
Partly uncovered missile on the Soviet ship Labinsk, photographed on the same day as the Bratsk, Nov. 9, indicates a truncated delta fin configuration instead of the delta shape on Shyster (above). Shysters photographed at various Russian parades reveal differences in length, fin shape, skirt and fairings for exterior plumbing or electrical lines.



Air-sea teamwork in Cuban missile surveillance is caught in an unusual photo of a Lockheed P3V Orion of Patrol Squadron 44 and the destroyer Barry monitoring the progress of the Soviet ship Anosov (above). Anosov (in another view below) is carrying eight missile transporters with canvas-covered MRBMs. Note Anosov's exposed waterline, indicating lightweight nature of load, like that on the Soviet freighter Poltava photographed earlier reversing course in the English Channel (AW Nov. 12, p. 32). P3V was delivered to first operational squadrons late in the summer (AW Sept. 17, p. 63).



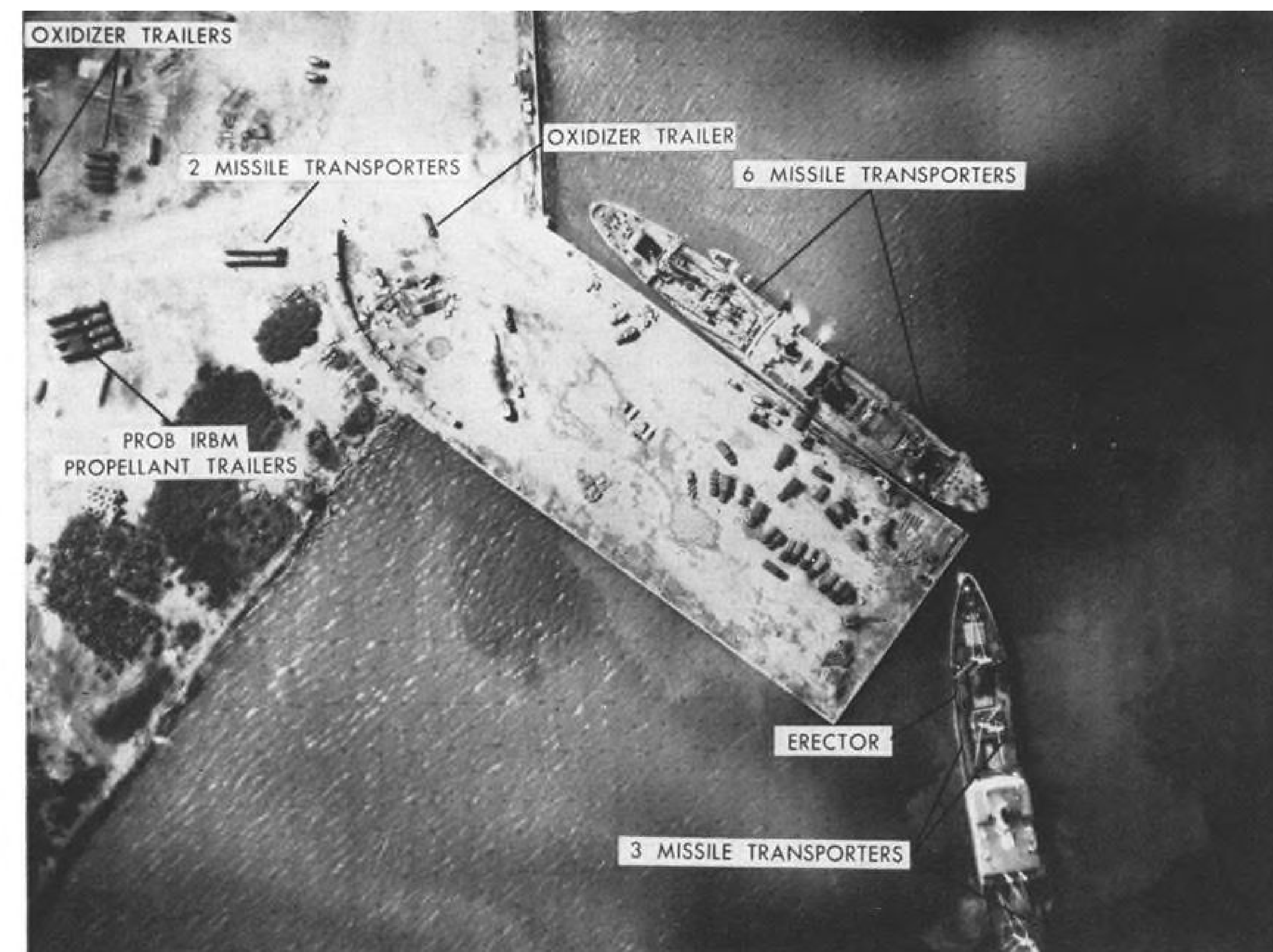
Soviet freighter Fizik Kurchatov (below), photographed Nov. 7, carries a canvas-covered missile erector as well as six canvas-covered missile transporters.







Three Russian freighters, with hatches open, load MRBMs and support equipment Nov. 2 at the major Cuban naval base of Mariel, 20 mi. west of Havana. Besides equipment designated, Defense Dept said nine missile launch rings were present. The missile rests on three such rings when erected to a vertical position.



Loading of Soviet MRBMs, transporters, launcher erectors, fuel and oxidizer trucks and other support equipment monitored by U.S. photo reconnaissance at the Cuban naval port of Mariel showed progress made over a four-day period. Equipment was at dockside and loading of three ships was getting under way Nov. 2 (left, top). On Nov. 5 (above) the freighter Bratsk has left the dock side, the Dvinogorsk, with three missile transporters and one erector is lying off the dock and six missile transporters are loaded on the Anosov. Two other missile transporters are on the dock, probably destined for Anosov, which departed with eight. Also visible are four propellant trailers and eight oxidizer trailers. Enlarged section of the same dock area (left, below) shows four large and 10 smaller fuel trailers and 18 oxidizer trailers besides the four missile transporters designated. Another area at Mariel the same day (right) revealed 17 canvas-covered missile erectors, and 16 launch stands, 12 of them loaded on the erectors. The four unloaded ones are designated. U.S. counted 42 missiles on eight Soviet freighters as of last week. Besides the Anosov, the list was Labinsk, two; Bratsk, two; Komsomol, eight; Kurchatov, six; Dvinogorsk, four; Volgoles, seven; Polzonov, five.





# Saturn SA-3 Aimed at Further Testing Engine Cluster Concept

By George Alexander

**Cape Canaveral**—Third flight of the Saturn C-1 launch vehicle, scheduled for late last week, was programed to be a stiffer test of the clustered eight-engine Saturn concept than the previous two C-1 flights and, in addition, was to serve as a testbed for a number of C-1 Block-2 systems and procedures.

Built by the National Aeronautics and Space Administration's George C. Marshall Space Flight Center, Huntsville, Ala., the third Saturn—designated SA-3—was a Block-1 vehicle like the SA-1, SA-2 and the yet-to-fly SA-4 boosters.

Block-2 vehicles will be introduced into the flight test program with SA-5—now tentatively scheduled for August, 1963—and will be differentiated from Block-1 units by increased propellant capacity, uprated thrust and the addition of stabilizing fins to the airframe (AW July 2, p. 113).

SA-3 was to be loaded with 750,000 lb. of liquid oxygen and kerosene-like RP-1, an increase of 130,000 lb. over SA-1 and SA-2. Because of this greater propellant load, SA-3 was programed to burn approximately 30 sec. longer than its predecessors and consequently fly a higher and longer ballistic trajectory down the Atlantic Missile Range

than either of the earlier vehicles. Maximum altitude of SA-3 was expected to be 104 mi., compared with 85 mi. for both the SA-2 and SA-1. Extrapolated range was expected to be 270 mi., compared with 225 mi. estimated for SA-2 and 215 mi. for SA-1. Velocity at burnout was to have been about 4,000 mph., or roughly 400 mph. faster than the preceding flights. SA-1 was successfully flown Oct. 27, 1961 and SA-2 Apr. 25, 1962.

Because of the greater weight it was to carry, SA-3 was to have accelerated more slowly than either SA-1 or SA-2 and, in so doing, place heavier demands on the flight control and propulsion systems than has been experienced to date.

Engineering model of the ST-124 stabilized platform, a major element of the C-1 Block-2 inertial guidance package (AW July 1, p. 113), was to be flown open-loop and its performance monitored.

Other Block-2 items carried by SA-3 included four solid propellant retro-rockets, programed to fire for 12 sec. after shutdown of the four inboard engines but which were not to affect stage separation; and one panel substituted for a regular Block-1 inset in the heat shield just above the engine compartment.

Cutoff of the engines was to be triggered by a propellant utilization system, unlike the timer used on the SA-1 and SA-2 flights. Level switches were to shut down the four inboard engines after approximately 95% of the propellant had been consumed and the four outboard engines were to continue burning until the liquid oxygen was depleted. Approximate burning times of 140 sec. for the inboards and 147 sec. for the outboards were expected.

Two dynamic pressure instruments were mounted on the adapter section between the dummy payload and third stage. Eleven points on these two panels were to measure the pressure applied to the devices and the rate of onset; data is expected to be used in the analysis of the first Centaur's failure. It is thought that a structural collapse in this same region caused the explosion of the Centaur last May 8.

On the ground at Complex 34, from which SA-3 was to be launched, a recently installed 240-ft. umbilical mast was to be used in a test for forthcoming Block-2 vehicles. Not required for the first four C-1 flights, where only the booster is live, the umbilical will carry power instrumentation and air-conditioning to the live second stage and payloads for Saturn SA-5 and succeeding vehicles.

SA-3, which was expected to develop about 1.3 million lb. thrust on its eight Rocketdyne H-1 engines, was instrumented with 716 telemetry channels. Of these, 612 were in-flight channels, reporting data on such parameters as engine turbine temperature and rpm., temperature on engine bearings, heat exchanger outlets, tail skirt and turbine exhausts, pressure in combustion chambers, propellant tanks, dummy upper stages, maximum dynamic forces exerted on the vehicle; performance of the ST-124 platform, engine gimbaling; propellant levels correlated with engine cut-offs, battery voltages and current and inverter frequency.

SA-3 also carried, for the first time in the C-1 flight test program, a pulse-code-modulated (PCM) transmitter in the S-1 stage and an ultra-high-frequency (UHF) transmitter in the payload.

Repeating the experiment first conducted with SA-2, the vehicle was to have been deliberately destroyed after burnout of the S-1 booster so that the 95 tons of water ballast in the dummy second and third stages would be ejected into the upper atmosphere.

Experiment, called Project High-water, is designated to study various characteristics of the ionosphere through the effects of that stratum on the ice cloud formed by the water. Destruction was planned to occur at the apex of the trajectory, at about 104 mi. or 295 sec. after liftoff.



**Engines Installed on Saturn SA-5**

Six of the eight engines that will power the 1.5-million-lb. thrust Saturn SA-5 are in place at National Aeronautics and Space Administration's Marshall Space Flight Center, Huntsville, Ala. SA-5 is the first of the Saturn Block 2 vehicles. It will be the first Saturn with tail fins and elongated tankage for more propellant and will carry a live second stage.



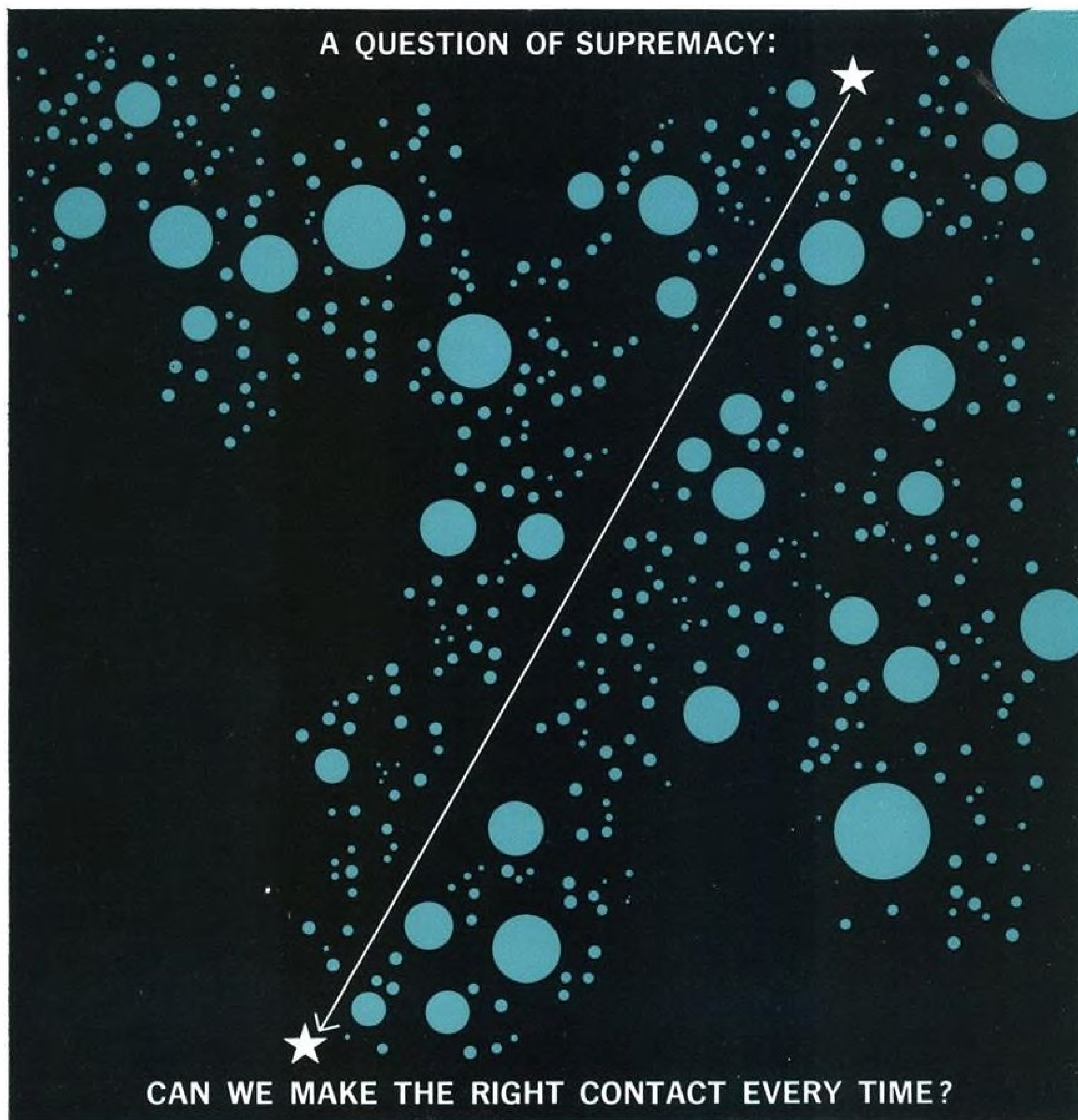
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## NASA to Evaluate Laser Radar In S-66 Satellite Tracking Test

Washington—Space agency will evaluate a laser radar for precision satellite tracking using the S-66 polar ionosphere beacon satellite scheduled for launch early next year. The experiment will be conducted at its Wallops Island, Va. facility.

The narrow beam of intense infrared radiation from a pulsed ruby laser will be aimed at the S-66 and reflected back to a photo-multiplier tube from nearly 300 1-in. cube corner reflectors attached to the satellite. Both the laser source and the receiving tube, being provided by General Electric's Missile and Space Division, will be installed on an optical tracking telescope mount.

Radio Corp. of America, which plans to participate in the S-66 program on a voluntary basis, is building a similar laser radar under company funding (AW Oct. 29, p. 67).

The National Aeronautics and Space Administration laser radar will use a 6-in. long ruby rod, operated at the rate

of 1 pulse per sec., with an energy of about one joule per pulse. The inherently narrow beam generated by the laser will be intentionally broadened to a width of about 3 min. of arc to make it easier to train it on the satellite. The extremely narrow laser beamwidth, a characteristic which makes the laser useful for precision tracking, is a disadvantage for space surveillance or initial target acquisition unless the position of the satellite is precisely known.

To simplify the satellite acquisition process, NASA is sponsoring the development of a more advanced automatic optical tracker at Consolidated Systems Corp. This real-time automatic digital optical tracker (RADOT) will employ a digital computer and a magnetic tape containing information on the satellite's orbital parameters obtained from NASA tracking stations.

The computer will use this data to position an image orthicon type receiver, more sensitive than the photo-

multiplier, to the approximate satellite position. If the tracker is not perfectly aligned, the reflected laser signal will be received off-center on the image orthicon. This will generate an error signal for correction of the slight misalignment. The new equipment is expected to be able to determine satellite position to within about 5 sec. of arc.

The NASA laser radar program is under the direction of Dr. Henry H. Plotkin of the Goddard Space Flight Center.

## Mariner Experiments Resume; Power Back

Washington—Mariner 2 passed the 19-million mi. altitude mark today on its flight from earth to Venus after the payload circuit apparently corrected itself after the four on-board scientific experiments shut down for eight days because of drop in solar panel power.

National Aeronautics and Space Administration has theorized that there was a short in the solar power conversion loop which caused the power output to drop to a level of 156.2 watts on Oct. 31. The science experiments were inactivated at that time. When they were reactivated on Nov. 8, the available power was 250 watts. Science experiments use about 11 watts of power.

The payload is expected to pass Venus on Dec. 14 at a distance of 20,900 mi. For the remainder of its flight to Venus, Mariner 2 is scheduled to supply data on interplanetary magnetism, particle flux, cosmic dust and the spectrum of the solar plasma. Ten hours before the Venus encounter, infrared and microwave radiometers are to be activated.

The signal re-activating the interplanetary experiments was sent from Jet Propulsion Laboratory's Goldstone Station Nov. 8, when the probe was about 15 million mi. from earth. Command signal was received by Mariner 80.5 sec. after transmission.

## Rolls Revenue Declines In First Half of 1962

London—Revenue of Rolls-Royce, Ltd., for the first half of 1962, dropped \$2,240,000 under a similar period a year ago, for a total of \$14,280,000.

Rolls said the major portion of the reduction was attributable to a smaller program of deliveries for aeronautical engines and spares. Its automobile business also has slumped.

Company also predicted its total revenue for 1962 will be about \$294 million, a drop from last year's figure of \$344.4 million. Work force, as of September, has been reduced from 51,918 a year ago to 45,500 employees.

## Finland Orders MiG-21 Jet Fighters

Finnish air force plans to replace its Folland Mk. 1 Gnat fighters with supersonic MiG-21s purchased from the Soviet Union.

Decision marks the first time Finnish air force will depend on Russian equipment. Trade considerations, rather than political motivation, lay behind the choice.

Under the 1947 Paris peace treaty, which officially ended the war between Finland and the Soviet Union, Finnish air force was restricted to 60 combat aircraft and 3,000 men. The air force was also forbidden to operate bomber-type aircraft or to possess, construct or experiment with any type of guided or non-guided missile or nuclear weapon.

Since 1947, the Finnish air force has never been up to full strength authorized under the treaty. Its main combat strength consists of several squadrons of Mk. 1 Gnats ordered in 1956 and delivered in 1958. Remainder of the air force consists mainly of French Fouga Magister jet trainers, some de Havilland Vampires and two Ilyushin Il-28s used in target training.

Finnish decision to buy MiG-21s was made over a year ago but was never announced. The Finns trade heavily with the Soviet Union but have been finding it increasingly difficult to offset their exports to Russia with imports from that country.

The Soviets, as usual, trade with Finland on a barter basis. Having already ordered some Army weapons from Russia, the Finns apparently decided to ease their trading position with Moscow by buying supersonic fighters.

Some Finnish observers believe the MiG deal was arranged at the highest level by Finland's president, Urho Kekkonen. Late in 1960, Soviet Premier Nikita Khrushchev abruptly called for talks on the 1947 treaty. Kekkonen went to Moscow and convinced the Russians there was no need to re-open the treaty.

It was during this period that the Finns probably decided to ease their trading position with Moscow and satisfy Soviet suspicions about Finnish neutralism by buying Soviet supersonic aircraft.

Reportedly, Russia originally wanted to train Finnish pilots in MiGs in Finland. The Finnish government refused to permit this and instead sent Finnish pilots and ground technicians for training in the Soviet Union. Over the past week, at least four MiG-15 two-seat trainers were flown from Soviet bases to Finland by Finnish pilots.

Plan apparently calls for Finnish pilots to be trained on MiG-15s by Finnish instructors before arrival of the supersonic MiG-21s.

Finnish government hasn't disclosed how many Soviet fighters have been bought. Observers here estimate that about 20 MiG-21s are involved.



# India Seeking Stronger Defense Industry

By Cecil Brownlow

New Delhi—Communist Chinese attacks along the Indian frontier are sparking new requests here for additional U.S. military aid, including Lockheed C-130 turboprop transports, machinery, machine tools and complete factories to strengthen a now largely nonexistent defense industry.

Request for the C-130s reportedly includes a proviso that the aircraft be provided on a loan or lend-lease basis. This is to avoid adding to India's mounting debts incurred in the U.S. and other Western countries since aid began flowing into the country following China's Oct. 20 attack along widely-separated border areas of Ladakh and the northeast frontier (AW Nov. 5, p. 26).

The request was under consideration last week by U.S. authorities.

U.S. has agreed to turn over its production line priorities on two de Havilland Caribous to the Indian government (AW Nov. 12, p. 29), which is hard-pressed to support its front line troops in roadless Himalayan tracts.

## Air Supply

In those areas almost all supply must come by air, either through parachute drops or actual landings on improvised mountain airstrips at altitudes averaging about 14,000 ft. and ranging up to almost 17,000 ft.

Caribous probably will be paid for in rupees on a long-term, no-interest-rate loan basis, as will almost all U.S. military aid to India.

Canada also has agreed to send India several C-47s to ease the strain on present transport fleet, which consists primarily of Air Force C-119s (AW Nov. 12, p. 127) and C-47s plus nine Air-India Super Constellations

which have been taken over with their crews during the present emergency.

Indian air force flight crews and ground personnel are now being dispatched to Canada for training on the Caribou.

India's Prime Minister Jawaharlal Nehru said last week he had been assured by the Soviet Union after the Chinese attack that Russia will stand by a prior commitment to supply India with a "specimen" batch of approximately 12 MiG-21 all-weather fighters beginning in mid-December, plus facilities and technical knowledge to build the aircraft in India.

MiG-21 production plan, Nehru said, is "the real thing" in the agreement, so far as India is concerned. Other observers are not so optimistic that the Soviets will respect their MiG commitment, in part or whole, so long as fighting here continues.

Some believe Russia may deliver "specimen" aircraft sometime this winter while stalling off construction work on production facilities—a point on which the Soviets were reluctant to agree initially and probably would not have accepted if India had not warned it would turn to the West if it could not be obtained.

If the full MiG deal should fall through, India probably will still turn to the West for an aircraft with similar capabilities. On an informal basis, Indian air force officers already are sounding out American officials here on the possibility of obtaining an aircraft with a performance capability roughly comparable with that of the all-weather Lockheed F-104G.

India also probably has asked, or will ask the U.S. to provide a limited quantity of helicopters capable of high-altitude performance for cargo and liaison missions near the front lines of the Himalayas.

Whatever fighter India obtains to replace its present aging Hawker Hunters for intercept missions, it undoubtedly will want to produce the aircraft here.

India, in its post-independence push to widen its general economy, has largely overlooked defense, and high costs of modern weapon systems.

The Chinese attack has shaken Indian leaders considerably, although not to the point of abandoning their non-alignment policy. They hope to build up a broad-base military production capability as fast as funds, foreign aid techniques and availability of technicians will permit.

Present industry, however, is largely geared to consumer products, except for a number of arsenals of obsolescent ammunition left behind by the British,

and the move will be largely a matter of creation rather than of conversion.

Extent and length of U.S. aid will depend primarily on the time the Indians require to build their capability in this field. U.S. ordnance specialists already have arrived here on survey missions, and an American observation and review team will arrive in the near future to help monitor the military aid program.

India also has made formal requests to the Soviet Union since Oct. 20 for several military aid items, including helicopters. Russian reaction to date has been generally negative, although requests are still under formal consideration.

Chinese reaction to the announcement that the Soviets still plan to supply India with MiG-21s has been severe. Any further Russian military aid to India could cause a serious and enduring political rift between the two communist nations and their respective allies.

MiG gesture is doubly humiliating to the Chinese, whose requests for the MiG-21 have fallen on deaf ears so far in the Kremlin.

## Aid Requests

Indians appear none too hopeful that any of the military aid requests after Oct. 20 will be granted by the Soviets or overly concerned over the expected denial. They hope, however, that the requests may serve as a lever whereby Russia will at least decline sending military equipment to both combatants for the moment.

India's big need is for transport aircraft to carry supplies to the front lines once they have arrived in the rear area. Thus far, each side has scrupulously avoided using combat aircraft in the undeclared limited-action war. Reasons

## European V/STOL

West German Defense Ministry officials are quietly contacting industries in Belgium, Holland, Great Britain and Italy in an effort to promote common development and production of a V/STOL close-support fighter to replace present aircraft.

Move is being made because it appears almost certain that there will be no final agreement in North Atlantic Treaty Organization's BMR-3 competition for a V/STOL fighter, and that France will produce its own aircraft.

Aircraft proposed by the Germans would be built around a version of the Bristol-Siddeley BS.53 vectored-thrust engine.

for this appear to be political as well as military.

On the political side, the Chinese have persistently declared that their troops are waging a purely defensive war and fighting only when attacked. Use of strike aircraft on any scale would cripple that stand.

Indians, with an air force inferior in both quantity and quality of equipment, have no desire to touch off a major aerial war—especially since their sprawling cities along the Ganges would be particularly vulnerable to attack by Soviet-made Ilyushin Il-28 medium-range jet bombers.

From a military standpoint, the rugged terrain of the combat area would seriously hinder the potential accuracy of any bomb drops, including napalm, almost to the point of no return. Neither side has an aircraft well suited to a strike role under such conditions.

There is speculation in this regard that should India decide air support is necessary to dislodge the Chinese by an all-out spring offensive, it may adopt the "low and slow" technique now being used in Vietnam.

Lack of aerial reconnaissance also has handicapped India's capability to assess Chinese offensive moves, particularly the massing of troops from high plateaus in Tibet into the Himalayas on the Indian side of the disputed border.

## Flight Hazards

Supply flights are hazardous, with crews flying C-47s and C-119s into mountain-ringed, improvised air strips or dry creek beds at altitudes so high that flight crews cannot cut their engines while on the ground with any hope of starting them again.

Loaded C-119, adapted for airlift over the Himalayas by a 3,400-lb.-thrust Westinghouse J34 turbojet engine mounted on the center wing section, reportedly set a record for the operation to date by setting down on an isolated strip at 16,800 ft. altitude and then taking off safely again.

Air-India Constellations, with airline flight crews aboard, are regularly ferrying equipment into Ladakh, where the runway is a 15,000-ft.-long dry river bed at an altitude of approximately 14,000 ft. At night, runway lights are provided by individual soldiers strung along either side of the river bed, each carrying a flashlight.

Meanwhile, requests for arms aid are continuing, including daily requests to the U.S., according to Prime Minister Nehru. In all, India is sending out arms requests to 111 nations, including Yugoslavia, Poland and Czechoslovakia in accordance with India's political policy of non-alignment. Both requests and shipments probably will continue for some time to come.

# C-135s Flying Indian Airlift Show USAF's Quick-Reaction Capability

Calcutta—Emergency U.S. Air Force Boeing C-135 jet flights of light infantry weapons, ammunition and communications systems into India provided concrete evidence to the Soviet Union and Communist China that USAF airlift reaction time to a crisis, once woefully inadequate, is at least improving.

Flights showed that USAF can adequately respond to limited, immediate needs, although the aircraft had been used on humanitarian quick-reaction flights to areas hit by natural disaster.

Indian airlift provided the C-135 with its first opportunity to prove its worth in an actual combat crisis. Airlift, which began Nov. 2—only four days after receipt of the initial Indian request for immediate military aid in view of the Oct. 20 Chinese border attacks—continued for about seven days on an eight-flights-every-24 hr. basis.

The emergency push was discontinued when immediately available and usable equipment was on hand.

Fast U.S. reaction time to the Indian request for aid had provided an urgently-needed military and psychological lift to the Indian population and infantrymen (Jawans) who had been fighting with World War I Lee-Enfield bolt-action rifles. Chinese infantrymen were equipped with modern Soviet-made automatic rifles plus heavy mortars and mountain artillery. Jawans were outnumbered by approximately eight-to-one in the border thrust.

## MATS Operations

Military Air Transport Service aircraft are still flying into Calcutta's Dum Dum Airport with top-priority items and probably will continue to do so for some time to come.

But so long as the relative lull in fighting along the disputed Himalayan border continues, as it has since the initial attacks, heavier-capacity sealift will be used to move the bulk of U.S. military aid to India. First ships from Japan and the United States are due to begin arriving at Indian ports sometime this week.

Airlift, according to American spokesmen here, will now be used on a basis of need when time required for sealift obviously is too great. Equipment, whether it arrives initially by air or sea is being moved to the front largely by Indian air force planes.

During seven days of all-out operation, a total of 56 MATS airlift flights landed at Dum Dum, 40 of them C-135s flying a roundabout route to avoid communist East European territory. The aircraft flew from the staging

point at Rhein-Main Air Base in West Germany, over France, down the Italian Peninsula and across Greece to Adana Air Base in eastern Turkey for their first refueling stop.

Flight of little more than 2,000 mi. required about 4½ hr. after the Adana stop. The planes then flew a northerly course over Teheran, Iran, before cutting back south into India. This route was plotted to avoid the territory of Pakistan, a Western ally that is still feuding with India over Kashmir territorial claims and has refused to grant MATS aircraft permission to overfly.

Flight time on this leg was normally scheduled at approximately 6 hr. The detour around Pakistan added only 40 mi. to the total flight.

## Return Flights

On empty return flights to Rhein-Main from Dum Dum, C-135s flew nonstop with a 10 hr. 20 min. scheduled flying time. On inbound flights carrying equipment collected from U.S. Army weapons depots in Western Europe, forty C-135 flights carried an average of a little more than 42,000 lb. of cargo each for a total of about 840 tons. Highest payload carried by a single aircraft during the seven-day period was 52,000 lb.

The only major bottleneck that upset the schedule for C-135s landing at Calcutta every 3 hr. was in Adana, according to Brig. Gen. Robert B. Forman, commander of MATS' 1602nd Air Transport Command at Chateauroux Air Base, France, who flew here to direct the airlift operation.

Only refueling method at Adana is by hydrant system, and since airlift aircraft had no particular priority, some were forced to wait up to several hours.

Twelve C-135 aircraft from U.S. bases were assigned to the airlift, including two "A" models used as backup planes. Ten regular aircraft, however, were "B" models, equipped with Pratt & Whitney TF33 turbofans. C-135Bs taking off from Dum Dum's 8,500-ft. runway with no wind and 95F temperature were rotating their nose wheels after 6,400 and 6,600 ft. No water injection was involved, although it had to be employed on takeoff by the relatively few C-135A flights into Calcutta.

Maintenance problems experienced here were minor, primarily involving electronic malfunctions and tires deeply slashed either on takeoff from Rhein-Main or landing at Calcutta. Air-India, which was experiencing the same problem on commercial Boeing 707 flights into Calcutta, blamed the Rhein-Main





## S-61 Modified for USAF Order

First details of the Sikorsky S-61R to be produced for the Air Force as the CH-3C are revealed in an artist's concept showing extensive modifications from the Navy SH-3 Sea King (former HSS-2). Tail section is redesigned for rear loading utilizing a hydraulically operated split type cargo ramp, and to provide a flat catwalk surface on top for easy access to the tail rotor. Sponsons have been enlarged and redesigned with low drag profile. Beside providing buoyancy for water operation, these house the main wheels of a tricycle landing gear, a change from the Navy version's tailwheel layout. Other features include a self-contained auxiliary powerplant, self-lubricating main and tail rotors and ground level access to the electronics compartment. Powered by two General Electric T58-8 turbine engines, the CH-3C has a range of 238 mi. with a payload of 5,000 lb. or 810 mi. with 2,400 lb. payload. Normal gross weight is 19,300 lb. and maximum gross, 22,000 lb. First flight of the CH-3C is scheduled for June, 1963, and delivery in Fiscal 1964. Air Force has taken delivery of six HSS-2s of its total order of 28 ordered under its SOR-190 requirement (AW Nov. 5, p. 23). Balance of the 28 will be the S-61R version.

runway for the majority of its problems.

Twenty C-135 flight crews were involved in the operation, some making as many as three flights from Germany to Calcutta. Normal crew rest between flights was between 12-15½ hr.

In addition, Gen. Forman had 31 maintenance and support personnel stationed at Adana and 87 at Dum Dum. Aircraft averaged 4-hr. ground times each, using lift trucks and soldiers.

C-135 were offloaded here in an average of 25 min., with cargo going onto antiquated civilian trucks drafted for the purpose. Cargo was then taken to a rail or another air center for final shipment to the front or a storehouse.

Only items that failed to reach India on or near schedule were several pieces of mountain artillery which, at the re-

quest of the United States, the Turkish army had agreed to provide. Turkey, however, later backed down on the offer of U.S.-made equipment without announcing its reason.

Other MATS flights into Calcutta during the airlift included several support missions by C-124 Globemasters from Tachikawa Air Base, Japan, and C-130s from Rhein-Main. Support equipment included one flyaway kit, a lift truck for unloading and a minimum of spares, including tires.

At other times, parts from incoming aircraft simply were "stolen" to remedy any malfunction in an outgoing plane.

## News Digest

Atlas F was successfully silo-launched at Vandenberg AFB last week. Principal objectives were to evaluate operational ground equipment and missile systems. Launch was made by SAC crew from 576th Strategic Missile Squadron.

New York Airways Vertol 107 helicopter with 25 persons aboard made a forced landing at Idlewild Airport last Wednesday when the pilot heard a bang and noted power drop shortly after takeoff. Maintenance officials said failure of the sprag clutch assembly in the rear transmission was suspected as source of trouble. Transmission was sent to Boeing's Vertol Division for disassembly. Helicopter was returned to service with new transmission.

Kaman K-1125 Huskie 3 twin-turbine, company-developed helicopter was damaged after turning over following an autorotative landing last week in the front yard of a home near the Kaman plant at Bloomfield, Conn.

John I. Lerom, manager of Washington, D. C., operations for United Technology Corp., was killed when an Air Force Cessna U-3B aircraft crashed into Mt. Guyot in eastern Tennessee Nov. 10. Lerom, a brigadier general in the Air Force Reserve, was en route from Andrews AFB, Md., to Robins AFB, Ga., where his mobilization assignment was deputy chief of staff, operations, for the Continental Air Command.

First Relay communications satellite was shipped to Cape Canaveral, Fla., from Radio Corp. of America's Princeton, N. J., laboratories Nov. 14. Launch is scheduled for next month. RCA developed active repeater satellite.

Lockheed Aircraft Corp., contending that it is opposed to any form of compulsory union membership, has rejected the arbitration proposal made by International Assn. of Machinists. Union members were scheduled to meet yesterday to take a strike vote.

X-15 No. 2 was damaged extensively during emergency landing on Mud Lake Nev., after Pilot John B. McKay noted that only 30% of engine power was available and consequently shut down the engine and jettisoned the fuel. Nose strut collapsed after normal touchdown, skidding the aircraft and causing it to roll over one and a half times.

Morane-Saulnier, French private plane manufacturer owned by the Saulnier family, is expected to file a petition for bankruptcy this week after running heavily in the red.

Coast and Geodetic Survey announced last week that its satellite tracking camera at Aberdeen, Md., recorded five flashes of an unannounced test of the ANNA satellite on Nov. 2.

## Hughes MMRBM Role

Washington—Hughes Aircraft Corp. has been selected by Air Force to complete the program definition phase of the integration, assembly and checkout mission on the mobile medium-range ballistic missile. This eliminates Northrop Corp.'s Norair Division and completes selection of final program definition contractors in six MMRBM work areas. Hughes and a Martin-Sylvania team still are doing program definition work in the command and control system.

# AIR TRANSPORT

## Trunkline Profit of \$25 Million Expected

Anticipated 1962 earnings would reverse two-year trend; rate of return is still termed unsatisfactory.

By L. L. Doty

Washington—Domestic trunkline industry appears headed for a \$25-million net profit for 1962, despite an anticipated slowdown in passenger traffic growth during the fourth quarter.

While this would be a welcome switch from the loss of \$34.6 million last year and the meager net earnings of \$1.2 million in 1960, it falls far short of providing a rate of return that can be termed economically healthy. If the trunklines could realize the Civil Aeronautics Board's recommended rate of return of 10.5%, the industry this year would show a profit of \$132 million.

The highest rate of return reached by the industry in the last six years was in 1959, when a 7.1% rate was reported. Total net earnings for the industry during the five-year period between 1957 and 1961 totaled \$100 million, a rate of return slightly over 4%.

Key to profit potential is the industry's ability to continue the traffic growth recovery that began last November, but which in recent months has shown signs of dwindling. Improved gross revenues will be required to keep pace with a rising expense level and a steady increase in interest on debt which so far this year has climbed 17% over last year.

Interest costs will probably reach an estimated \$71.5 million this year, compared with \$61 million last year and \$24.5 million in 1958, when turbojet transports were first introduced into U.S. scheduled service.

The over-all industry picture cannot be interpreted as representative of each individual carrier. Seven of the 11 trunklines will undoubtedly show a profit this year, but losses expected at Eastern, Northeast and Trans World Airlines could seriously depress total industry results.

Eastern, for example, has reported a substantial \$23.5 million net loss for the first nine months of 1962, a figure close to the forecasted industry profit for the year. It should be noted, however, that the Eastern loss, equivalent to \$7.26 per share, does not reflect about \$16 million it has received from other airlines participating in the Mutual Aid Agreement.

The CAB has not given its final approval to the pact.

Industry revenue passenger miles will probably increase 9.5% over last year. Traffic remained dismally low through-

in September, but fell in October to 4.4%.

Meanwhile, available seat miles jumped to 5.36 billion in October, highest monthly level ever reached and a 13.3% increase over October, 1961.

As a result, the industry load factor plummeted 4.35% to 49.25%, the first time in 20 years it has fallen below the 50% mark.

Only three carriers—Continental, Northeast and Northwest—showed a load factor improvement in October. American's load factor dropped 7%, TWA and United 6%, and Braniff 7%.

First-class load factors were hit particularly hard during October with no carrier reporting a load factor higher than 49%. National's first-class load factor fell 10% to 31%, Northwest's dropped to 38% and Western's fell to 38%.

Each of the 11 carriers experienced declines in first-class revenue passenger miles, most of them severe. For the group, first-class revenue passenger miles decreased 15.4% from the volume reached in October of last year.

First-class available seat miles were reduced by 4% during the month but it was not sufficient to offset the steady

## British Treasury Moves to Approve SST

London—There were strong indications here last week that the British Treasury has approved funding up to \$280 million to join with France in building a Mach 2.2 supersonic transport. Airplane will be called the Concorde.

Decision to proceed with the project will be announced in the House of Commons by Minister of Aviation Julian Amery at the end of the month.

Earlier, Amery and his French counterpart, Roger Dusseaux, met in Paris to discuss final administrative and technical details. Both ministers have since reported to their governments. The ministers also discussed military versions of the aircraft, although emphasis remained on a civil aircraft.

Speaking in the House of Lords last week, Lord Chesham, the parliamentary secretary to the minister of transport, indicated that the British financial decision will be made very soon. Supporting the project, he warned that abandonment would be a setback to British aviation in view of what he called a lead of several years in development of supersonic transports.

Chesham also said that the government has spent \$8.5 million on supersonic transport research since 1956. If the joint project is funded, money would be spread over a 10-year period (AW Sept. 17, p. 34).

His comment followed an attack on the joint project by Lord Brabazon of Tara, president of the Royal Aero Club and a member of the Air Registration Board. Lord Brabazon questioned how much the government should spend for prestige purposes and claimed that problems of fatigue and radiation in supersonic transports remain to be solved. On radiation, he said:

"It would be a tragic thing if you sent your best girl in a supersonic airplane and then found yourself the father of an orangoutang."

Referring to the costs of the project, and backing his contention that there is no civil need for such an aircraft, Brabazon contended that Amery's construction policy would ruin civil aviation, from the point of view of paying, forever.



## Reactions Mixed to UAL One-Class Trial

New York—United Air Lines' competitors on the Chicago-Los Angeles and Chicago-San Francisco routes have mixed reactions to UAL President W. A. Patterson's plan to begin experimental one-class service on one of these routes by Mar. 1, 1963, if Civil Aeronautics Board approves (see p. 52).

Patterson elaborated on his one-class service plans (AW Oct. 15, p. 43) recently in San Francisco. He said he would file the experimental fare with CAB in December, to begin by Mar. 1.

Four Boeing 720 jet transports would be converted to 2-3 seating configuration with 100-passenger capacity plus the lounge, Patterson said. A meal and a drink would be included in the service.

Patterson predicted the fare increase would not exceed 5%, which, taken with the recent 5% federal transportation tax cut, would leave one-class fares at about the present coach level.

Trans World Airlines President Charles C. Tillinghast, Jr., opposed the one-class fare, saying it would "reduce the comfort enjoyed by first-class passengers and cause a significant increase in fares now enjoyed by coach passengers.

"The American consumer is used to making his own free choice . . . whether it involves automobiles, refrigerators or clothes . . . no significant industry has to our knowledge sought to force the consumer to accept a single pre-determined grade of product or service," Tillinghast added.

Continental Air Lines said it must evaluate its own business-class experiment (AW Aug. 27, p. 47), which it characterized as "encouraging, but too early to tell," before it could comment on United's one-class plan. Continental planned to file for an extension of its experimental fare to Feb. 28 to obtain experience from business-class operations during the Christmas season.

American Airlines, United's third competitor on the Chicago-Los Angeles and Chicago-San Francisco routes, said its management still feels there is room for two-class service in the airline market, but that it was studying Patterson's proposal.

United spokesman indicated that seating on that carrier's Boeing 727 jet fleet, now on order, has been altered to a one-class, 92-seat configuration—three fewer seats than under the original coach, first-class configuration. The new seating is the same type United would use on its one-class 720s.

switch of passengers from first-class to coach travel.

All but Northeast reported gains in coach travel in October. Industry increase during the month in coach traffic rose 19% over the same period last year. Coach load factor was 52.1%, a 4% drop from October of last year, due to a 27% increase in coach available seat miles.

Six carriers showed spectacular improvements in the volume of coach traffic handled during October. Delta reported an 89% increase, Continental 50%, Northwest 39%, National 38%, Braniff 36% and Western 35%.

The 4.4% increase in total revenue passenger miles for the 11 trunklines does not reflect the traffic activities of individual carriers any more than the industry's total profit figure represents average individual carrier gain.

Both Eastern and Northeast, for example, showed declines in revenue passenger miles. American, TWA, United and Braniff reported slight traffic increases, but National's total traffic climbed 23% and Delta's 22%.

It can be presumed that these two carriers are benefiting from the recent extension of their routes to the West Coast. Continental, Northwest and Western reported substantial gains in total revenue passenger miles.

During October, United held its posi-

tion as the nation's leading carrier in terms of traffic handled with a total of 641.6 million revenue passenger miles for the month. American generated 544.7 million revenue passenger miles for the period, and TWA was in third position with 392 million.

Local service airlines continued to show strength during October with a 17% increase in revenue passenger miles and a load factor of 41.2%, only slightly lower than the 42.4% reported in October of last year. Only two local service airlines failed to show a gain in revenue passenger miles during the month.

## Inquiry Could Affect 100 Regional Airports

Washington—Scheduled airline service into 100 airports eventually may be affected by the Civil Aeronautics Board's current series of regional airport investigations.

The investigations are designed to reduce the industry's subsidy needs by consolidating flights at one airport for two or more cities. In four separate actions, CAB is examining service into 39 cities in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, North Carolina, Wisconsin and Texas.

It is probable that CAB will expand the scope of the investigations to in-

clude other areas of likely consolidation throughout the country. The Board estimates that 18% of the 545 certified airports directly compete with each other. This competition is increasing in every state, the Board contends, and stands at 36% in Illinois, 32% in Michigan, 33% in New York, 20% in Texas and 31% in Oregon.

The Federal Aviation Agency, in supporting the Board's regional airport program, has said it will not provide aid funds for airports being investigated by CAB. FAA noted that in several past cases it has required far less federal money to build a new airport serving two or more communities than it did to maintain two separate airports located a few miles apart.

Withdrawal of scheduled service from one airport has usually resulted in its use as a much-needed general aviation airport, reducing area traffic and requiring less federal support for such items as runway lengthening and taxiway additions necessary for most scheduled operations.

Informed observers believe CAB's program may face less opposition than expected from some communities, primarily because of the increased valuation of land around many airports, which could make it economically profitable to withdraw from the facility with a profit and participate with FAA aid in the construction of a new airport to be shared with a neighboring city. At the same time, they concede that consolidation of service in such areas as Dallas and Ft. Worth, which is a separate CAB regional airport investigation procedure, may be accomplished only by a direct Board order.

The Board's airport investigations were spurred by these circumstances: Northeast Airlines' financial problems, aggravated by the necessity of providing subsidized service to several unproductive New England points, and recommendations from a group of New England state aviation officials that scheduled service at 13 airports be abandoned and operations consolidated into 20 other regional airports.

Generally, the CAB investigations concern cities which are located within a 50-mi. radius of each other. Maximum ground transportation time between city and airport would be limited to 1 hr. Other considerations, such as present and future road conditions and transportation facilities, would enter into the selection of a regional airport.

CAB noted that many communities may object to removal of airline service on grounds that they are able to meet CAB's "use it or lose it" policy for daily minimum passenger boardings. The Board said that this service may be transferred if it is indicated that service may be provided as well, or better, by an adjacent airport.



**NIGHT VIEW** of Dulles terminal was taken from main entry road used by airport arrivals. Public parking area for 8,500 cars occupies space to the immediate front of building. Airline arrivals will disembark from mobile lounges at main terminal level, descend to a lower level by escalators for baggage pickup and downtown transportation. Dulles International Airport became operational Nov. 19.

## First Scheduled Service at Dulles Begins

By Robert H. Cook

Washington—Dulles International Airport became officially operational Nov. 19 with 58 flights scheduled to be handled. President John F. Kennedy and former President Dwight D. Eisenhower were to attend dedication ceremonies Nov. 17.

Eastern, Trans World, Delta, Braniff and Northwest Airlines are providing the first service into the \$110 million federal facility with 30 turbojet and 28 piston engine flights. Eastern's 36 flights account for more than half of the total. TWA has the next highest frequency with 12 flights.

American Airlines will inaugurate Dulles service on Dec. 1 followed by Pan American World Airways on Jan. 1, and United Air Lines on Jan. 13. National, British Overseas Airways Corp., Northeast, Allegheny, Lake Central and Piedmont Airlines are expected to announce Dulles schedules in the near future.

Although officially operational, Dulles is still faced with construction delays and probably will not be completed until March of next year, FAA sources indicate (AW Apr. 30, p. 36).

Most of these remaining problems are considered minor and primarily involve the completion of installation of mechanized and automatic items within the terminal building, such as baggage conveyor belts and main entrance doors. Work is still in process behind hastily-erected partitions on some airline ticket counters, concession stands and jet apron operational buildings.

Under the terms of its construction contracts, FAA can demand liquidated damages ranging from \$500 to \$5,000 per day from contractors for each day's delay in meeting completion dates. At

this time, these FAA damage claims could total \$450,000, since the finishing contract on the terminal building alone called for a completion date of July 30, with assessment of liquidated damages at the rate of \$5,000 per day.

However, it is doubtful that FAA will fully implement the assessment clauses, since some time extensions have been granted, and because those assessed would probably take the matter to court. They would insist that much of the delay has been unavoidable due to weather conditions and plan changes made by the FAA, agency sources said.

While FAA missed its dedication target date of Oct. 1 by a considerable margin, sufficient runways and instrumentation were available to permit aircraft landings and takeoffs by that date. Since then more than 4,000 practice operations have been conducted on Dulles runways.

Both 11,500-ft. north-south oriented instrument runways are equipped with touchdown zone lighting, centerline lighting and runway edge lights. A third 10,000-ft. west-east runway is equipped with a Visual Approach Slope Indicator (VASI) to aid pilots in maintaining a proper glide path while landing under limited visibility conditions. The VASI system will later be added to the north-south runways.

Eleven mobile lounges, which eliminate the need for terminal "fingers," are in operation at Dulles, and the balance of an order of 20 is expected by March. Design of the terminal building currently provides 24 lounge docks. This may be expanded to 56 when traffic growth is expected to require a doubling of the building's present 600-ft. length, according to FAA Administrator N. E. Halaby.

Halaby noted that long walks have

almost been eliminated at Dulles, through use of the mobile lounge. He said that airports should not be "gymnasiums or trackfields" requiring long and tiresome walks between the ticket counter and boarding gate.

Halaby conceded that Dulles is still not fully finished, but said he considered it important to have it operational "as a business airport" as soon as possible.

"The taxpayers were told it would take \$60 million to build this airport two years ago. We looked at it, found the cost underestimated and set a new figure of \$106 million with a new completion date of this fall. Now we've made it," he said.

Public demand for service will be the deciding factor in the airlines' expansion of service at Dulles and the volume to be retained at Friendship International Airport, at Baltimore, Md., he said.

By 1975 traffic growth in the Washington-Baltimore area will require the use of all three area civil airports—Dulles, Friendship and Washington National—as well as three new general aviation fields, the FAA administrator predicted.

FAA has a large investment in Friendship, considers it a good, safe airport and wants it to "thrive," Halaby said.

However, he said, Dulles' location closer to the traffic population center of the area, as revealed by FAA studies, may create a demand for more Dulles schedules. It might be "10 or 15 years, maybe as little as five" before Friendship could succeed in recapturing some of its turbojet traffic, he said.

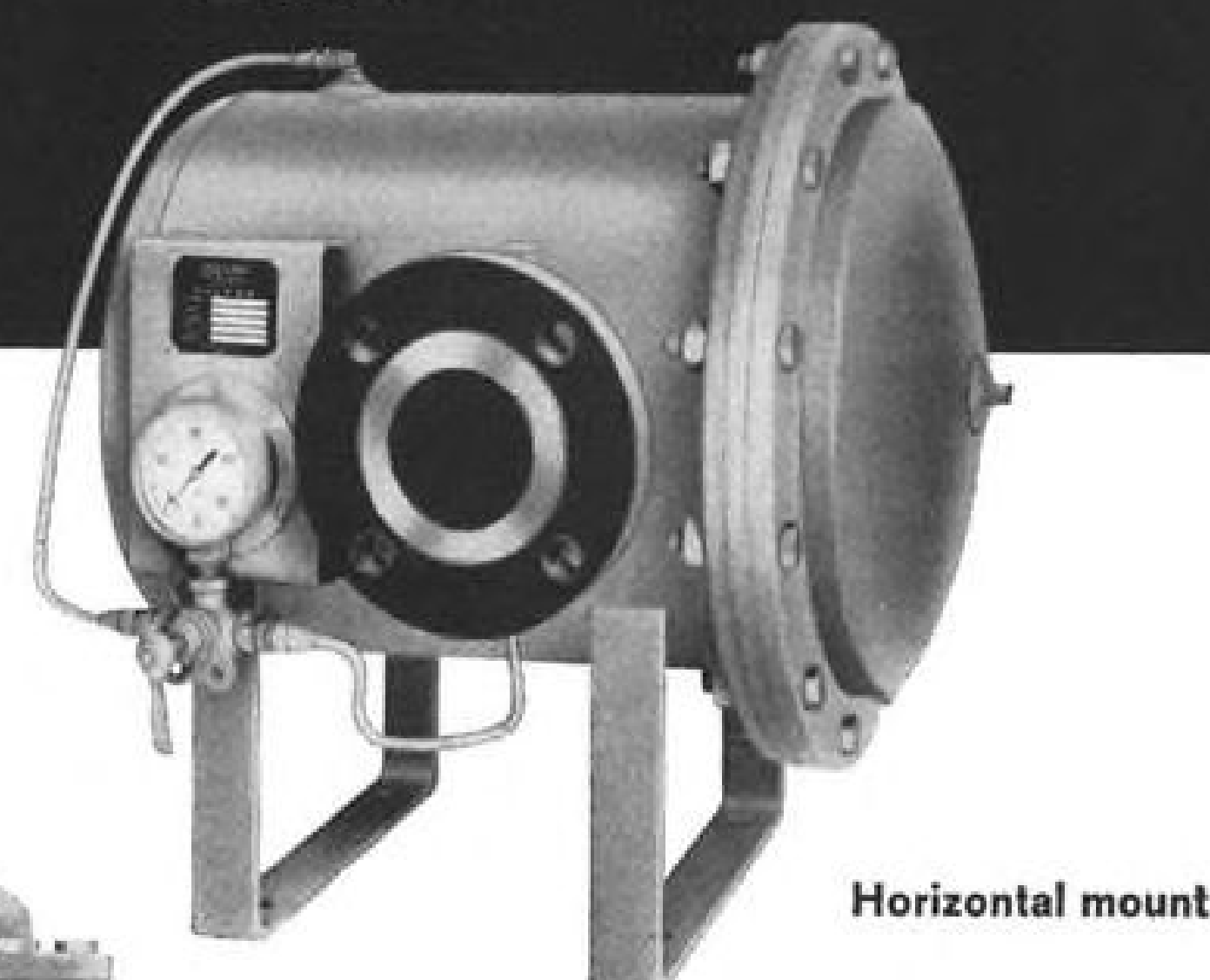
"The one thing I want to emphasize is that we're going to need all three airports over the long term," he said.



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**CARGO LOADER DEVELOPED** for USAF 463L is demonstrated on wood mockup of Lockheed's C-141 at Marietta, Ga.

## Air Cargo Standardization Program Urged

By James R. Ashlock

Atlanta—Airlines seeking to standardize their cargo operations cooperatively in the interest of better service for shippers are adopting as guidelines the Air Force's 463L system and techniques compatible with trucking firms.

The 463L Materials Handling Support System (AW June 11, p. 56) is a strong influence, since it is a ready example of standardization in the vital areas of cargo aircraft design, palletization and ground handling techniques.

However, 500 delegates to the International Forum on Air Cargo here recently were cautioned against adopting 463L standards strictly in the interest of attracting more military cargo business.

Brig. Gen. James G. Sherrill, commander of 1068th Air Transport Wing of MATS, said the Lockheed C-130E and C-141 transports will enable MATS to carry much of the volume now contracted to commercial carriers. In the fiscal year just ended, this amounted to \$185,000,000 in passengers, cargo and mail, or about 50% of the military transoceanic traffic.

"While we can expect demands for military airlift to continue on the upswing, I think we must also reasonably assume that part of the slack between

demand and supply will be taken up by MATS' increasing capability," Gen. Sherrill said.

"For this reason, although we will always need the capable backup of the commercial airlines in our logistical operations, it is apparent to everyone that the growth of the commercial air cargo industry should not and cannot depend entirely upon military requirements," he added.

Airline officials attending the forum, which was sponsored jointly by the Institute of Aerospace Sciences and the Society of Automotive Engineers, said 463L was an acceptable standardization pattern because it has features for transfer of shipments between air and surface vehicles.

"The not-so-glamorous truck will continue to be the umbilical cord of our over-all freight operation," said Emery F. Johnson, president of Air Cargo, Inc.

"We must adapt our system to work with trucks, rather than have truckers change to meet our needs."

The 463L cargo pallet measures 88 x 108 in., and agreement was general that the 88-in. dimension should be adopted as standard, since it conforms to truck-bed width.

Several trucking representatives questioned the 88-in. width, saying that only

50% of the trucks in the U.S. and fewer in Europe are wide enough to take it. Others said narrow trucks are mostly older models rapidly being replaced by vehicles with 88-in. width.

An airline cargo official reflected that "if we could put 50% of the trucks in this country to work supporting air cargo, we'd be rolling in profits."

William Littlewood, vice president of equipment research for American Airlines, said standardization was already partially under way among air cargo carriers. Boeing 320C freighters ordered by American and Pan American World Airways, and Canadair CL-44s in use by all-cargo operators, have palletized systems compatible with 463L. Standardization among loading systems will also result as carriers purchase mechanisms proven most efficient through experience, he added.

The 88-in. pallet is uniform, in most cases at present. Besides the 88 x 108-in. 463L pallet, there is one measuring 88 x 118 in. for the CL-44. On the 320C, American will use not only the 463L pallet, but also others measuring 88 x 88 in. and 88 x 125 in. (AW Oct. 29, p. 43).

Still to be resolved are variations in aircraft size, terminal facilities, ground handling equipment and the legal snarl of customs red tape for international



# MISSIONS & MILESTONES

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## MODEL XHRPX

1945: Developed for the U.S. Navy, the XHRPX, world's first successful tandem rotor helicopter makes first flight on March 6.

## MODEL HUP



dolph. 1950: HUP is

first helicopter to be flown with an automatic pilot. 1962: The Boeing-Vertol HUP plays a typically useful role in the sea operations following the space flight of Lt. Colonel John Glenn. In the accompanying photograph the helicopter is lifting the astronaut from the Destroyer U.S.S. Noa to take him to the U.S.S. Randolph.

## MODEL H-21



since have produced

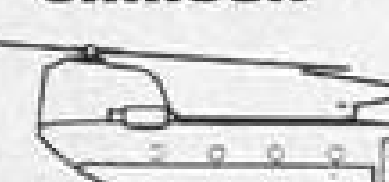
invaluable operational data used in developing improvements and refinements in later helicopter models. 1962: Boeing-Vertol H-21 assault helicopters are assigned in large numbers by the U.S. Army to combat guerrilla war operations in South Viet Nam. 1956: The French Army puts H-21's into service in the Algerian conflict. (The more than one hundred introduced there

## MODEL 107



1962: Passenger airliner configuration of the 107 is certificated by the FAA... delivered to New York Airways. 1961: Military version of the 107 wins U.S. Navy competition for a marine transport helicopter.

## MODEL HC-1B CHINOOK



1962: The HC-1B Chinook, America's most powerful helicopter, is in large scale production and flying; attains speeds over 150 mph with higher than normal maximum loads. 1961: First Chinook completed and ready for ground tests. 1959: Vertol Division gets go-ahead to develop a new 2-3 ton capacity transport helicopter for the U.S. Army.



**SPRING LOADED BALL BEARING** rollers in the Douglas DC-8F facilitate easy movement of pallets. Mechanism is compatible with the military 463L system.

shipments. "Standardization will result," Littlewood said, citing a universal desire for it among cargo operators. "But it will take a lot of argument, and some heads will be knocked together."

Littlewood said carriers must cooperate more in deciding what type of aircraft best meets a program of standardization, then have the manufacturers build it. He said the only reason the Douglas DC-8F and Boeing 320C have identical floor widths is because the airlines jointly determined the dimensions when the passenger versions of these planes were being designed.

"The next generation of cargo aircraft should be designed toward standardization," Littlewood said.

Example of the need for uniformity among aircraft, Littlewood said, is the CL-44's inability to take pallets stacked as high as those that can be placed in the 320C or DC-8F. The Lockheed L-300, commercial version of the C-141 (AW Oct. 29, p. 44), will be able to take longer containers, because of its end loading feature, than those that may go into the side doors of the Douglas and Boeing freighters.

Committees discussing progress on standardization at the meeting here determined that aircraft represent the greatest advancement to date. Some steps have been taken toward standardized processing of cargo for shipment. In administration, or paperwork, uniformity is practically nil.

"This meeting should have been held two years ago," said R. F. Stoessel, chief marketing development engineer for Lockheed-Georgia Co., and general chairman of the forum. "But concern over standardization wasn't nearly so widespread then as it is today."

Stoessel said it is doubtful whether any appreciable standardization in air cargo operations, and in air-surface co-operation, will result before 1970. To get it even that early, work must begin

now, he said (see following story).

"If we don't attain standardization, if the airlines fail to agree, then air will not receive its fair share of the freight market," Stoessel said.

He identified time as the main problem. With air cargo volumes growing, carriers must buy the airplanes and support systems and adopt the practices that meet their immediate needs. The airlines that go the farthest may be the most reluctant to change to any standards proposed later, he said.

"To obtain a greater share of the market, we must standardize," Stoessel said. "Today, the airlines are carrying only 1% of the world's freight volume."

"I doubt we'll ever get more than 1%," he added. "But if we do gain 1% of the market, we'll require twice as many airplanes for freight service as we need for passenger schedules."

Alan S. Boyd, chairman of the Civil Aeronautics Board, endorsed the airlines' efforts in a speech to the forum delegates.

"Cargo is not a stepchild in our philosophy and action," Boyd said. "We are working to develop less burdensome tariff filing procedures. We are exploring the great possibilities of joint air-surface movements, trying to bridge the regulatory gap between the Board and the Interstate Commerce Commission."

Boyd said the CAB is also trying to develop a suggested rate philosophy for cargo, one that is geared toward a fair return for the service.

"Let me emphasize that we are not seeking to force any carrier into any particular rate-making philosophy," he said. "We are trying to find a starting point in the hope that everyone will reach agreement on where the race is to begin."

Next move in the cargo standardization program is a February meeting in

New York coordinated by the Society of Automotive Engineers. Stoessel said airline representatives will be invited, as well as officials of U.S. and international standards bureaus.

"We also want this to come to the attention of the International Air Transport Assn., to initiate a program for standards among IATA members."

## Slick, Surface Movers Discuss Cargo Service

Dallas, Tex.—Slick Airways held its first meeting here last week with executives of six major surface freight carriers to discuss details of a new truck-air-truck cargo service based on economy rates now before the Civil Aeronautics Board (AW Oct. 1, p. 32).

Cooperative airfreight-truck program would provide joint through service between 1,500 to 2,000 points in California, Oklahoma, Texas, Indiana, Ohio, New York, New Jersey, Connecticut, Arkansas and Louisiana. Guaranteed service would feature a single waybill, single responsibility and a transcontinental tracing system.

Rates of \$8.73 per hundred-weight between Galveston, Tex., and New York City, and \$15.28 per hundred-weight between Sacramento, Calif., and Bridgeport, Conn., are examples of the proposed tariffs.

Joint program calls for guaranteed third-morning delivery for transcontinental shipments. Service from Dallas to intermediate points would provide second-morning delivery, Slick Corp. President and Board Chairman Delos W. Rentzel said.

Rentzel said the meeting with key executives of the six motor carriers was to involve discussions of how the cooperative venture would develop joint sales and promotion efforts in the geographical areas they serve.

He added that Slick plans to put most of its sales effort and money in the future into a coordinated program with its member surface carriers. Slick is seeking coordination of surface and air transportation, initially with truckers, and eventually with railroads, in a cooperative enterprise, he said.

Under the plan, committees will be set up to develop single billing, coordinated promotion efforts and through-rate schedules. A committee also will study development of a mutually acceptable surface and air container system. Six surface carriers meeting with Slick are: California Cartage Co., of Los Angeles; Commercial Motor Freight, of Indianapolis, Ind.; Le Way Motor Freight, Inc., of Oklahoma City, Okla.; Pacific Motor Trucking Co., of San Francisco, Calif.; Perkins Trucking Co., of New York City, and Southwestern Transportation Co., Dallas.





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**WESTERN AIRLINES**



**FINNAIR MARK 3 CARAVELLE** is seen at Helsinki Airport. Nose of another Caravelle is visible at the extreme right. Finnair has four Mark 3 Caravelles.

## Finnair May Trade in Caravelle 3s To Finance Horizon 10B Purchase

**Helsinki**—Finnair-Aero O/Y, the Finnish national airline, may finance the purchase of six Caravelle Horizon 10Bs powered by Pratt & Whitney JT8D-1 turbofan engines by trading in its fleet of four Mark 3 Caravelles.

Reported deal would mark the first sale by Sud Aviation of its Caravelle Horizon 10B. Even more important, the Sud-Finnair contract would be a precedent-making example of new jet aircraft being financed in part by trading in used jet transports.

Aviation sources here say Finnair would take delivery on its first Caravelle Horizon in March. Deliveries of the first five aircraft reportedly would be spaced at closed intervals so that Finnair could operate three Caravelle Horizons in the 1964 season. Delivery of the last aircraft, however, might not take place until 1966.

Connected with the Sud-Finnair talks is the possibility that Kar-Air, private Finnish airline doing charter flight business in Western Europe as well as operating a domestic service in Finland, may enter into the deal by ordering a single Caravelle Horizon 10B. Thus, the total Finnish order would be seven aircraft.

Finnair also has been studying the British BAC 111 intensively, and the smaller twin-jet may represent an alternate equipment plan for the airline.

The agreement, involving partial payment in used jets, is far from easy to negotiate, and last-minute hitches could quash the accord. The French air force, for example, initially indicated interest in taking over the Finnair Mark 3 Caravelles, or some of them, but then backed off.

Main reason for Finnair's attempt to negotiate a trade-in is a lack of capital to finance the entire cost of the new equipment. The Caravelle Horizon 10B costs \$3.6 million, compared with

an initial price of about \$3 million for the Mark 3 Caravelle.

Then too, Finnair obviously would have to concern itself with disposing of its used Caravelles once it bought new ones. Purpose of the present agreement is to have Sud take over the responsibility of finding buyers for Finnair's used Caravelles. Trade-in price is believed close to the original figure paid by Finnair.

For its part, Finnair has agreed to reschedule its Caravelle major overhaul downtime in order to permit latest modifications to be made. In this way, the used Finnair Caravelles will be up to date, as far as modifications are concerned, when Sud Aviation takes them back.

Finnair's present fleet consists of four Caravelles, all Mark 3s, seven Convair 440s and five Douglas DC-3s (AW Nov. 21, 1960, p. 41). Delivery of Finnair's last Caravelle took place last February.

Finnair's main international route still consists of a daily Caravelle flight from Helsinki to Paris via Hamburg and Amsterdam. The carrier also operates Caravelles from Helsinki to London via Goteborg, Sweden, four times weekly, and twice-weekly Caravelle service between Helsinki and Moscow.

Mixture of Caravelles and 440s is used in servicing Copenhagen, Stockholm and Frankfurt. In winter months, when traffic slackens to Moscow, the carrier often replaces its Caravelle flight with a Convair 440.

Expected purchase of the new Caravelles probably means Finnair, after several years of route stability, is planning additional European service. It is expected that Finnair will try to extend its routes toward such points as Rome, Madrid or Barcelona. New equipment also could mean increased Finnair interest in charter activity, both on its

own operation and in renting out to other carriers.

At present, for example, Finnair charters a Caravelle daily to Lufthansa. After a Finnair Caravelle arrives at Paris from Helsinki on its daily run, it makes a round-trip flight to Frankfurt for Lufthansa. Finnair flight crews fly the charter, although the cabin crew is from Lufthansa. Once returned to Paris, the Finnair Caravelle then makes its return Finnair flight to Helsinki.

The arrangement has helped to push Finnair's Caravelle utilization rate to about 7 hr. daily. The carrier's four Caravelles handle about 75% of Finnair's international traffic.

Finnair, although 73% government-owned, operates with more of a profit goal than prestige motivation. The carrier receives no subsidy from the Finnish government. Finnair's basic operating philosophy, as explained by carrier officials, is that the airline exists to meet the traffic needs of Finland.

Sense of independence has always led Finnair officials to turn down invitations to enter into the Scandinavian Airline System (SAS) consortium. Finnair, however, cooperates with SAS by a pooling arrangement on flights between Helsinki and Scandinavian points. SAS also does major overhauls of Rolls Avon engines used on Finnair Caravelles.

### New Argosy Version

**London**—Whitworth Gloster Aircraft, builders of the Rolls-Royce Dart-powered Argosy 650 transport, is negotiating with several U.S. airlines for a mixed passenger-cargo version hauling 46 passengers and 14,000 lb. of freight.

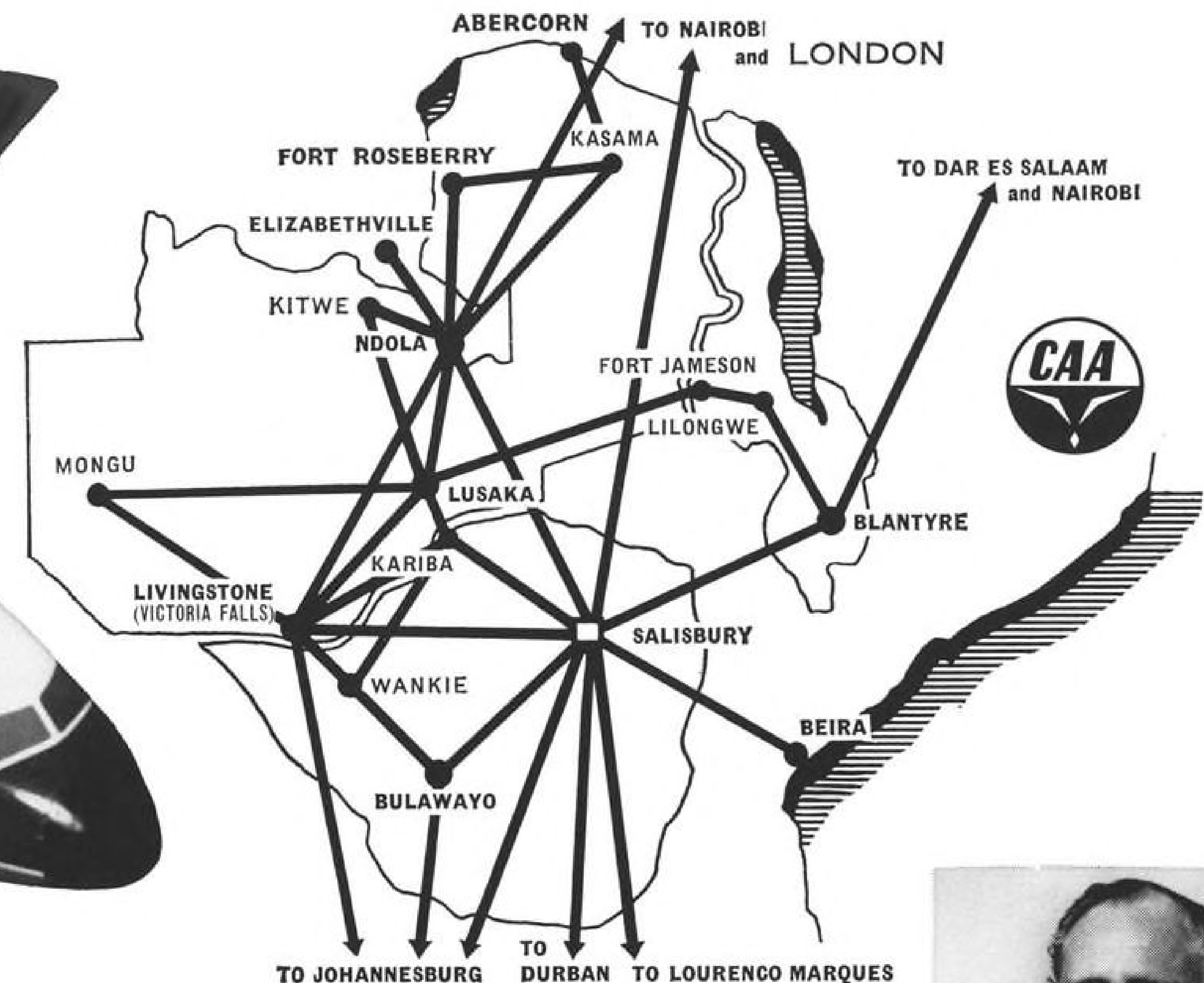
Roy E. LeLong, general sales manager, said current design studies have been worked out for a direct operating cost of 4.5 cents on available ton miles for cargo, and 2.17 cents on available seat miles for passengers. Company turned to the mixed configuration design when it learned that Eastern Air Lines was considering revamping its Douglas DC-7s for mixed use, and Allegheny Airlines and Alaska Airlines were exploring a similar plan involving Convair 440s.

Whitworth Gloster Argosy version, the 200 series which includes the box spar wing for full fail-safe operation, features a full cabin-width loading door at the front of the cabin to permit straight-in loading of outside cargo up to 8 ft. 4 in. wide, 6 ft. 8 in. high and 20 ft. 1 in. long. Passenger door is at the rear, and compartment is completely separated by a movable bulkhead to allow loading flexibility.

Series 200 Argosy now is in production for Royal Air Force Transport Command. Unless RAF decides to order more than the 56 now scheduled, production will phase out by next summer.



# ***CENTRAL AFRICAN AIRWAYS*** ***chooses BAC ONE-ELEVEN***



**Mr. M. Stuart-Shaw,**  
Chief Executive and General Manager, Central African Airways  
says:

C.A.A.'s selection of the BAC One-Eleven for its short and medium haul inter-city services and for its routes between the territories of Central, East and South Africa has been made only after the most searching analysis—technical and economic—of likely aircraft for the onerous task of operating at comparatively high altitudes and high temperatures and into airports not all designed to take the largest jet aircraft.

C.A.A.'s need was also for an aeroplane which would provide a standard of passenger service—in speed, comfort, quietness and ease in flight and ground handling which would enable C.A.A. to hold its own with long haul jet operators over the Corporation's regional routes.

I am confident that in the BAC One-Eleven C.A.A. will have a jet aeroplane that the public, pilots, ground staff and financial controllers will like.

**BAC**

JET SUCCESSOR TO THE VISCOUNT WITH EVEN BETTER THAN VISCOUNT ECONOMICS

**ONE-ELEVEN**

TWO ROLLS-ROYCE SPEY TURBOFAN ENGINES

**THE SHORT HAUL JET**  
**BRITISH AIRCRAFT CORPORATION**  
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USA: BRITISH AIRCRAFT CORPORATION (USA) INC.,  
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## AIRLINE OBSERVER

► Protests against the recent proposal by United Air Lines' President W. A. Patterson for a one-class trunkline service (AW Oct. 15, p. 43) are another sign that the domestic trunkline industry is still a long distance from finding a pricing formula that will be acceptable to all airlines. Wide-spread differences on rates and fares within the industry has forced the reluctant acceptances on some promotional fares and caused others to be dropped. The single-class fare proposal undoubtedly will stir a flurry of counter proposals, none of which is expected to win unanimous industry support.

► Next big order for the BAC 111 twin-jet transport may come from American Airlines. American has drawn up specifications for the version it wants. If the order is placed, it will call for as many as 25 aircraft. Meanwhile, several local service carriers are showing active interest in the airplane. Braniff Airways is expected to increase to 18 its present order for six, plus an option for six.

► Russia and Sudan have formally signed a bilateral air transport agreement giving Aeroflot rights to fly Moscow-Khartoum with four-turboprop Ilyushin Il-18s. Sudan is the sixth African nation with which Russia has signed an air transport pact. Aeroflot says the Moscow-Khartoum run increases the Soviet carrier's total international route network to over 62,100 mi.

► Trans World Airlines equipment planners, told by the carrier's finance department to "assume" that funds will be available, are preparing a new evaluation of TWA's turbine freighter requirements. Canadair CL-44 is included in the study package, but airline officials favor pure jets to remain competitive with Boeing 320C turbofan all-cargo transports ordered by Pan American World Airways and American Airlines.

► First de Havilland Trident is being modified to lessen the hard ride given by present landing gear system due to bending forces on the oleo. A lever is being added to the suspension system to soften impacts, and will be included in all future production models. In addition, de Havilland has discovered that the inboard wing fence, installed on the Trident as a precautionary measure, is not needed. It will be removed, resulting in a reduction in drag.

► Lockheed Aircraft Corp., accelerating its effort to break back into the commercial field, is increasing research and development toward a supersonic transport and a practical VTOL aircraft, the two types of aircraft Lockheed feels will be the primary needs of the airline industry.

► Discussion has arisen in Military Air Transport Service circles about need for a large turbojet transport in the Douglas C-133 class. Some manufacturers are against bidding on the project if it develops, since the order probably would be for a small number and such a special mission aircraft would have no commercial application.

► Practicability of developing a bilateral air transport agreement with Red China is still being studied by Japanese government. Japan's foreign minister recently stated that the time is not yet ripe for a conclusion of an agreement covering air service between Tokyo and Peking. It is known, however, that a number of Japanese airline officials are anxious to begin such a service, but are deterred primarily by a government fear of straining U.S.-Japan relations. Possible loophole is Japanese attitude toward expanding trade with Red China; projected trade program will be justified on grounds that economics and politics are separable.

► Financial problems and internal differences on cargo equipment needs have stalled British Overseas Airways Corp. plans to order CL-44 freighters. BOAC officials term the order "dormant," not dead. Sources within BOAC feel the delay may result eventually in an order for pure jets. BOAC has spoken to Vickers about all-freighter potential of the VC.10. Lufthansa also is re-examining its interest in the CL-44 (AW July 23, p. 34).

## SHORTLINES

► Alitalia Airlines has expanded its all-cargo service from New York and Boston to Shannon, Milan, Turin and Rome to three weekly round trips with Douglas DC-7F all-cargo transports.

► American Airlines has repurchased a Ford Trimotor aircraft operated by a predecessor company three decades ago and contributed it to the Smithsonian Institution's Air Museum in Washington, D. C.

► British Overseas Airways Corp. has inaugurated a third weekly freighter service between New York and London using a Douglas DC-7 transport.

► Civil Aeronautics Board has postponed procedural steps in the U. S.-Caribbean-South American Route Case in compliance to requests by a number of participating airlines.

► International Air Transport Assn. technical committee will meet in Bangkok Nov. 27-30 in a regular session, but attention will be focused on navigation, communication and operational problems in the Bangkok area which, in recent years, has become a major hub of airline services in the southeast Asia sector.

► Northeast Airlines, in a flat challenge to Eastern Air Lines' Air-Shuttle, has asked CAB to approve a no-reservations tariff between New York, Washington and Boston at five cents per mile. Fares would be \$10 between Boston and New York and \$12 between New York and Washington, compared with Eastern's rates of \$14 and \$16 respectively. The rate would apply to tickets sold on a standby basis.

► Qantas Empire Airways has reported a profit of \$920,838 for the year ended Mar. 31, a slight increase over the net profit earned in the same period last year. Continuing profit was attributed by the carrier to reduced costs, which were said to be among the lowest in the industry.

► Swissair has begun its winter transatlantic schedule with eight weekly round trips out of New York and two weekly round trips out of Chicago and Montreal.

► Trans World Airlines has reported a 9.6% increase in revenue passenger miles in October compared with the same period last year. Cargo ton miles increased 24.4% in the same period.

## Simplified Power for V/STOL Aircraft

Bristol Siddeley lift/thrust turbofans are the optimum power units for all V/STOL applications, because the total thrust can be used for both lift and forward propulsion. They permit the simplicity of a single-engine installation or, used with separate lift engines, they provide a simpler and more economical solution than can be achieved with any combination of separate lifting and propulsion engines.

### SINGLE-ENGINE INSTALLATION

- \* Simplified installation.
- \* Simplified aircraft control.
- \* The resultant thrust and intake drag

passes through a fixed point near the aircraft centre of gravity.

- \* Maintenance and spares requirements are confined to one engine.
- \* Availability of a large power reserve for acceleration and manoeuvre.

### MULTI-ENGINE INSTALLATION

- \* Fewer specialised lift engines required as the total propulsive power is also available for take-off.

### SUPERSONIC FLIGHT

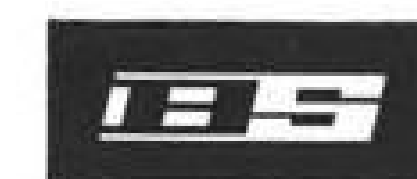
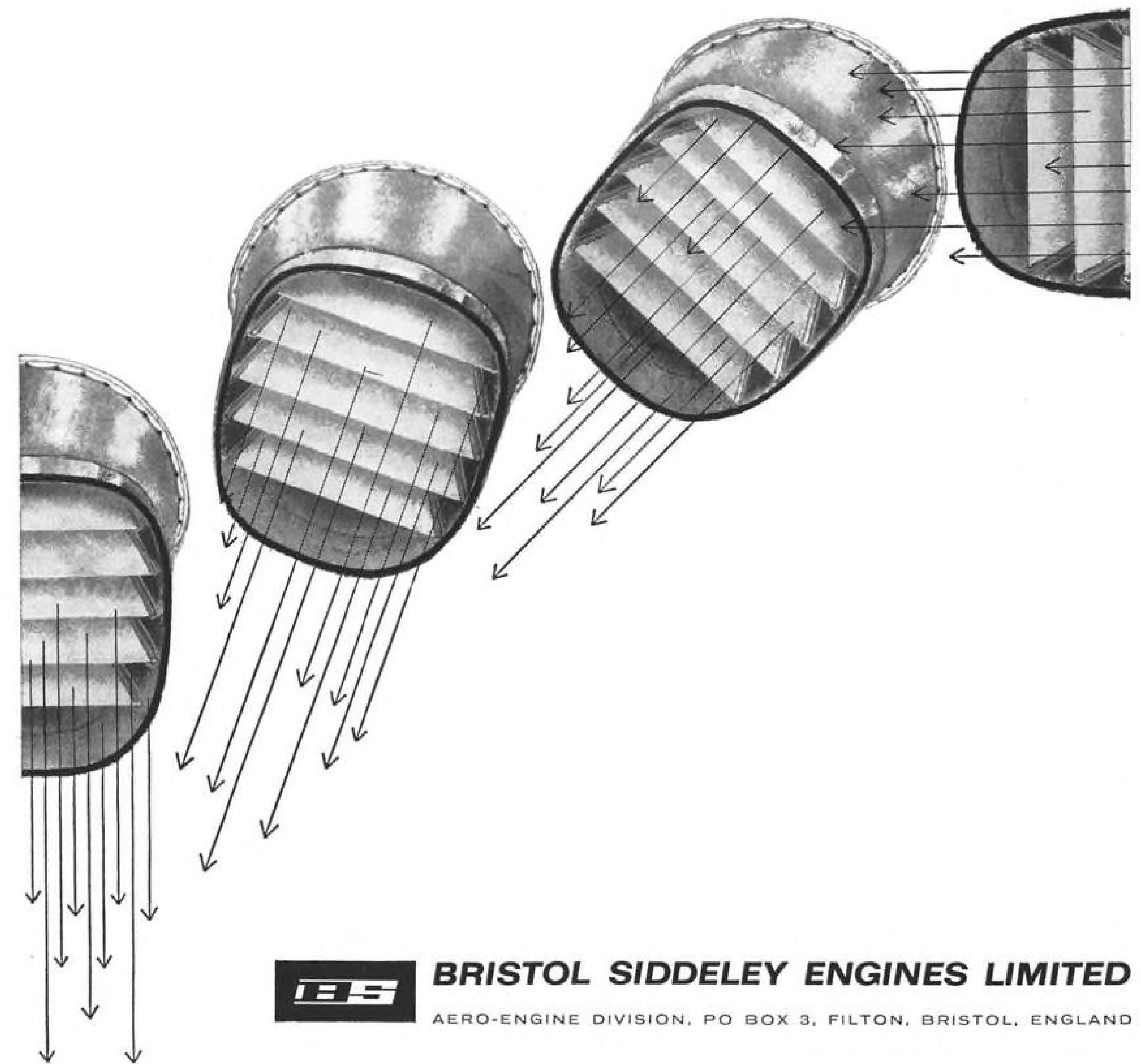
In Bristol Siddeley lift/thrust turbofans fuel can be burned in the by-pass ducting or plenum chamber to give a thrust boost for

take-off and supersonic flight. This plenum chamber burning permits:—

- \* A large thrust boost for supersonic speeds with only a modest increase in specific fuel consumption.
- \* Engine performance matched to aircraft cruise requirements.
- \* Greater thrust for transonic acceleration.
- \* Greater radius of operation.

These thrust boost advantages are achieved more economically by plenum chamber burning than by reheat in the hot exhaust gases.

The development of Bristol Siddeley lift/thrust engines is supported by the US Government through the Mutual Weapons Development Programme.

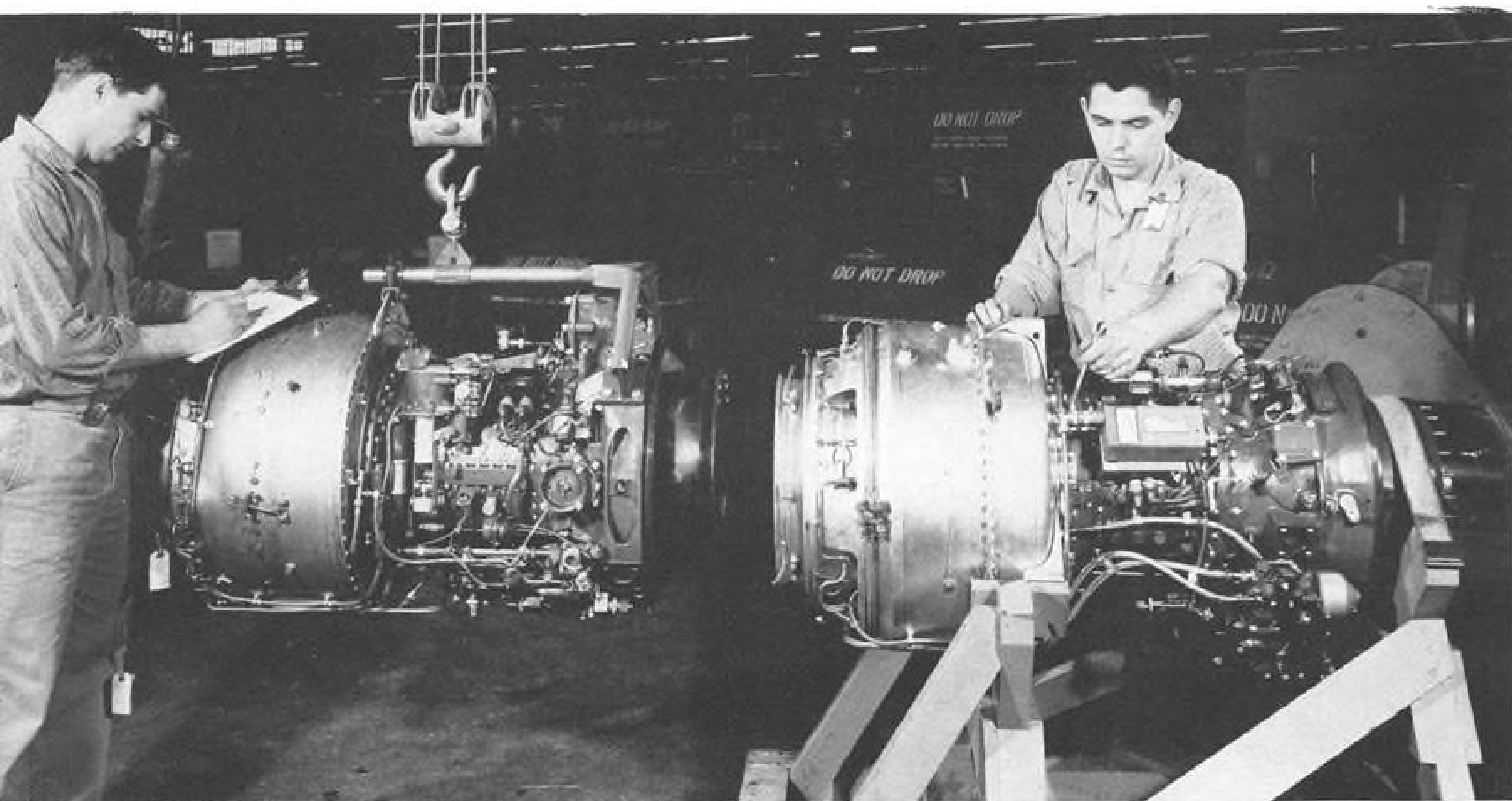


**BRISTOL SIDDELEY ENGINES LIMITED**

AERO-ENGINE DIVISION, PO BOX 3, FILTON, BRISTOL, ENGLAND



# AERONAUTICAL ENGINEERING



**MAJOR LYCOMING PRODUCT LINE** is a series of T53 and T55 gas turbine engines, typified by the T55-L-5 (left) and T53-L-1 (right). First of the T53 series to enter service, the -1 is rated at 860 military shp.; T55 series entered service at 2,200 military shp.

## Lycoming Plans to Develop Family of Gas



**PRODUCTION LINE FOR T53** turboshaft engines is shown from overhead, above left. Right, vertical test stand with operating T53 is used to check characteristics of powerplant through typical VTOL operations. Wing can be pivoted during engine run.



AVIATION WEEK and SPACE TECHNOLOGY, November 19, 1962



**PRODUCTION STANDS FOR T53 ENGINES** are shown at Stratford, Conn. Production rate of T53 versions is expected to increase by about two and one-half times and production rate of T55-L-5 engine also is expected to increase.

## Turbines for Aircraft, Industrial Uses

By David A. Anderton

Stratford, Conn.—Lycoming Division of Avco Corp. is developing its T53/T55 gas turbine series to increased ratings and expanded applications hopefully carrying a future price tag of \$25 per horsepower.

The division plans to stay with the "small" gas turbines, which range up to either 5,000 hp. or 5,000 lb. thrust and to develop in that range a family of engines for civil and military aircraft, industrial and marine powerplants.

Basis for the development program is the current series of T53 and T55 gas-turbine engines, being built in large quantity primarily as helicopter powerplants. Future engines will include turboshaft, turboprop and turbofan types, and will deliver horsepowers approaching the 4,000 mark, and thrust levels near 5,000 lb. With this improved performance will come reduced specific fuel consumption and improved power-weight ratios.

### Current Production

Most of Lycoming's current production of gas-turbine engines is in the T53 series, with the T53-L-7 and T53-L-9 the major items. Production rate of these engines, already high, is expected to increase by two and one-half times soon so that the line will be

turning out several engines per working day. Piled on this will be the increasing load of the T55-L-5 engine now in moderate production.

Lycoming built a large portion of its reputation on piston engines, and they still account for a good portion of the corporate income. But developments in the piston engine have leveled out, and today's engine represents just about the best the state-of-the-art will permit. Consequently, there is not much future research and development aimed at improvements in the piston engine.

But that background, plus the experience Lycoming has had as a prime producer of Wright engines, have taught company production men the ways to reduce costly processing of machined parts. Lycoming built more than 5,000 R1300 and R1820 piston engines under license from Wright Aeronautical Corp. They were produced for the lowest cost achieved in the entire production program for those engines, which were built in several locations including the Wright plants.

This kind of experience, plus the performance of its current crop of gas turbine engines, gives Lycoming engineers the basis for their predictions of more power for less cost.

They point to their experience on the T55 contract as one specific example of the division's capability. The

program was bid as a fixed-price contract for \$7.2 million, and it was probably the first engine to be financed that way in this country. Along the route the requirements were changed. The engine had to be qualified in a 150-hr. test, not a 50-hr. test. Its power was increased from 1,850 to 2,200 shp. for takeoff. It had started as a geared engine, and was to be changed to an ungear, highspeed output shaft engine. An integral oil system had to be incorporated.

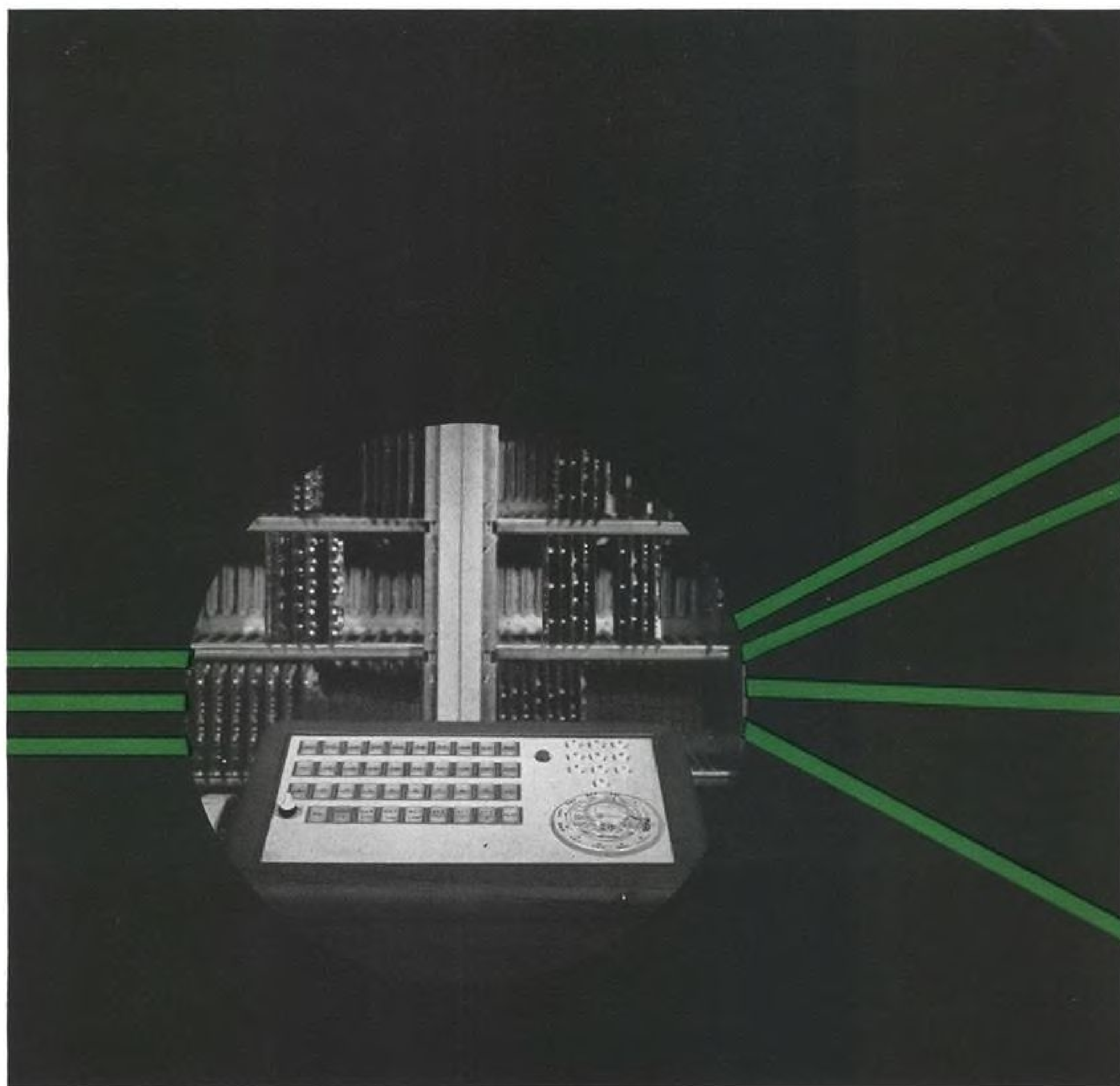
### Leftover Funds

At the end of the 150-hr. qualification, there was money left over which was returned to the government. Since then, the division has offered several other programs on a comparable basis with a fixed-price bid. Seven engines are now on contract with the division.

• **T53-L-1A and -1B**, powerplants for the Army's Bell HU-1A helicopters and the USAF's Kaman H-43B helicopters. In the Army -1A engines, the time between overhaul is 800 hr.; for the USAF -1B engines, that time is 600 hr. Engine has a military power rating of 860 shp., and a residual thrust of 102 lb., for an equivalent shaft horsepower of 901. Equivalent specific fuel consumption is 0.735 lb./hp./hr. The engine weighs 484 lb. dry.

• **T53-L-3**, powerplant for the Army's



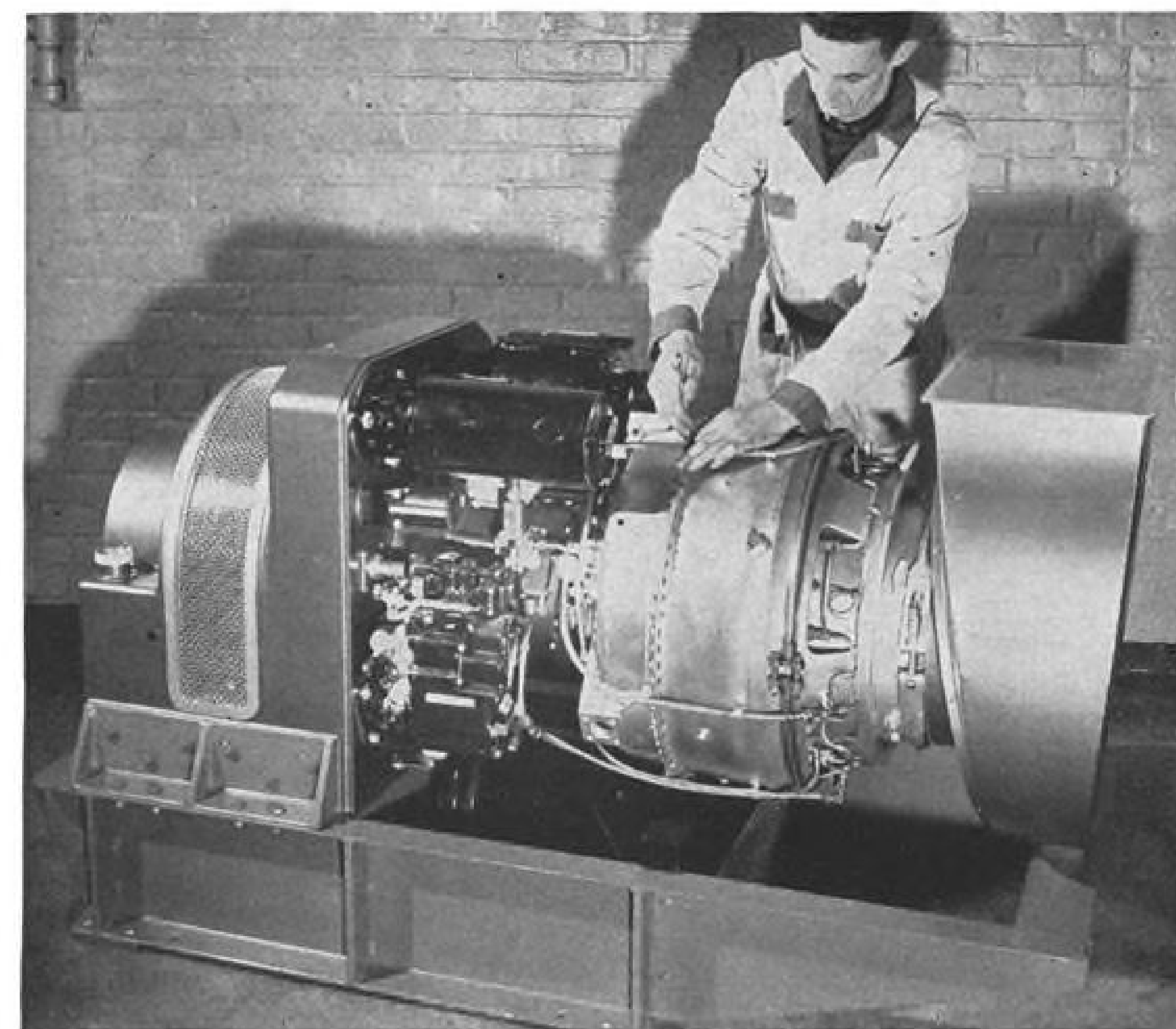


## K 1500 automatic electronic switching systems

The K-1500 series is designed for advanced communications use by government and the military. This fully transistorized two or four wire system combines the advantages of space division in the voice paths and time division in the control circuits. Replacing a roomful of sprawling equipment, the K-1500 series simplifies and expedites the switching of both vocal and coded data communications. The completely self-contained system occupies as little space as two 4-drawer file cabinets, operates on as little power as a television set, and can be installed in a matter of hours. The K-1500 is easy to operate; the color-coded, cordless attendant's console shows the operator what to do at any given time. The K-1500 is easily maintained; miniaturized solid state circuitry is on interchangeable printed circuit cards. The K-1500 is readily expandable, one of the many benefits of modular construction. The system can be expanded to accommodate any number of lines for intra unit and outside calls—and is not affected by environmental variations. Unique proven logic concepts and features assure that the K-1500 is ready, now, to do your communications job.

**ITT KELLOGG** COMMUNICATIONS SYSTEMS

A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION • 500 NORTH PULASKI ROAD, CHICAGO 24, ILLINOIS



**MARINE VERSION** of Lycoming gas turbine engine, aimed at applications to Navy amphibious vehicles, represents one of division's hopes for large future market.

Grumman AO-1 Mohawk. This engine has a 600-hr. TBO. It is rated at 960 shp. plus 113 lb. residual thrust for takeoff, for an equivalent shp. of 1,005. Equivalent sfc. is 0.655. The engine weighs 524 lb.

- **T53-L-5**, powerplant for the Army's Bell HU-1B helicopter. This version of the basic engine develops 1,005 eshp., but has a higher equivalent specific fuel consumption than the -3. Figure is 0.665 lb./hp./hr. The engine weighs 487 lb., and has a 400-hr. TBO.

- **T53-L-7**, powerplant scheduled for later versions of the AO-1. This engine has 1,150 eshp. for takeoff, with a corresponding specific fuel consumption of 0.641 lb./hp./hr. It has recently completed its 150-hr. qualification test. Dry weight of the powerplant is 540 lb.

- **T53-L-9**, powerplant for the Army's Bell HU-1D and which will become effective as powerplant for the HU-1B also. This engine carries the 1,150

eshp. rating for takeoff, with a corresponding specific fuel consumption of 0.652 lb./hp./hr. Dry weight is 485 lb. It has entered service with a 400-hr. TBO. This powerplant has been certificated by the Federal Aviation Agency as the T5309A, and will be used in the commercial Bell Model 204B.

- **T53-L-11**, powerplant to be phased into the Bell HU-1D. This engine completed its 150-hr. qualification last month at its design rating of 1,150 eshp. for takeoff. Equivalent specific fuel consumption was 0.652 lb./hp./hr.

- **T55-L-5**, powerplant for the Vertol Chinook helicopter and the Curtiss X-19 VTOL aircraft. This engine, which has completed a 150-hr. qualification at an uprated power of 2,650 shp., is normally rated at 2,280 eshp. military. Equivalent specific fuel consumption is 0.600 lb./hp./hr. Engine has a preliminary TBO of 150 hr., but



## PUMP PRIMERS

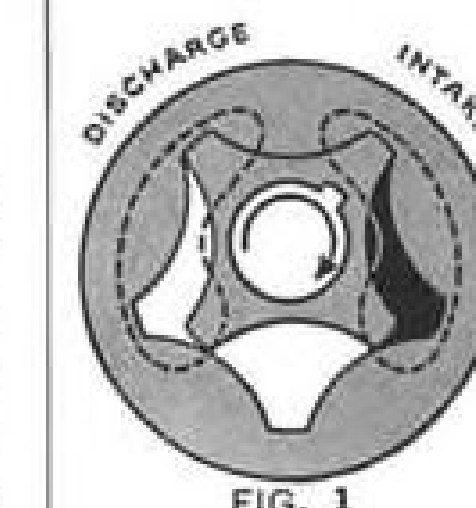
ARTHUR A. NICHOLS

### Better Pump Reliability In Severe Environments

► Engineers concerned with drives, auxiliary power sources, gear boxes and various transmission design problems involving pressure lubrication have found Gerotor type pumps extremely useful in their attempts to hold weight down and achieve maximum compactness with high service reliability.

► These pumps are positive displacement types inherently simple, valveless, balanced and quiet. In severe environments they prove exceptionally reliable.

► The Gerotor is a form of internal gear pump consisting of only two moving parts: an inner toothed element and an outer, meshing toothed element. The inner element has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the inlet port to the outlet. (See Figure 1). Pump capacity is measured by the volume of the "missing tooth" multiplied by the number of driver teeth and RPM.



► Low relative speed and closely held clearances between the two Gerotor elements mean high volumetric efficiency is maintained.

► Slow opening of the chamber as it traverses the large inlet and discharge ports results in avoidance of the sudden shock, rapid pressure change and turbulence which, in other types of pumps, results in foaming and lowered efficiency. Thus, Gerotor pumps offer exceptionally good performance at high altitude.

► Engineers find the Gerotor pump most attractive because there are several convenient variables that can be adjusted to meet the application requirements: Gerotor diameter which governs the area of the pumping chamber, Gerotor thickness, which, taken with area, determines unit volume per revolution and R.P.M. Thus, it is possible to vary the diameter, length and speed of the pump elements to secure wanted capacity. In addition, the porting of this type of pump is completely flexible in location, making for ease of fitting, adaptability to the available space and geometry of the engine structure.

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

**W. H. NICHOLS CO.**

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

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### Advanced T53 Engine Series

Lycoming Model	LTC1L-3	LTC1K-3	LTC1K-4	LTC1F-3	PLF2A-1
Type of application	Helicopter	Helicopter	Helicopter	Turboprop	Turbofan
Takeoff shaft hp.	1,445	1,100	1,400	1,400	—
Max. thrust, lb.	126*	104*	126*	126*	2,140
Output shaft rpm.	20,150	5,770	6,300	1,625	—
Dry weight, lb.	472	517	522	575	600

Remarks: In advanced research and development, running on test stands. Improved components, developed by Lycoming and government funding, are major features.  
\* Residual thrust.

Design Only





## TRANSACTER® Helps Keep Them Flying

Each U.S. Navy and Marine Corps aircraft is regularly updated and maintained in readiness by periodic induction into an Overhaul and Repair Department. Timely performance of the "O&R" mission presents fantastic scheduling and parts control problems.

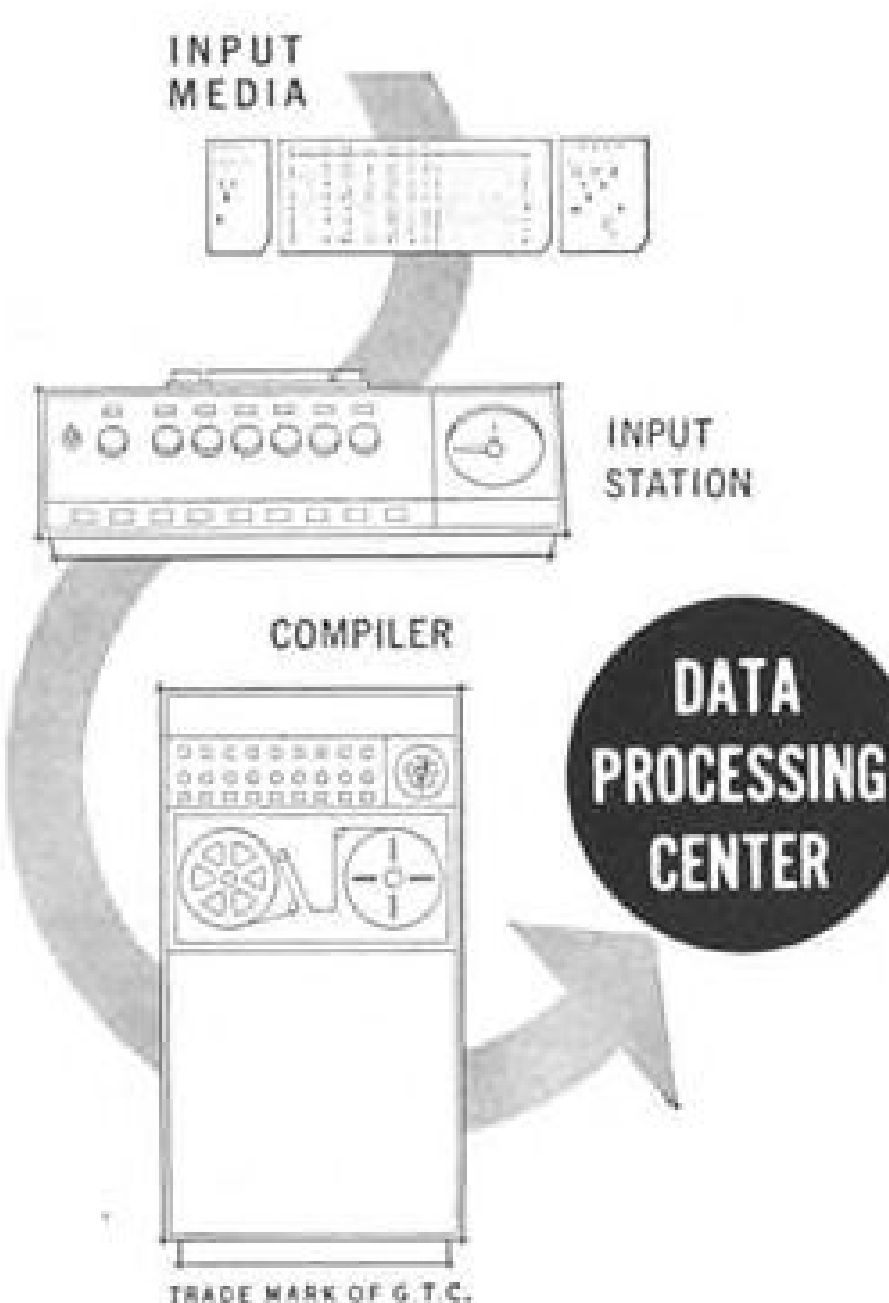
In addition to installations at Norfolk Naval Air Station and at Alameda and San Diego on the West Coast, the Bureau of Naval Weapons is currently installing the TRANSACTER Data Collection System in all Overhaul and Repair Departments.

In these vital defense areas TRANSACTER input stations — located throughout engine, air frame, instrument and avionic divisions — are continuously reporting overhaul progress and status in the interest of fast "turn around" and return to duty of the world's most effective manned Naval weapons.

Error-free data is recorded for accurate work load and labor distribution calculations and for quality control, stores withdrawals and material requirements. This indispensable data — continuously translated to punched tape by Stromberg Compilers — is immediately processed for control decisions by production supervisors and by top management. All directed toward maximum efficiency and the most productive use of the Taxpayer's Dollar.

Write for informative brochure, "The Missing Link in Your Chain of Command!"

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GENERAL TIME CORPORATION  
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specific engines have been run more than 675 hr. after a major overhaul without showing need for another tear-down.

Beyond these seven are 11 advanced engines, developments of both the T53 and the T55, which are, in varying degrees, available. Component development has been done for several (see boxes) and others have been run on the test stand. The primary objective now is to get orders for them.

Most interesting of the T55 developments in many ways is the LTC4G-3 turboprop engine rated at 2,535 eshp. This engine has been running for about one year now, using a split power gear system to distribute the loads on the gearing and improve the life of gears. In principle, the torque is fed from the highspeed engine shaft to a first stage of gears which transmit about one-third of the input power directly to the propeller shaft before it ever gets to the second stage of gearing. This reduces the loads on the second stage, so that the designer can then trade off weight for gear life. This Lycoming development is proprietary and patents have been applied for. All the work was company-funded.

### VTOL Test Stand

Lycoming has had a continuing program of testing engines in simulated VTOL operation, using a special test stand which can rotate the running engine through a range of positions corresponding to those expected in VTOL aircraft.

Work started with a YT53-L-3 engine mounted in a complete nacelle on

a stub wing section. The wing section was pivoted on the test stand so that it could be swung through the angles simulating transition from vertical takeoff to horizontal flight. The engine was somewhat modified to handle the different operational technique; the main bearings were sealed with positive-contact seals, and a scavenging pump was added to the accessory gear box to scavenge No. 3 and 4 bearings.

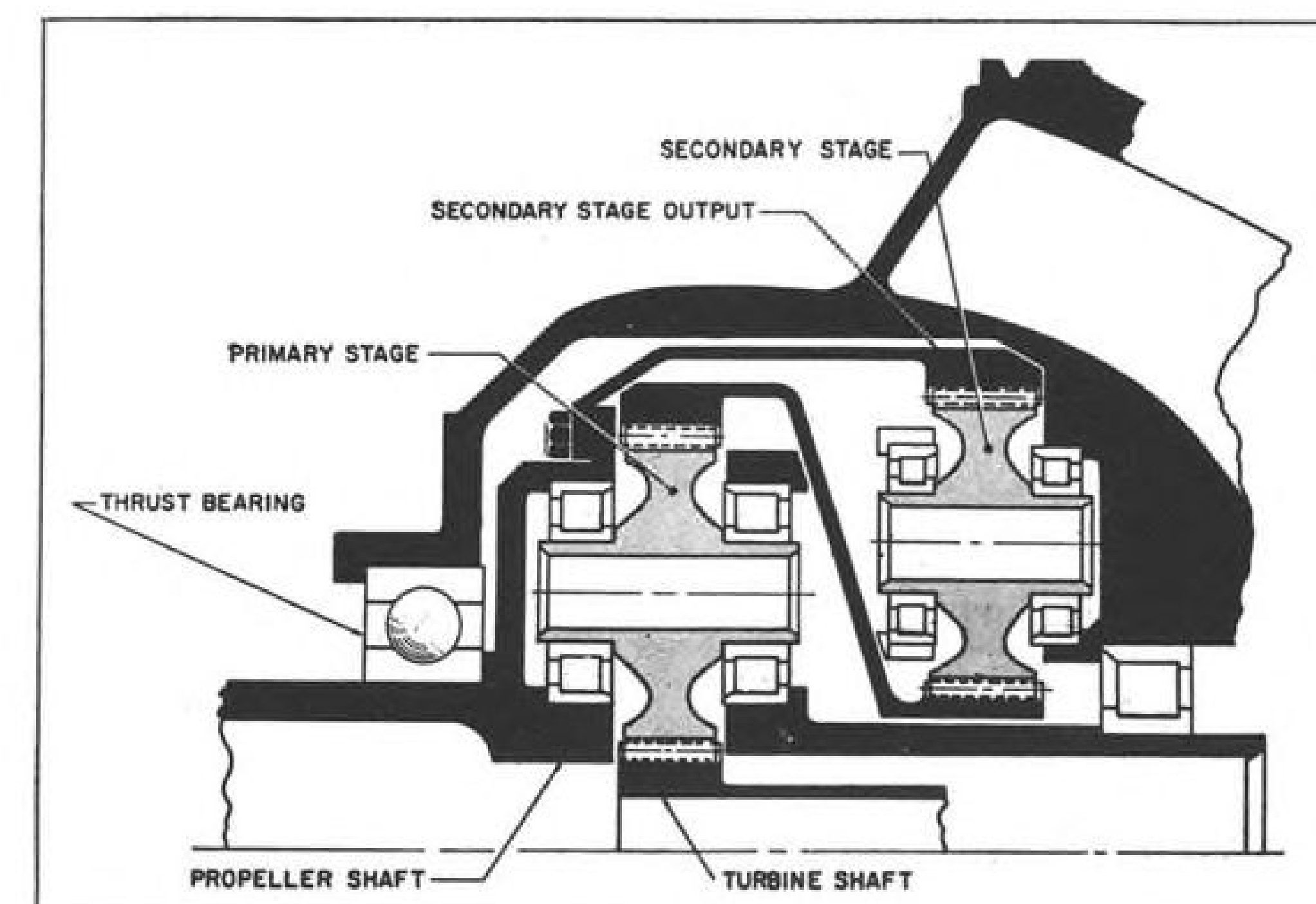
Apparently the only problem with the vertical operation of the engine occurred during shutdown; the engine smoked. Bearing temperatures were normal, there was no apparent increase in heat rejection to the oil. There no difficulties in starting the engine in a nose-up position or in intermediate attitudes between vertical and horizontal.

Lycoming looks to the marine and industrial market as a major future source of orders and income. One engineer close to the program believes the division will be doing one-third of its 1965-1966 business in this area.

Potential market is primarily Navy amphibious vehicles, and Lycoming sees the possibility of sizable orders beginning in about two years for engines for those kinds of vehicles. One estimate is that the number of powerplants for that market will equal the number of helicopter engines sold during the same time period.

The division is competing with both Solar and Pratt & Whitney, relative old-timers in the industrial gas turbine business. Both have sold numbers of their units for power systems.

Lycoming intends to work in the horsepower range between 1,000 and



**CROSS-SECTION** through Lycoming split-power gear system shows the layout of this different approach to gas-turbine gearing. Turbine shaft drives primary stage reduction gearing, which in turn drives a secondary stage reduction ring. Output from the secondary stage drives the propeller shaft through a large ring gear bolted to the shaft.

# LEWIS

## SELECTOR SWITCHES

for

- Resistance Thermometers
- Thermocouple Thermometers

### THERMOCOUPLE SWITCHES



Flanged Cases  
in 2 inch  
3 inch  
4 inch dia.

Engineered to give years of service in test work as well as in permanent installations, LEWIS switches have heavy, low-resistance contacts; positive detent action and sturdy terminals for easy wiring.

The cases are splash proof and dust tight, of close fitting bakelite. Husky black-finished aluminum indexing knobs are used to turn the stainless steel shaft supporting the rotating brushes.

### RESISTANCE BULB SWITCHES

A companion line of the same construction except that they are fitted with a common-terminal ring for three-wire bulb connections.

### THE 9S SERIES THE SPACE SAVERS

FOR AIRCRAFT RESISTANCE THERMOMETERS



Small, sturdy, steel-cased switches 1 1/4 inches in diameter, 2-9/32 inches total shaft length, one hole mounting with 1/2-32 NS-2A threaded bushing. Designed especially for connecting two or more resistance temperature detectors to one instrument, now flying in the modern jets.

Write for our descriptive bulletin on Selector Switches

**The LEWIS ENGINEERING CO.**  
Specialists In Temperature Measurement  
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## SPACE TRAVEL IS A PEOPLE BUSINESS

While space travel is a dynamic changing art encompassing all types of exotic vehicles and equipment, "people experience" in design and manufacture is of the utmost importance in fulfilling the critical missions of the space projects currently facing our nation. Tomorrow's spacecraft will need even further sophistication and the professional growth of people is absolutely essential. This growth is a never-ending challenge to Pacific Scientific Company. Pacific's Aerospace Division, located in the heart of beautiful Orange County, is currently working on mechanical and electromechanical components for space and missile programs that offer unlimited future and advancement for graduate design and sales engineers.

For those qualified men who seek the opportunity to demonstrate their talents, ambitions, and design capabilities, write:

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"An equal opportunity employer"



**LYCOMING T55 ENGINES** are assembled on this small line before being run and accepted. Rotatable holding fixtures are used for convenience.

2,000, with a possible stretch as high as 3,000 hp. if the engine can still be competitive at that rating.

The projects are based naturally on the T53 and T55 series of engines, which have been adapted for marine and industrial use by modification. Accessories have been moved to the top of the engine, for accessibility. There are new front-end and rear-end casings, the former containing the air inlet and screen. The industrial engines are designed around multi-fuel capability and are currently running on Diesel fuel.

Lycoming offers two current industrial or marine turbines:

- **TF-1460**, a marine version of the T53, rated at up to 1,200 hp. It weighs 1,200 lb., complete with accessories and gear box. It is currently the powerplant in the Lycoming LVH, a landing-force amphibious vehicle using a hydrofoil system.

- **TF-2036**, a marine version of the

T55, rated at 1,500 hp. It is being used as the powerplant for a vehicle competitive with the LVH, the Borg-Warner LVW, built around the planning-hull concept.

Lycoming work in the industrial field started about 20 months ago with an adaptation of the T55, and then the work later expanded to include the T53 engine.

The tendency of most observers is to concentrate on Lycoming's position as an engine manufacturer and to overlook the capabilities of the mass of machinery that makes the division. A major portion of its revenue comes from subcontracting, on the fabrication of large or difficult or unusual pieces or sub-assemblies, generally aimed at space or missile applications.

The Stratford plant currently is building the Mk. 4, Mk. 5 and Mk. 11 re-entry vehicle used on Titan 1, Minuteman and advanced Minuteman re-



## Navy Launches Q-2C

First launch of a Ryan Q-2C by Navy personnel at Pt. Mugu, Calif. is shown. Smoke is from 11,000-lb. thrust JATO unit. Missile was aloft 44 min.

spectively. These re-entry bodies were developed by Avco's Research and Advanced Development Division. One indication of the volume of work involved is the dollar value of the contract for the Mk. 11 body. Value is \$39,566,000.

## Minuteman Work

In addition, Lycoming is manufacturing second-stage rocket motor chambers for the Minuteman for delivery to Aerojet-General. These chambers are now being built from both steel and titanium; but indications are that the titanium will be standardized at some point in future production. Work involves production of the cylindrical can section, and both upper and lower closure sections.

However, the work does not include the nozzle.

At one time, Lycoming was producing

casings for all three stages of the Minuteman, plus the Mk.5 re-entry vehicle. It has now phased out of some of that work, including the production of second-stage casing for the Polaris missile and work on the Nike-Hercules and the Talos.

## Rocket Motor Chambers

Now on the shop floor, in addition to Minuteman production, are rocket motor chambers for the acceleration rocket of the X-20 Dyna-Soar. These are not too different from a compacted Minuteman second-stage casing. The division is also building nose and center body sections for the Martin Bullpup missile.

Lycoming is also a subcontractor to Wright Aeronautical Division on the first-stage Minuteman motor casings, supplying complete disassembled chambers to the company. Also in production are spherical rocket motor chambers being built for Thiokol. The rocket motor chambers eventually will be used in the Surveyor space vehicle.

Large portion of this type of work is done with a bank of three-dimensional milling machines controlled by punched tape, IBM card, or template. There is a long aisle of these machines in the Stratford plant, probably the largest group of these machines in the United States.

Lycoming has also won a reputation as a developer of fabrication techniques. One current contract, recently received from Aeronautical Systems Division of Air Force Systems Command, calls for the hot-spinning of some 4-ft.-dia., 10-ft. long cylinders made of high-strength steel, spun in the metastable austenitic condition.

These cases are the same size as those for the second stage of the Minuteman ICBM.



## Hercules Shows STOL Capability

Modified Lockheed C-130B Hercules transport demonstrates its short-field capability by taking off from rough field over obstacle. Modifications include increased flap operating rate and deflection, increased rudder and aileron chords and addition of a drag parachute in box under the rudder.

## Advanced T55 Engine Series

Lycoming Model	LTC4B-8	LTC4B-9	LTC4G-3	LTC4K-2	PLF1B-1	LTC4M-1
Type of application	Helicopter	Helicopter	Turboprop	Helicopter	Turboprop	Turboprop
Takeoff shaft hp.	2,500*	2,600	2,445	3,400	.....	3,325
Max. thrust, lb.	225*†	233†	225*†	220†	4,650	220†
Output shaft rpm.	15,000*	15,000	1,270	16,000	.....	1,365
Dry weight, lb.	570	630	795	620	850	850
Remarks	Growth T55	Growth T55	Split-gear system	Advanced T55	.....	K-2 with split power gear

\* Military rating; takeoff not available.

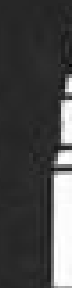
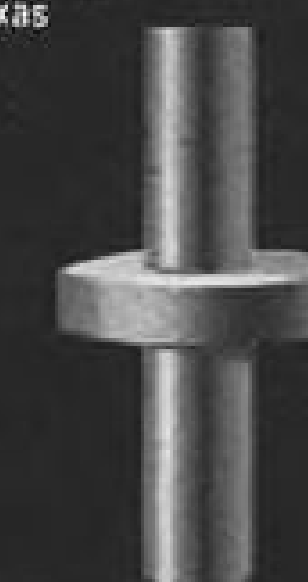
† Residual thrust.

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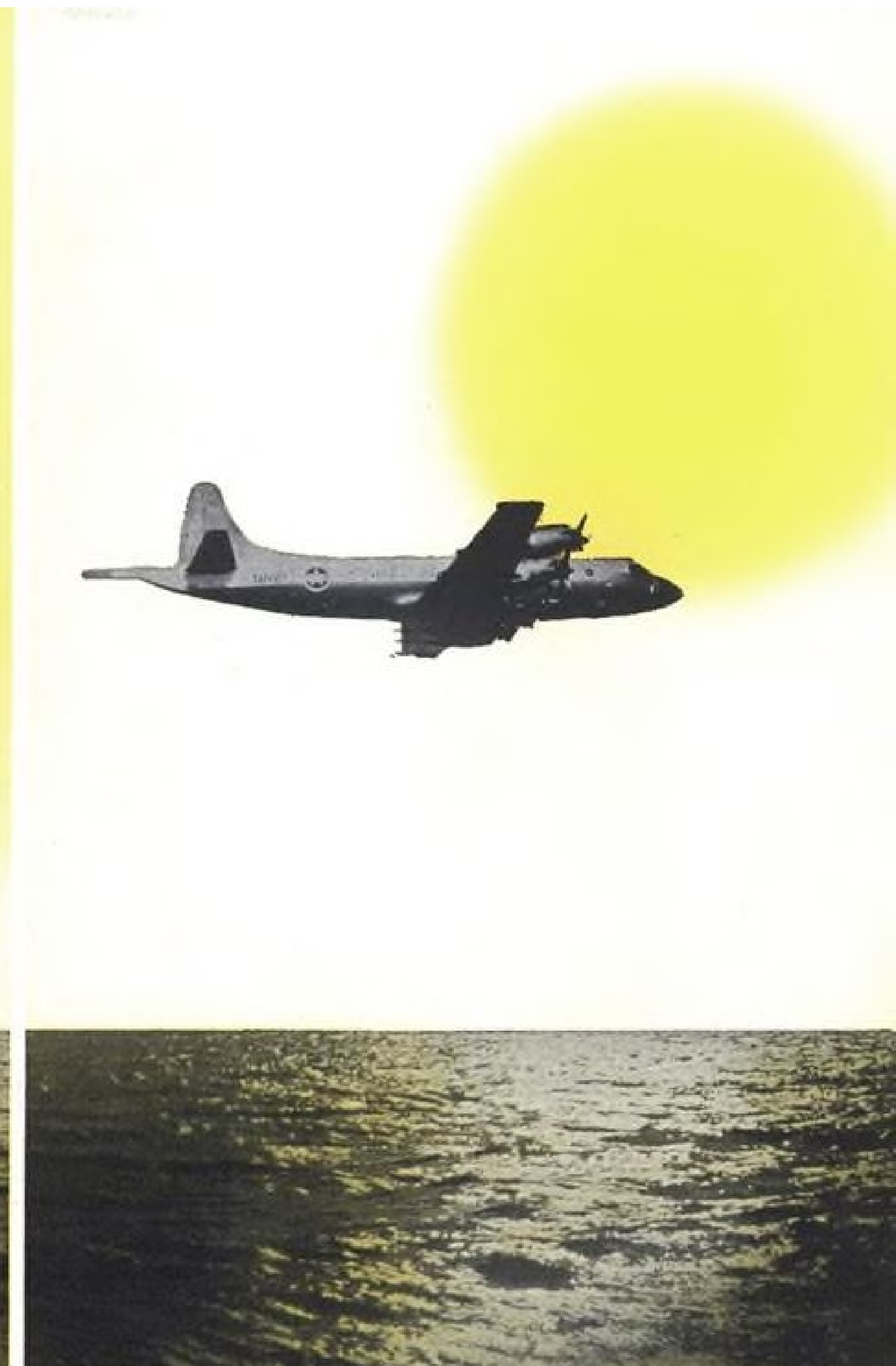
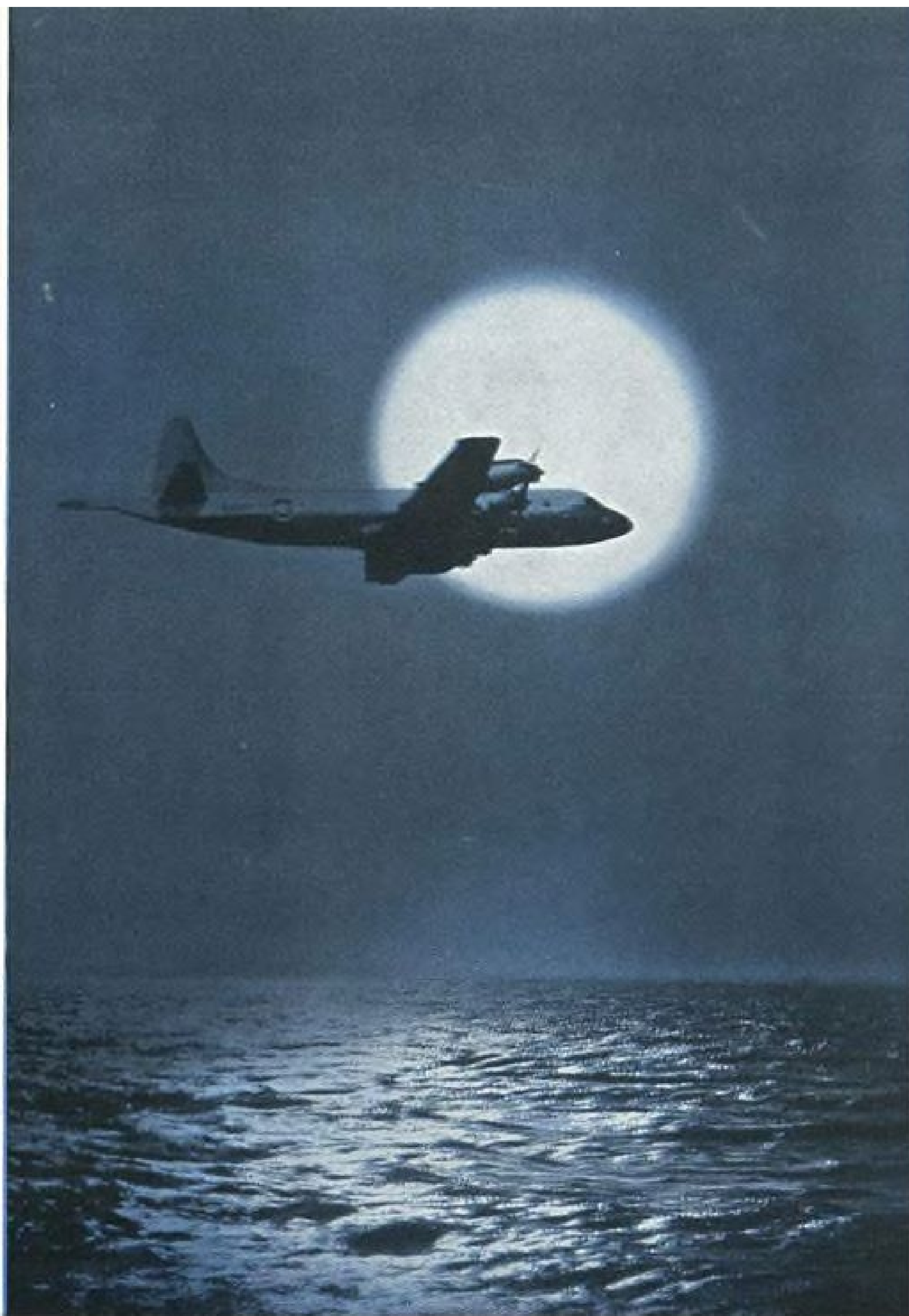
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## ON WATCH:

The Navy's anti-submarine warfare task is no longer confined to protecting our ships from enemy raiders. Now our cities—even those far inland—face potential danger from sub-launched nuclear missiles. Helping the Navy maintain alert watch over America's more than 14,000 miles of coastline—as well as the vital sea

lanes of the world—is the Lockheed P3V Orion. The big 400-knot Orion is the deadliest combination of men, electronics, and armament ever pitted against a submarine.

The P3V Orion is just one way Lockheed is working to help the Navy in its fantastically complex job of detecting, locating, and tracking hostile submarines.

## the Navy's new P3V roams vast reaches of the sea to keep hostile subs at bay

Six of Lockheed's divisions are deeply immersed in ASW and related phases of oceanography. Lockheed researchers are probing subjects like underwater-sound propagation and scattering; temperature gradient effects; sound transmission through the interface of the ocean and the atmosphere; and sea-bottom

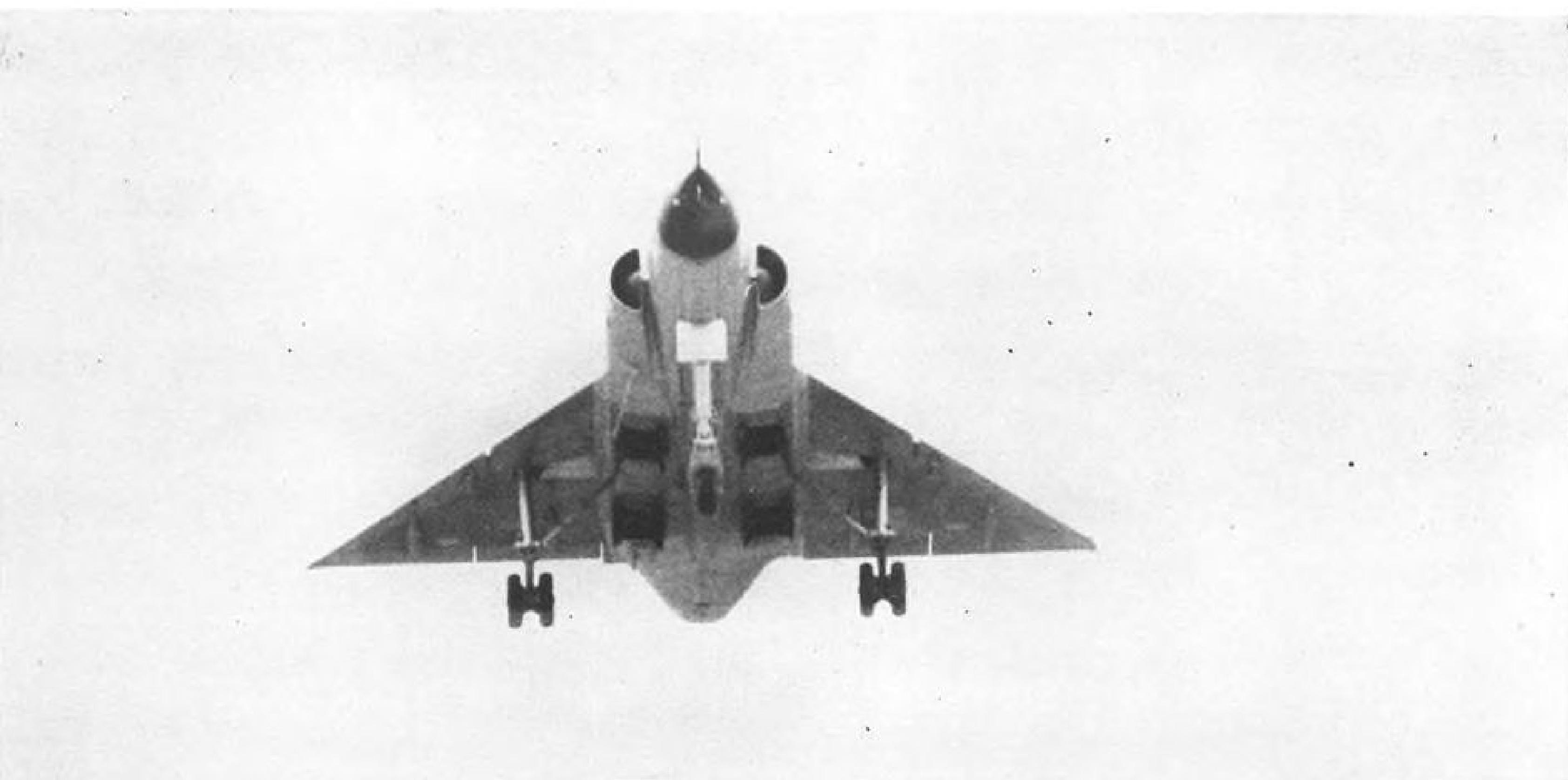
effects on sound transmission. They even record and analyze the sounds made by undersea creatures.

Lockheed's Anti-Submarine Warfare and Ocean Systems group coordinates a corporation-wide effort that runs broad and deep—from the depths to the surface to the aerospace above.

**LOCKHEED-CALIFORNIA COMPANY**

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## Final Balzac Testing Scheduled for April Completion

First Balzac transitional flights from vertical takeoff to horizontal flight will begin in February. Complete testing of this phase will be completed by April. Aircraft recently completed its initial free flight test phase (AW Nov. 12, p. 39) and now will be grounded for about a month while temporary gear shown in these photos will be replaced by normal retracting gear so that conventional flights can proceed. During free flight VTOL tests, Balzac lifted off its pad, a grill-covered pit, rose to an altitude of 150-200 ft. and hovered in that position. Handling performance of the aircraft appeared smooth and deliberate to ground observers. Free

flight was made Nov. 6 at Melun-Villaroche near Paris. Aircraft was piloted by Dassault's test pilot Rene Bigand. Note lowered doors on belly of Balzac in top photo for RB.108 engines which power the aircraft (AW July 30, p. 19). As speed increases, the spring-loaded louvers are closed and, after transition, is completed, the doors are closed to a flush position. Inlet ducting for the horizontal propulsion system in the Balzac is diverted by an S-shaped ramp into the fuselage to permit positioning of the lift engines just aft of the inlets in the intake fairings. Test personnel in bottom photo are garbed in fire-resistant uniforms.



## NASA Stresses Conventional Alloy Use for Supersonic Transport Skin

By Donald E. Fink

New York—Heat and stress forces anticipated on the skin of the proposed U.S. supersonic transport will have to be met with conventional alloys, since testing requirements of more exotic metals cannot be met in the projected time schedule.

This was the opinion George C. Deutsch, of National Aeronautics and Space Administration's Office of Advanced Research and Technology, expressed to the National Metal Congress here recently.

Deutsch based his remarks on findings of NASA's Special Committee on Materials for the Supersonic Transport—joint activity of NASA, the Federal Aviation Agency and the Defense Dept.—which has proposed a development schedule calling for first flights by mid-1967.

Deutsch listed five basic design concepts which will affect final selection of specific alloys:

- Supersonic transport will have a skin area of 15,000 to 20,000 sq. ft., depending on the design (AW July 2, p. 214).
- It will be subjected to temperatures ranging from 600F on the nose section up to 1,200F near the engine exhausts, with as much as 15% of the airframe in the higher temperature realm on some designs.
- Ambient temperature levels experienced during the initial and final phases of flight may reach as low as -60F at 70,000 ft.
- When the SST reaches its peak speed performance of Mach 3-3.5, transatlantic flights will take about 2½ hr., making possible four ocean crossings a day and exposing the skin to four extreme thermal fatigue stress cycles per day.
- To guarantee a return on the high cost of the SST, an airframe operating life of 30,000 to 50,000 hr. over a 10-year period must be sought.

### Test Program

To program for such a life span, 30,000-hr. tests should be started as soon as possible on certain alloys to determine what loads they can bear for that length of time and what strength they have left afterwards.

"Unfortunately, with the alloys under consideration, we cannot with any reasonable degree of assurance predict life or retained strength after 30,000 hr. from short time tests," Deutsch said. "This means it will take us 30,000 hr., or a little over three years of continuous testing, to gather this data. If the pro-

posed time schedule of flights by mid-1967 is to be met, such tests should be started very soon."

Another factor in the SST operation which will affect the choice of skin material is the corrosive environment to which it will be exposed, Deutsch said. Most of the airports from which it will operate are near oceans, many are in northern latitudes where salt is used to assist snow removal from runways, and a large portion of its operations will be over oceans.

### Stress Forces

Stress forces acting on the skin, however, represent an area in which the most unknowns exist, Deutsch said. Since the total stress on a component is a complicated resultant of the thermal, vibratory, direct load and maneuver stresses, it is unlikely that these will be precisely defined until the aircraft is actually test flown. Stress values of 25,000 psi. for titanium alloys and 40,000 psi. for steel are reasonable first approximations, however, he concluded.

Since the time schedule will not allow for development of new alloys to meet these requirements, Deutsch said, skin material for the SST will have to come from present alloys or slightly improved versions.

Exotic alloys, such as beryllium, have been suggested, but they do not meet all the requirements and time does not allow their further development. The field, therefore, is narrowed to the four conventional materials: aluminum, tita-

nium, stainless steel and super alloys, he said.

Comparing these metals, Deutsch said aluminum alloys do not retain their strength above 350F and can be considered for use only on transports in the Mach 2 or 2.4 range, in which French and English designers have expressed interest (AW Sept. 10, p. 151). Aluminum's advantages of lightness, formability and low cost make it an attractive material, however, and have induced some thinking about the use of an oxide dispersion hardening process to give it strength qualities closer to steel.

Deutsch said that even though the SST probably will operate first in the Mach 2 or 2.4 range until engines capable of pushing it to Mach 3.5 become available, the same basic aircraft structure will be used in all phases of the development.

"For this reason, the materials selected for the initial slower version must be capable of withstanding the heat and stress expected in the Mach 3.5 range," he added.

### 67 Alloys

In the three remaining metal classes, Deutsch said, 67 alloys show promise, but since the SST program to date is concerned primarily with proving the feasibility of constructing the airplane, no attempt has been made to single out specific alloys as being most suitable. The alloys have been classified in general groupings, however, on a strength-to-weight ratio basis.

"The strongest alloy on this basis is AM 355 precipitation hardened stainless steel in the XXH condition" Deutsch said, "but all 67 alloys have strengths which make them attractive."

Deutsch said "V-36 cobalt base super

## SHEET MATERIALS CONSIDERED IN THE SST SCREENING PROGRAM

STEELS	TITANIUM ALLOYS	SUPER-ALLOYS
AM350 CRT	α ALLOYS	NICKEL BASE
AM350 SCT	TI 6Al 1Mo 4V	RENE 41
AM355 CRT	TI 5Al 2.5 Sn	INCONEL 718
AM367	αβ ALLOYS	R 270
PH 15-7 RH 1050	TI 6Al 4V	INCONEL W
PH 15-7 CH 900	TI 4Al 3Mo 4V	INCONEL X
PH 14-8Mo SRH 950	TI 5Al 2.75Cr 1.25Fe	D 979
AISI 301; CR34, 51, 60%	TI 8Al 10V	WASPALLOY
	β ALLOYS	INCO 901
	TI 13V 11Cr 3Al	COBALT BASE
		L 605
		V 36
		IRON BASE
		A 286
		N 155



# Titanium

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*7,000 gallon tank open way to*

Titanium can hold more liquid hydrogen at less tank weight than any other metal, and still give you impermeability to hydrogen, generous elongations and notch toughness down to minus 423F.

In brief, titanium thus becomes the easiest way ever devised to buy more payload. And titanium can be used to produce tankage of unlimited size. Here's proof:

1. Beech Aircraft has successfully hydrostaticated a 7,000 gallon welded titanium tank, produced under an Edwards AFB contract.
2. Titanium Metals Corporation of America has introduced titanium alloy compositions modified especially for liquid hydrogen service. You'll have to know as much as possible about them — as fast as possible — to keep ahead of the LH<sub>2</sub> field. TMCA can help you here.

**One-third lighter than stainless.** The Beech titanium test vessel measures eight feet in diameter by 24 feet in length. Although its weight is classified, it weighs almost one-third less than a theoretical optimum stainless steel alternate.

The success of the titanium test tank — the largest assembly of its type yet built — makes even larger vessels practical. It was fabricated from sheet supplied by TMCA to less than AISI tolerances, in thicknesses ranging from 0.014 to 0.025 inches. Beech reports that the weight of this titanium test vessel could be reduced by 50%, by using even lighter-gage sheet and designing with titanium's high strength and ductility at liquid hydrogen temperatures.

**Titanium grades for liquid hydrogen.** Titanium Metals Corporation of America has introduced two grades of titanium modified specifically for service at liquid hydrogen temperatures. They are the "ELI" (Extra-Low Interstitial) grades, Ti-6Al-4V and Ti-5Al-2.5Sn. The Beech tank was produced of Ti-6Al-4V ELI. Both alloys have strength-to-weight

Table I — Typical Tensile Properties of Ti-5Al-2.5Sn ELI

	Test Temperature		
	70 F	-320 F	-423 F
Yield Strength, psi	102,000	168,000	206,000
Tensile Strength, psi	117,000	181,000	229,000
Elongation, %	16.5	16.0	15.0
Notched Tensile Strength, psi	155,000	228,000	233,000
Notched/Unnotched Ratio	1.38	1.26	1.03

K<sub>t</sub> = 6.3

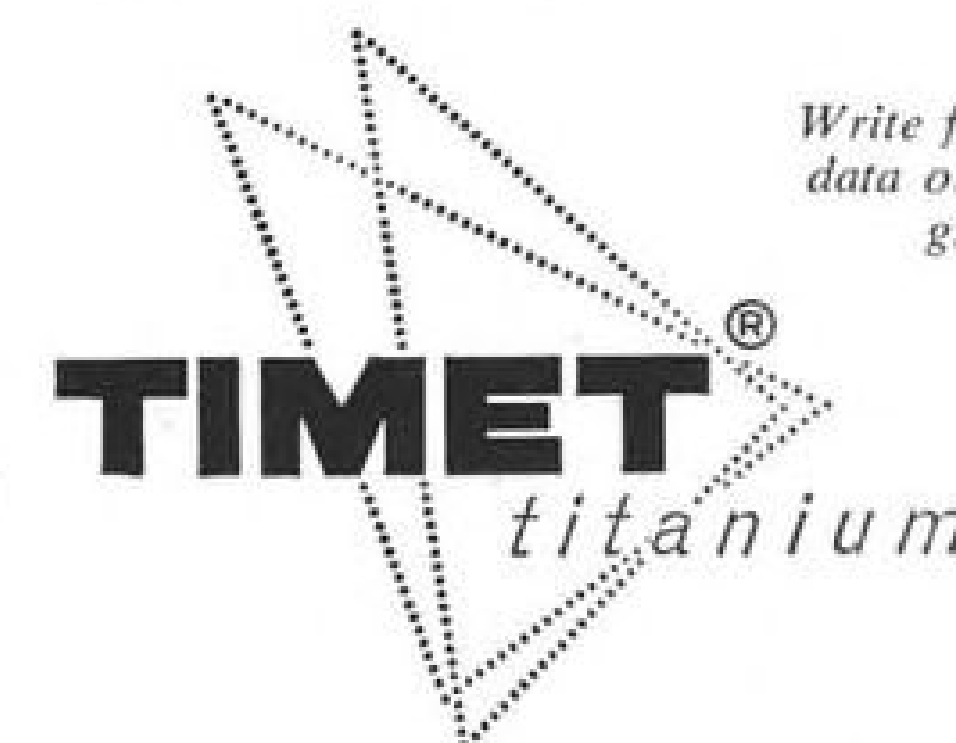
Table II — Typical Tensile Properties of Ti-6Al-4V ELI

	Test Temperature		
	70 F	-320 F	-423 F
Yield Strength, psi	127,000	202,000	248,000
Tensile Strength, psi	135,000	218,000	263,000
Elongation, %	14.0	13.0	7.0
Notched Tensile Strength, psi	165,000	206,000	211,000
Notched/Unnotched Ratio	1.22	0.94	0.80

K<sub>t</sub> = 6.3

ratios at cryogenic temperatures that are superior to stainless steel and aluminum (see Figure 1). At the same time they retain toughness — a feat that few materials can approach. Control of interstitials also enhances the rolling characteristics of the grades in production of wide, thin sheets needed for LH<sub>2</sub> programs. For example, material is now available in such representative sizes as 0.014 x 36 in. x coil and 0.020 x 40 x 120 in.

**TMCA your best bet in titanium.** The best bet today for cryogenic vessels in high-energy missiles is titanium. Its successful fabrication in large tankage, such as the Beech unit, underscores the fact that thin-gage titanium sheet is here. And if your best bet is titanium, then TMCA is your best bet in titanium. TMCA is the nation's only company devoted exclusively to titanium and is the only organization with the experience provided by an unbroken history of full-time technical assistance.

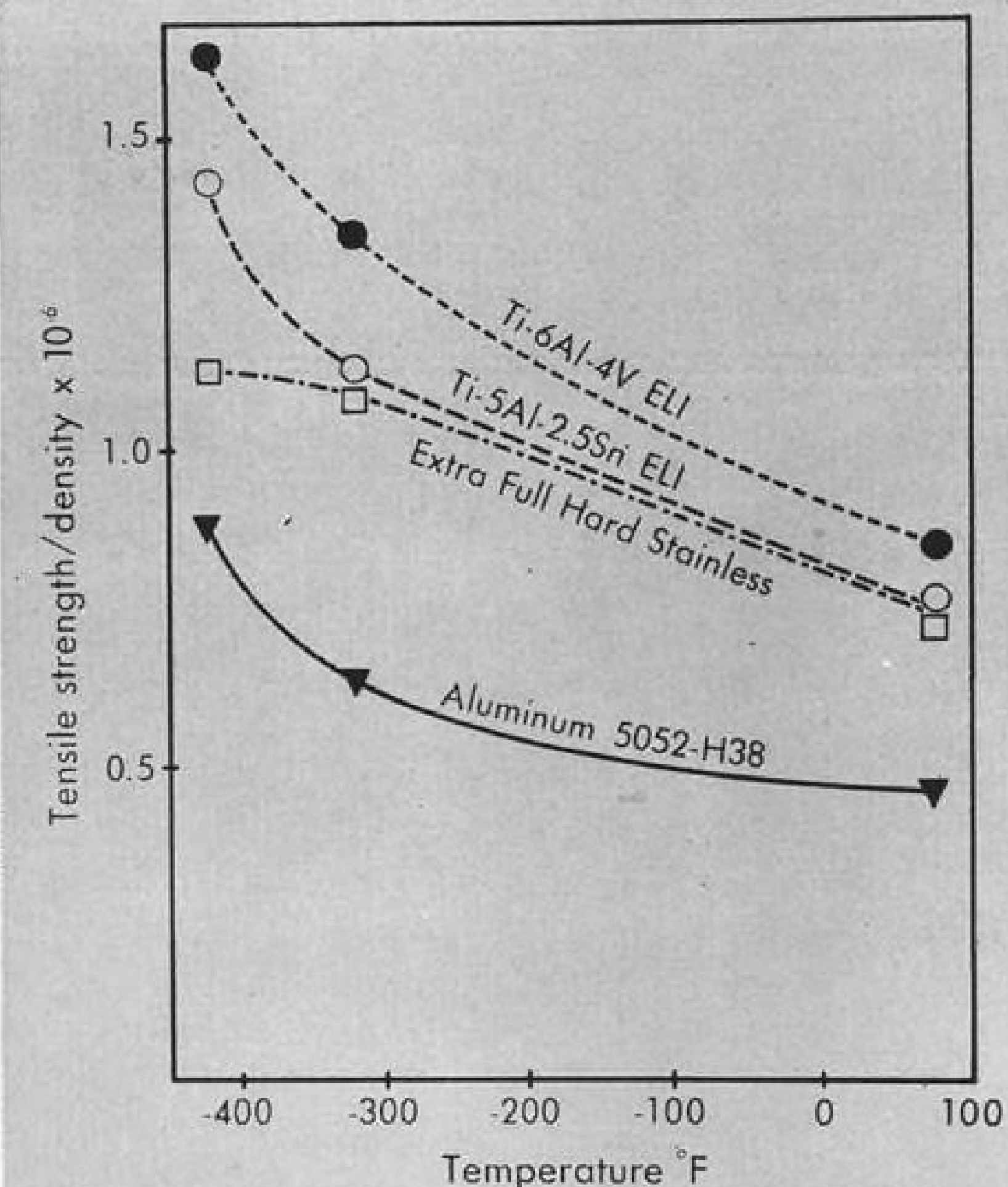


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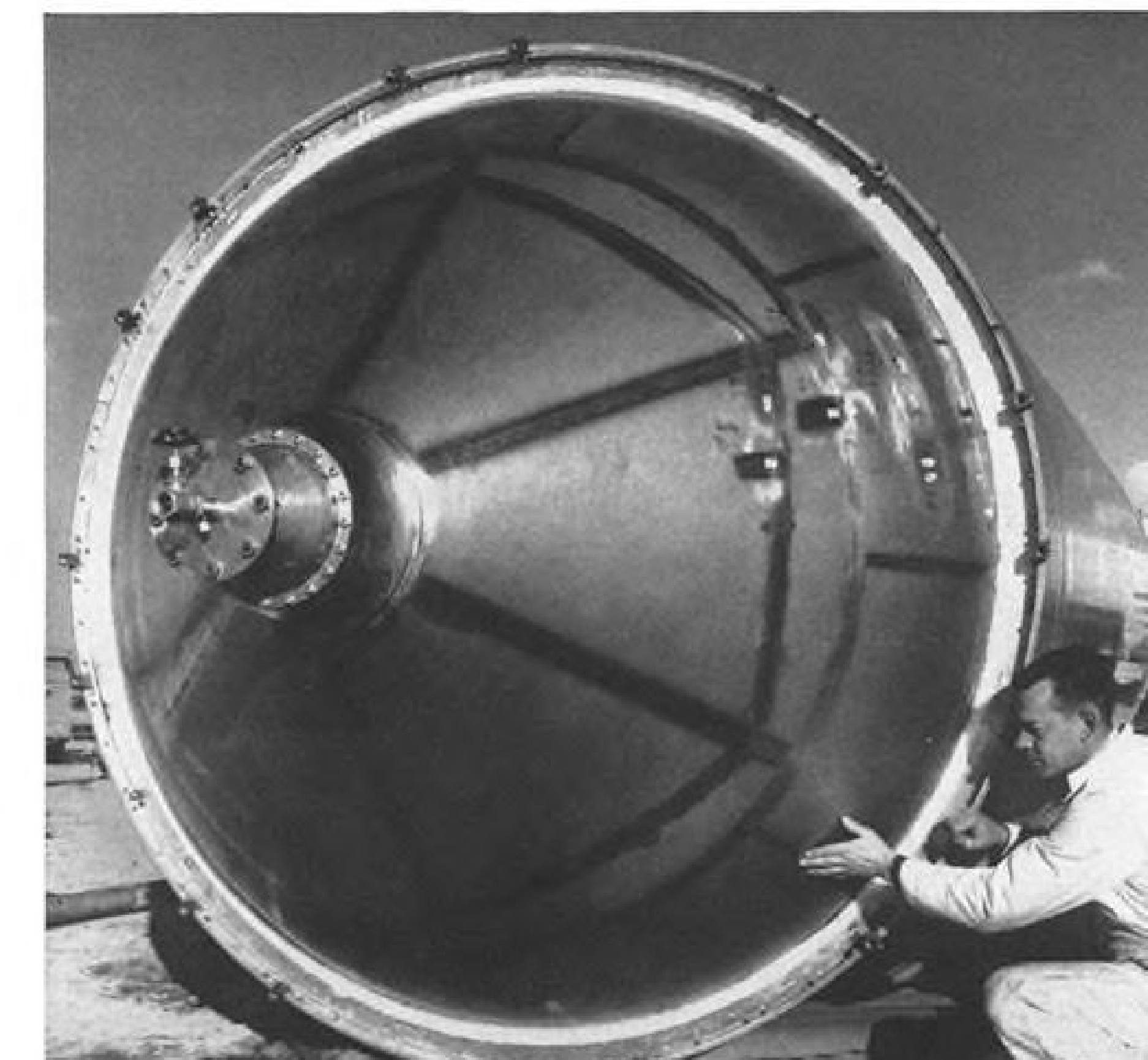
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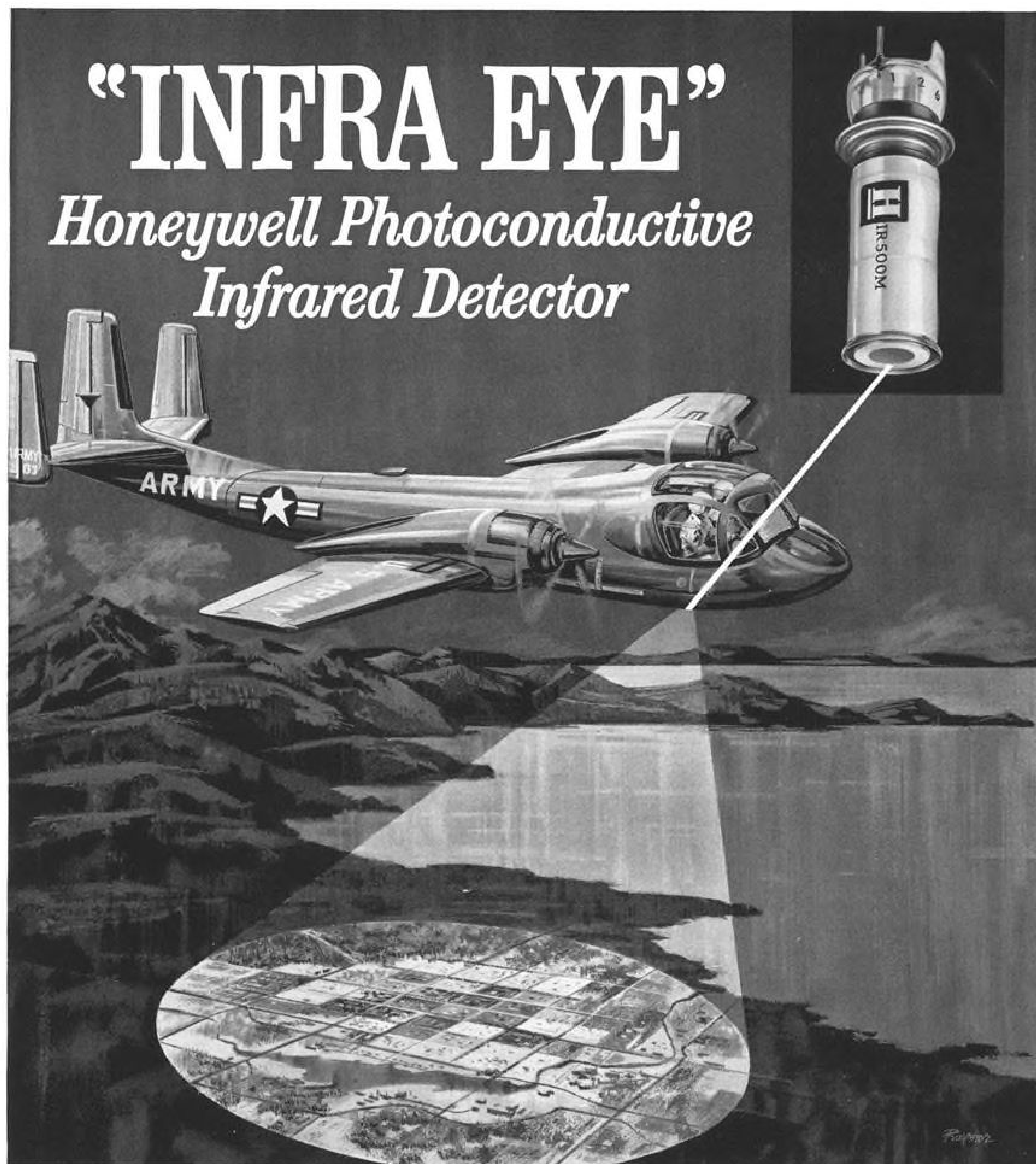
Comparison of strength-to-weight ratios of aluminum, stainless steel and titanium

**Figure 1.** Curves show superiority of new ELI grades of titanium to stainless steel and aluminum, on a strength-to-weight basis. Called Ti-5Al-2.5Sn ELI and Ti-6Al-4V ELI (for extra-low interstitials) the new cryogenic titanium grades also retain toughness at low temperatures and impermeability to hydrogen.

**Largest titanium assembly ever made,** the 7,000 gallon test vessel designed and produced by Beech Aircraft, measures 8 feet in diameter by 24 feet in length.







New capabilities in pin-point photo-reconnaissance are now made possible by Honeywell's Photoconductive IR Detector. Systems utilizing the high responsiveness and detectivities of this unique indium-antimonide detector produce highest resolution infrared maps.

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alloys, cold reduced to 60%, for example, compare favorably with the more common materials."

NASA has had a program under way for about 1½ years to compile data on most of the alloys under consideration. Deutsch briefly outlined some of the basic findings for each of the three categories:

- **Steel**—Precipitation hardened stainless steels can be produced with tensile strengths as high as 300,000 psi. in the cold-worked condition. These are rated at top temperatures of 900F, but tend to be limited by their creep strength. Stainless steel AISI-301 is one of the more promising because of the very high strength obtained when it is cold reduced to about 60%.

- **Titanium alloys**—These alloys generally are considered to have top temperature use of about 800F and afford ample safety margin for use on portions of the SST. Typical alloys in the alpha, alpha-beta and all beta categories are included, with the highly stable alpha alloys showing some superiority.

- **Superalloys**—These nickel, cobalt and iron base alloys at first do not appear suitable because they are expensive and difficult to form, particularly in the cold reduced condition in which their best properties are obtained. The alloys were designed for very high temperatures, however, and therefore will have application in the hot exhaust areas. Their stability and chemical inertness also make them attractive for use in the 500 to 600F areas as well.

"Ideally we would like to list the airplane requirements, compare them with the mechanical properties of each alloy and make a selection on that basis," Deutsch said. "Unfortunately, very little mechanical property data exists today for these materials, especially for the life span and temperature range involved."

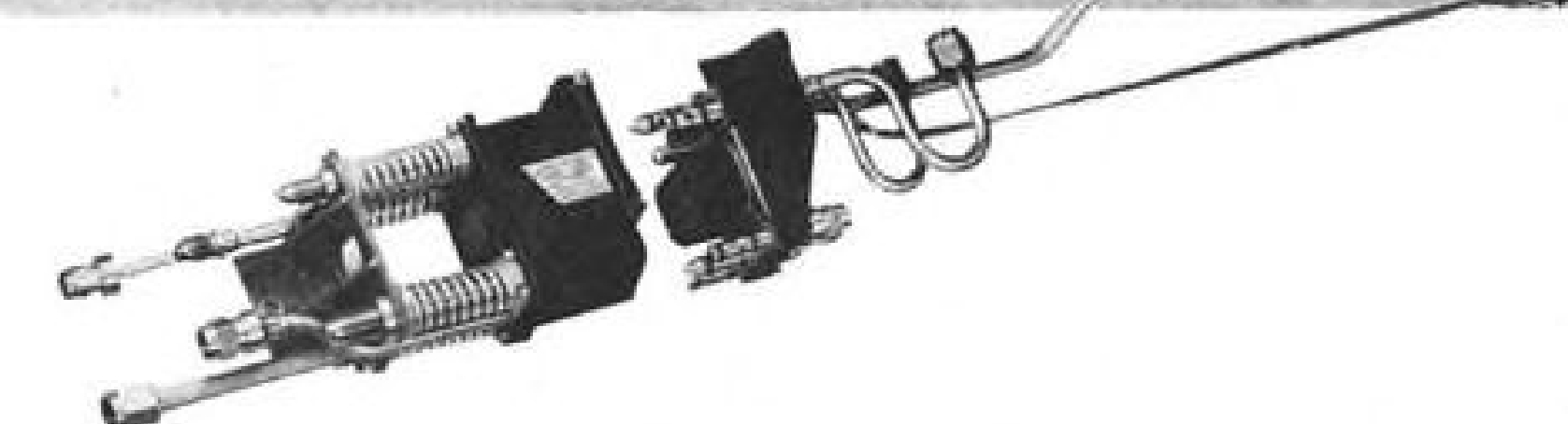
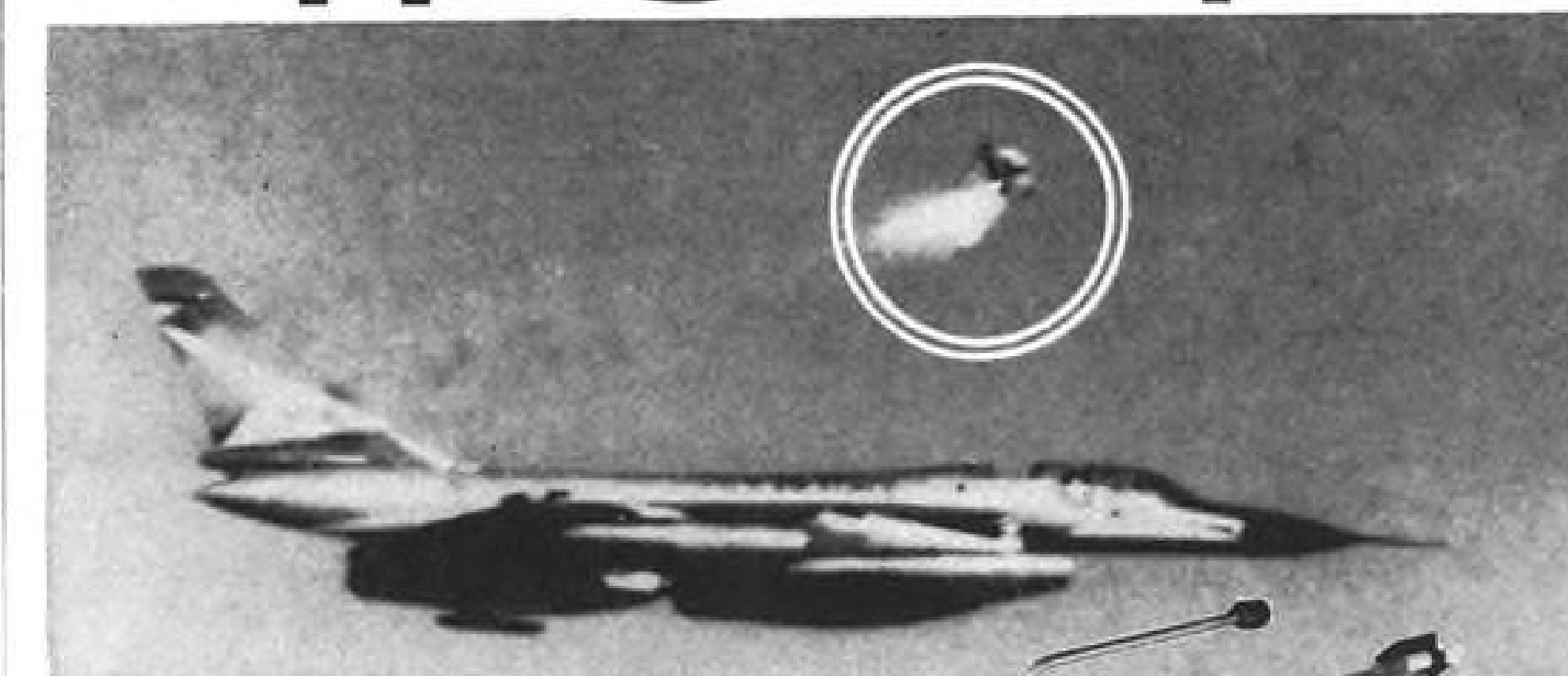
To compile some of this data, NASA has been conducting a screening program to weed out the less promising alloys. Toughness was evaluated by using the standard ASTM edge notch tensile tests, stability in mechanical properties was studied by re-examining tensile strength after 1,000 hr. under load at 650F, and corrosion susceptibility was evaluated by salt water tests.

Complete data on these NASA tests should be available by the first of the year.

In addition to this, the NASA materials group has drawn up a new formula for evaluating the alloys which passed the screening tests. Desirable characteristics on which the alloy rating is based are listed on a chart in two categories.

The first category is called the "go-no go" category and in it alloys are rated on how easily they can be welded and brazed and how they resist corrosion. If

## Stepping into Space



... at supersonic speeds



Floatation Systems



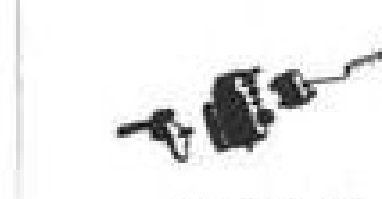
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Ejection of the first manned Stanley Aviation capsule at 565 mph from a General Dynamics B-58 was a milestone in aviation safety. Since that day in March, 1962, continued refinement of this escape system has culminated in an operational device now in squadron service and meeting the full performance range of the B-58.

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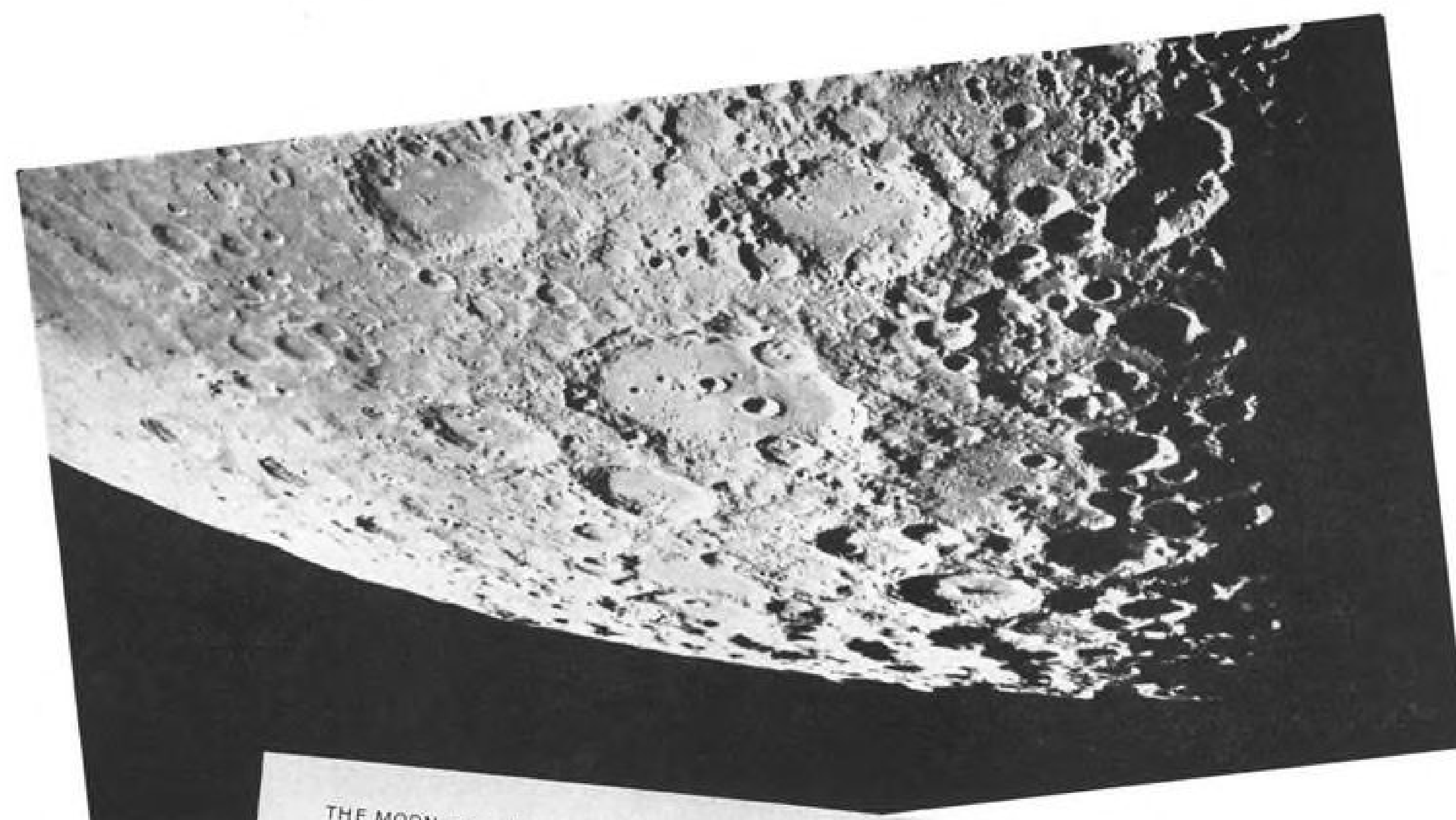
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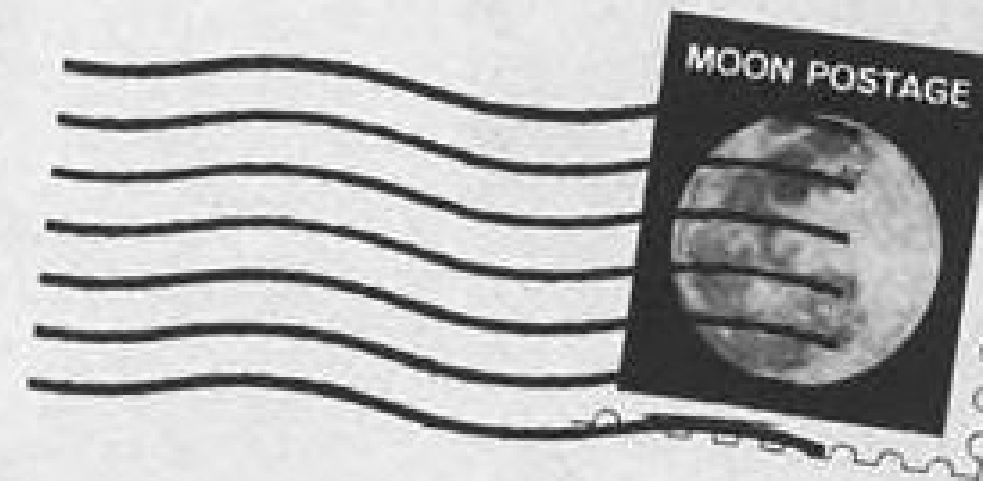
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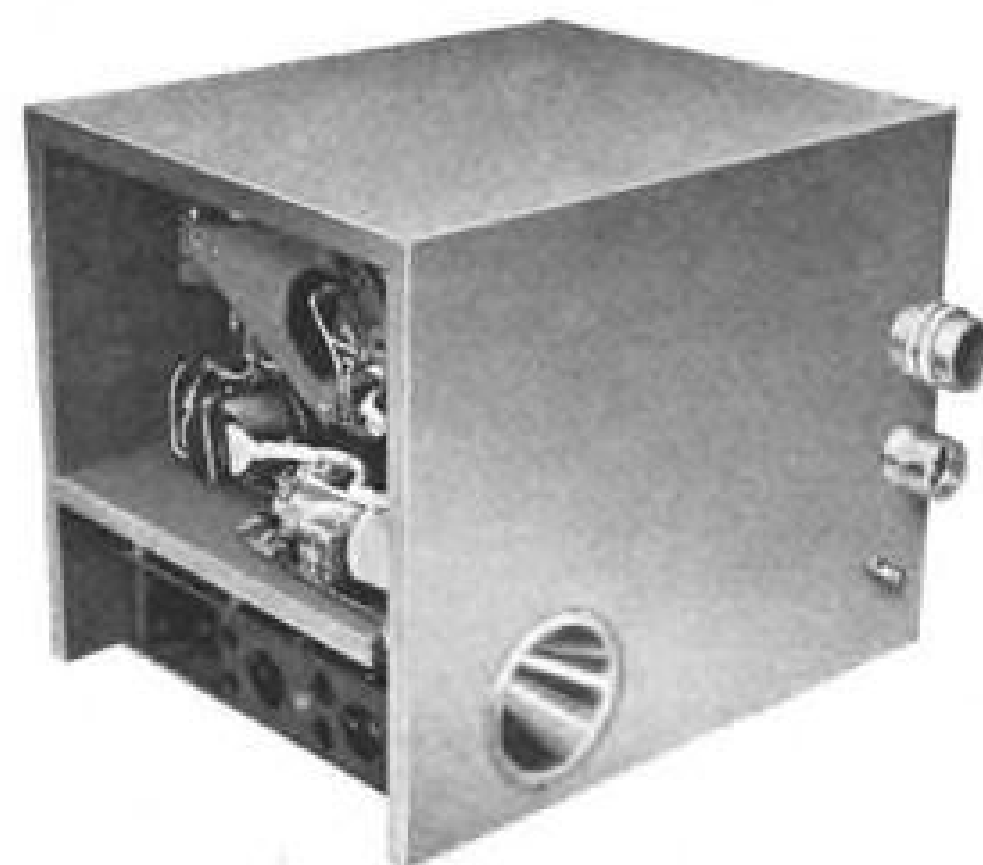


THE MOON—so called by its nearest neighbor, Earth, 238,857 miles away. Diameter: 2,160 miles. Mass: one-eightieth that of the Earth. Volume: one forty-ninth. Although the moon makes a complete revolution about its neighbor less than every month, it was not until recently that Earth began its visits.

Good trip up.  
Now analyzing 28 elements.  
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\*Gas Chromatograph

an alloy rates poorly on any of the three requirements, it is eliminated. Those which pass the requirements of the first category are then rated in the second on eight other characteristics: strength, toughness, stiffness, stability, fatigue resistance, as-welded strength, thermal stress and cost.

Number values of 1 through 5 are used to designate both the importance of each characteristic and to indicate the extent to which the alloys embody each characteristic. By compiling the totals, an over-all index number is obtained for each alloy.

#### Final Selection

Deutsch said the basis for the final selection process will be the most sophisticated and detailed data available at the time. He said additional information is needed in four more areas:

- **Low strain rate creep**—Materials selection thus far has been made with the tacit assumption that no creep will take place. Under extended exposure to the fluctuating temperatures that will be found on the SST, however, creep may become a factor and it should be further investigated.

- **Toughness**—A switch should be made from notch strength testing to a measure based on fracture mechanics. Of equal importance is the extension of testing to wide sheets ranging in thickness from foil, which may be used in honeycombs, to sheets thicker than the .02 in. on which most testing has so far been done.

- **Corrosion**—This question requires much more investigation from two viewpoints—first, to provide protective coatings to resist the heat environment, and second, to evaluate alloy stress corrosion characteristics under closely simulated operating conditions.

- **Fatigue**—Data on fatigue characteristics over the entire temperature range is particularly sketchy. Past experience indicates that this data is of greatest utility if it is obtained by using loading spectra and temperature cycles that simulate aircraft usage.

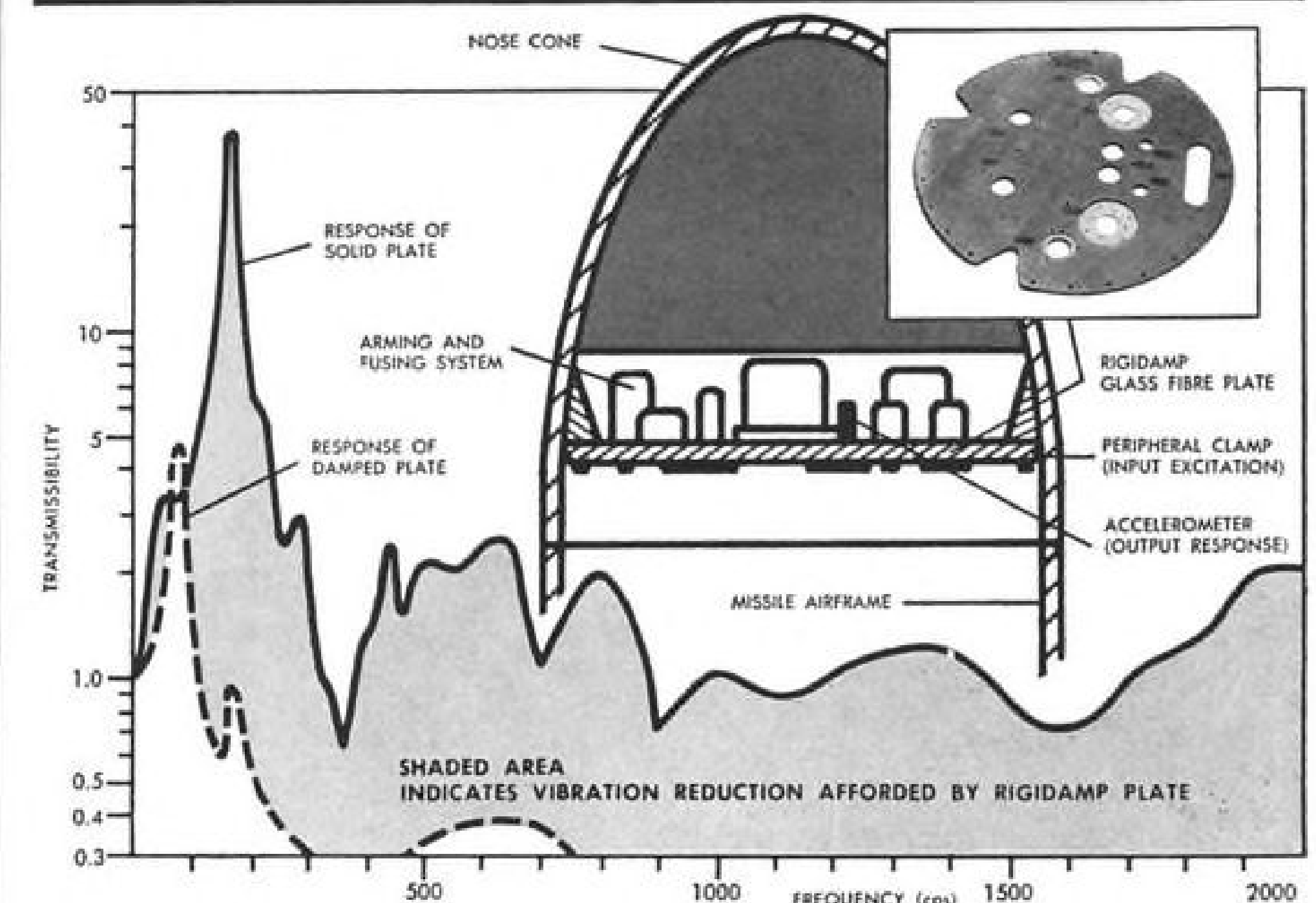
#### RS-70 Program

Deutsch said information of a general nature will be derived from Air Force's supersonic RS-70 program, but the operating parameters and life expectancy of the two aircraft are so different they cannot be readily compared.

Basic data on the fabrication of new alloys, the construction of large honeycomb panels and the development of protective coverings for hydraulic systems, landing gear and fuel tanks are areas in which the SST will benefit from the RS-70.

Studies of noise and traffic control problems with the RS-70 also will prove valuable in developing SST design and operating requirements.

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RIGIDAMP structures, with *built-in* damping have proven time and again that you can have *lightweight* structures and *controlled dynamic response*.

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#### SHOCK, VIBRATION AND NOISE CONTROL

**BARRY B CONTROLS**

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Pilots and radar operators race to their RCAF/McDonnell CF-101B Voodoo jet interceptors during a practice alert scramble for Norad exercise.

## RCAF Squadrons Flying CF-101B Interceptors



Personnel perform checks on CF-101Bs at Ontario station just before start of a mission, above. Turnaround arming demonstration, below, shows rapid loading of Hughes Falcon air-to-air missiles on the aircraft.



It is first RCAF supersonic jet aircraft.

## In Norad Support

Five Royal Canadian Air Force squadrons are now flying the McDonnell CF-101B Voodoo supersonic jet interceptor as part of RCAF's North American Air Defense Command (Norad) operations. Squadrons are located in Ontario, British Columbia, Quebec and New Brunswick. The two-man, all-weather interceptors have replaced subsonic Avro CF-100s in RCAF (AW Mar. 12, p. 288). CF-101B is powered by two Pratt & Whitney J57 turbojet engines providing more than 30,000 lb. total thrust with afterburners. Maximum speed is more than 1,200 mph., and peak operational altitude is above 50,000 ft.



Ground personnel stand away from CF-101B, above, as safety precaution during liquid oxygen fueling. Drag chute landing is shown below.

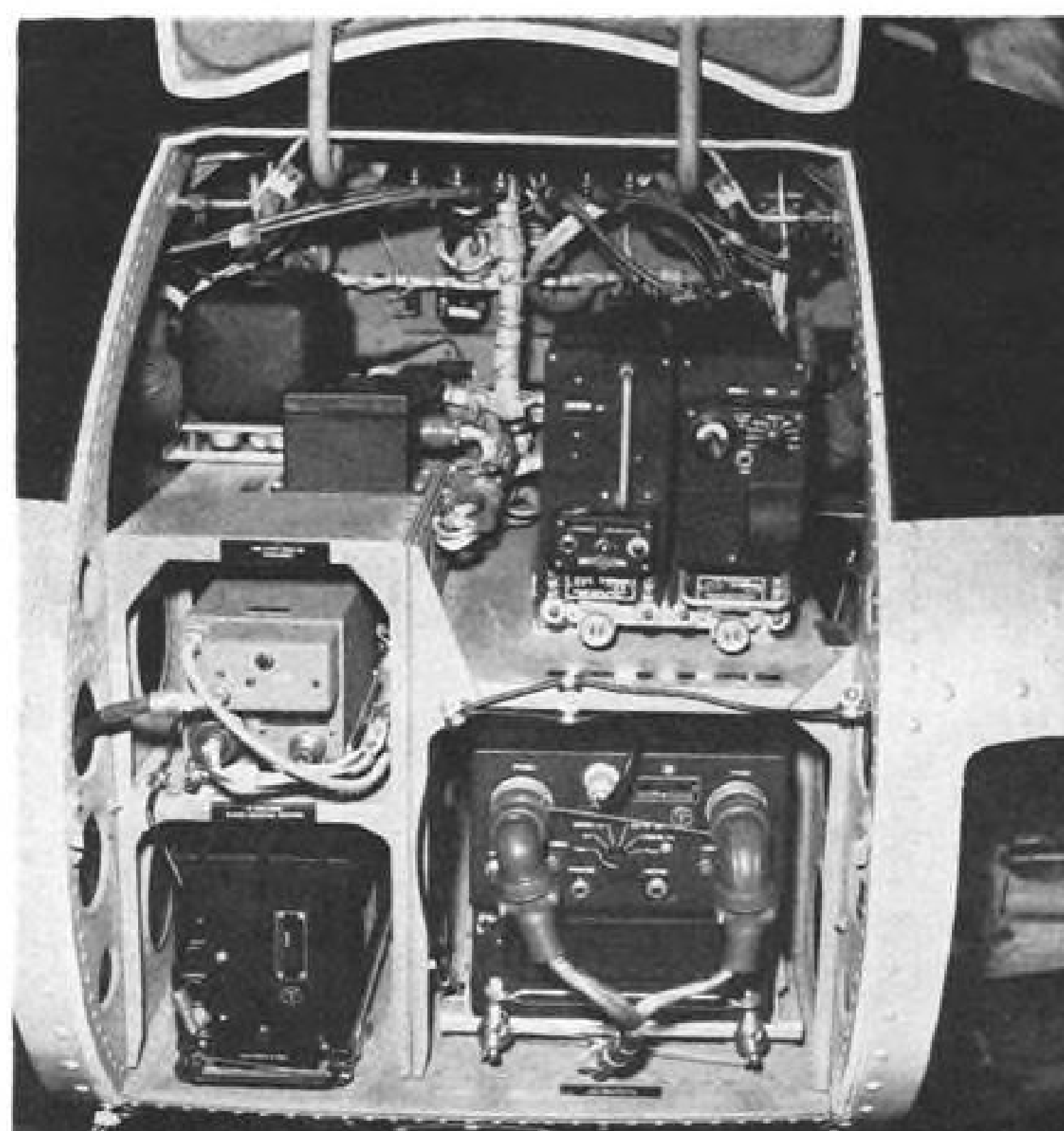
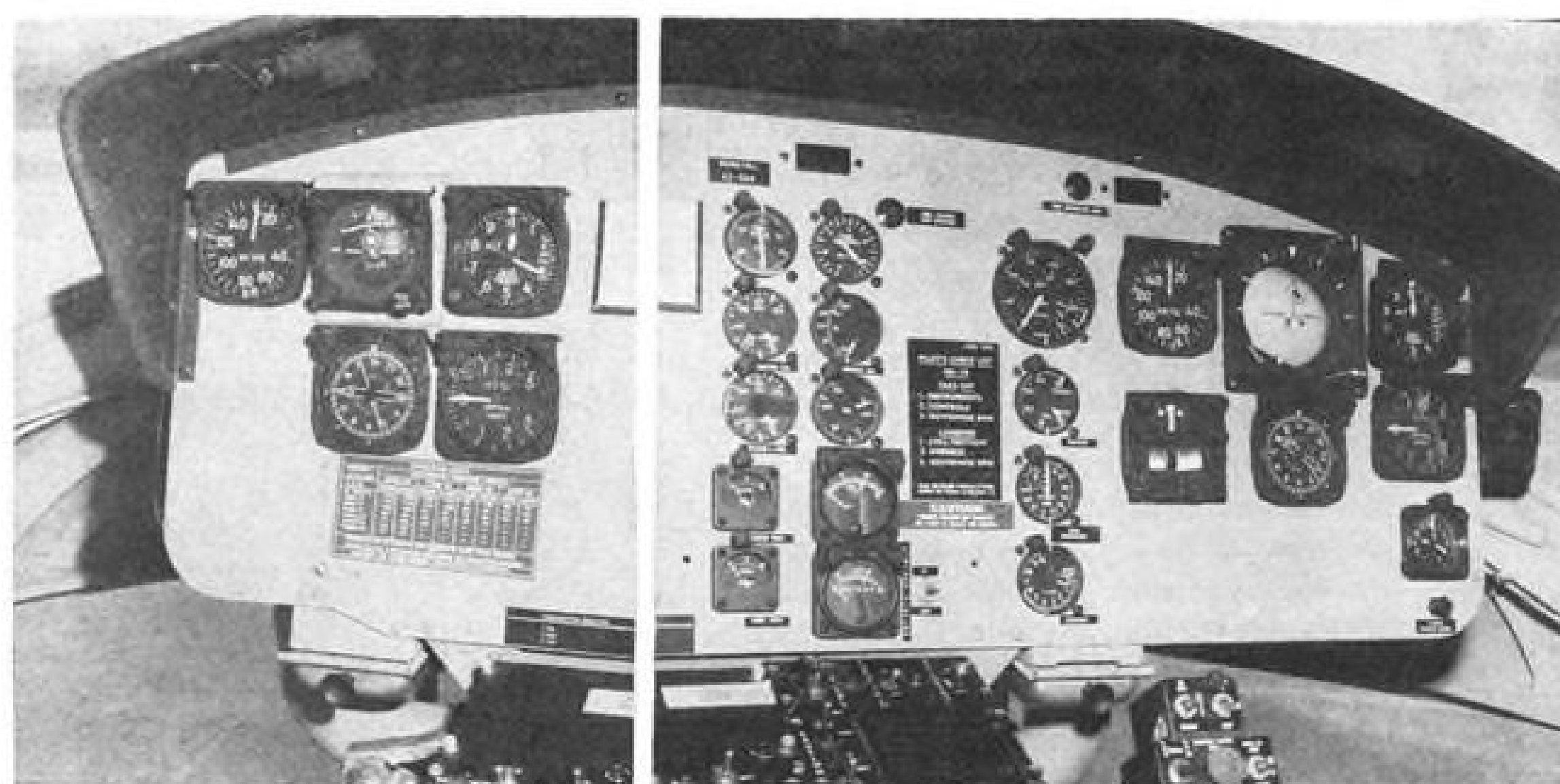






## RAAF Gets First Bell HU-1B Rescue Helicopter

First of eight Bell HU-1B helicopters, painted silver with Dayglo high visibility markings was delivered recently to Royal Australian Air Force. Remaining seven will be standard olive drab. Helicopters will be used by Search & Rescue Squadron 9. Dollar value of contract was about \$4 million. Pilots and ground crews received training at Fort Rucker, Ala. and at Bell's Fort Worth, Tex., factory. Composite view of instrument panel shows differences between pilot (right side) and copilot (left). Primary difference between this aircraft and those ordered by U. S. Army is electrically operated hoist, below right, and avionics equipment. Hoist has 600 lb. load limit and explosive-actuated cutting device for dumping load in an emergency. Avionics installation in nose is shown below left.



minus one for paper

	S	P	R
S	0	1	-1
P	-1	0	1
R	1	-1	0

The payoffs are known. The Scissors-Paper-Rock game matrix\* provides a mathematical abstraction of the conflict situation. Now a Game Theory analysis can be performed. Its objective is to answer the question of how best to play the game. Strategy options in real-life conflicts are exceedingly more complex. To select the optimal course of action is the major move in our global game. To this end do our engineers design command and control systems today for tomorrow's offensive and defensive moves. If you seek to devote your scientific skills to determining long-range strategies and their associated tactical systems, you will find us genuinely receptive to your original thinking. Engineers, mathematicians, and scientists are cordially invited to apply. A good first move would be to send your résumé to Mr. Harry A. Laur at 6700 Eton Avenue, Canoga Park, California. He will counter with an immediate response. Litton Systems, Inc. is an equal opportunity employer.

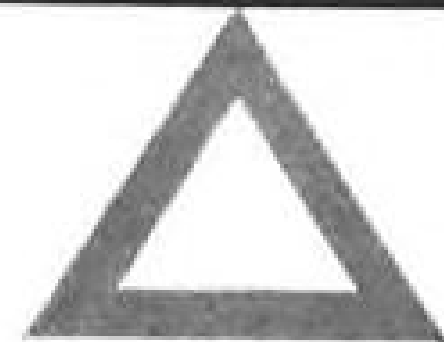
**LITTON SYSTEMS, INC./ DATA SYSTEMS DIVISION** A DIVISION OF LITTON INDUSTRIES

\*Williams, J. D., *The Compleat Strategist*



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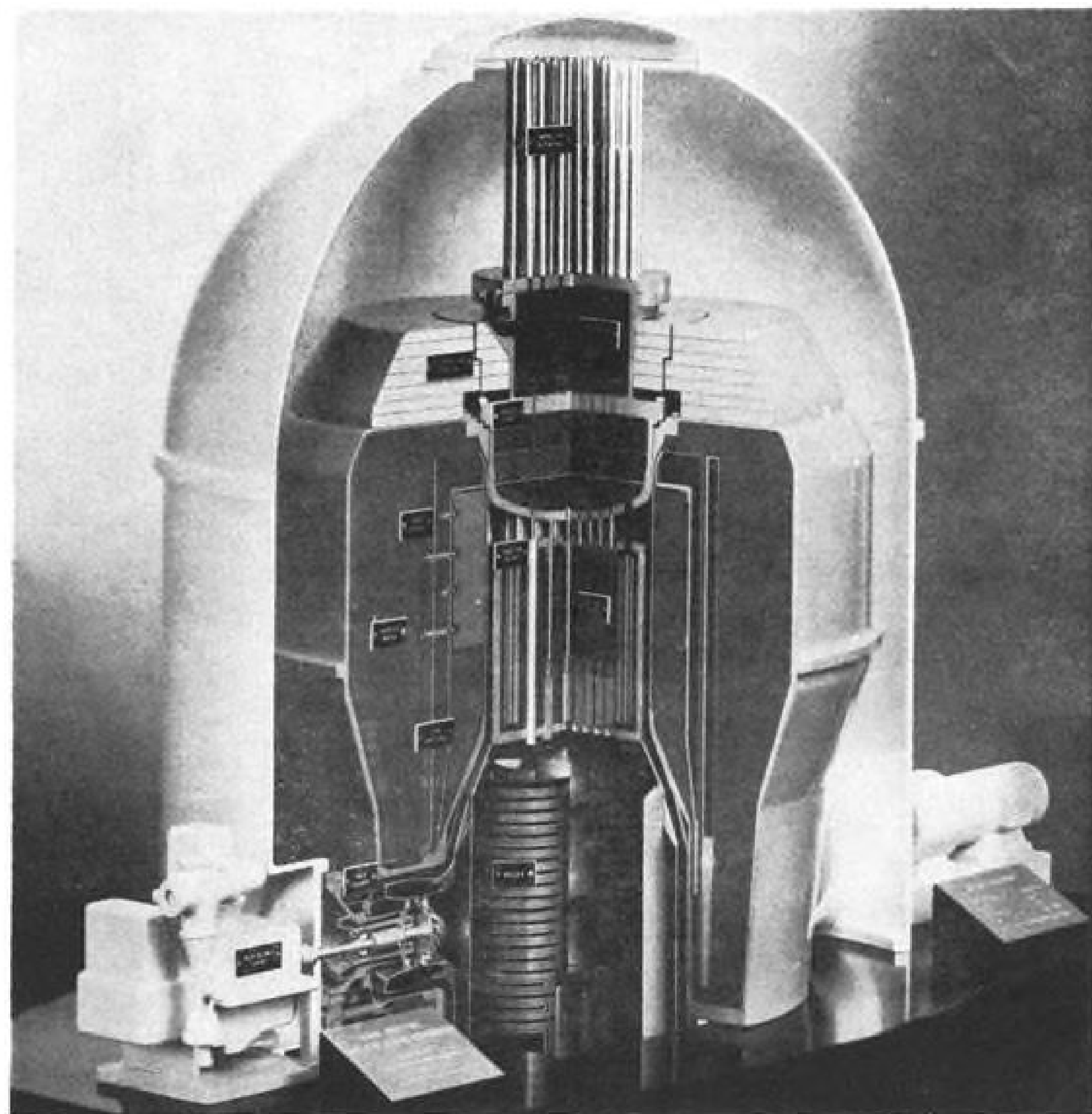
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Nuclear Metals Division

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**DEPLETED URANIUM METAL**



**MODEL OF NUCLEAR** steam generator built by GE for maritime use shows reactor core set above the boiler. Air is heated to 1,200F in the reactor and circulated through the boiler, producing steam. System is rated at 30,000 shp.

## Testing Set for Engine Developed From Nuclear Aircraft Program

New York—New maritime nuclear powerplant, developed by General Electric Co. from experimental nuclear engines originally designed for the now defunct Aircraft Nuclear Propulsion (ANP) program, is scheduled to begin test operations this week.

Testing of the nuclear steam generator, designated 630A, will be done at Atomic Energy Commission's National Reactor Testing Station in Idaho. The system, 34 ft. high and 18 ft. dia., weighs 340 tons and will develop 30,000 shp., according to Ben Blumberg, manager of the 630A development program.

First runs with the AEC-funded engine will be critical experiments to prove the safety of the engine's design, according to Blumberg. Power output will be low.

Blumberg said the new engine is based primarily on GE's Heat Transfer Reactor Experiments (HTRE-1) engine built in 1956, although it draws on technical advances made with all four engines developed for the ANP program between 1956 and 1958.

It is a closed cycle unit consisting of a water-moderated reactor set above a steam boiler. The reactor, fueled with 97% enriched U-235, replaces the burners in a conventional oil-fueled boiler. The fuel elements are designed for a 15,000-hr. life.

Air is heated to 1,200F in the reactor and circulated down through a boiler-superheater, which produces 950F steam at 850 psi. After the air has passed through the boiler cycle, it is recirculated through the reactor by a blower.

"Using air as the working fluid has made possible improved performance over the high-pressure water systems used in other nuclear engines," Blumberg said. "We can heat the air to 1,200F as opposed to 700F which is the maximum temperature that can be attained with a pressurized water system."

Blumberg said the air system had two other advantages—increased safety and a growth potential factor.

"The circulating air, in addition to

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LEFT, HILLER E-4

ABOVE, RYAN Q-2C FIREBEE



ABOVE, BEECHCRAFT MUSKETEER, MODEL 23

BELOW, NORTH AMERICAN T-39 SABRELINER



ABOVE, DOUGLAS NIKE ZEUS

BELOW, McDONNELL F4H PHANTOM II



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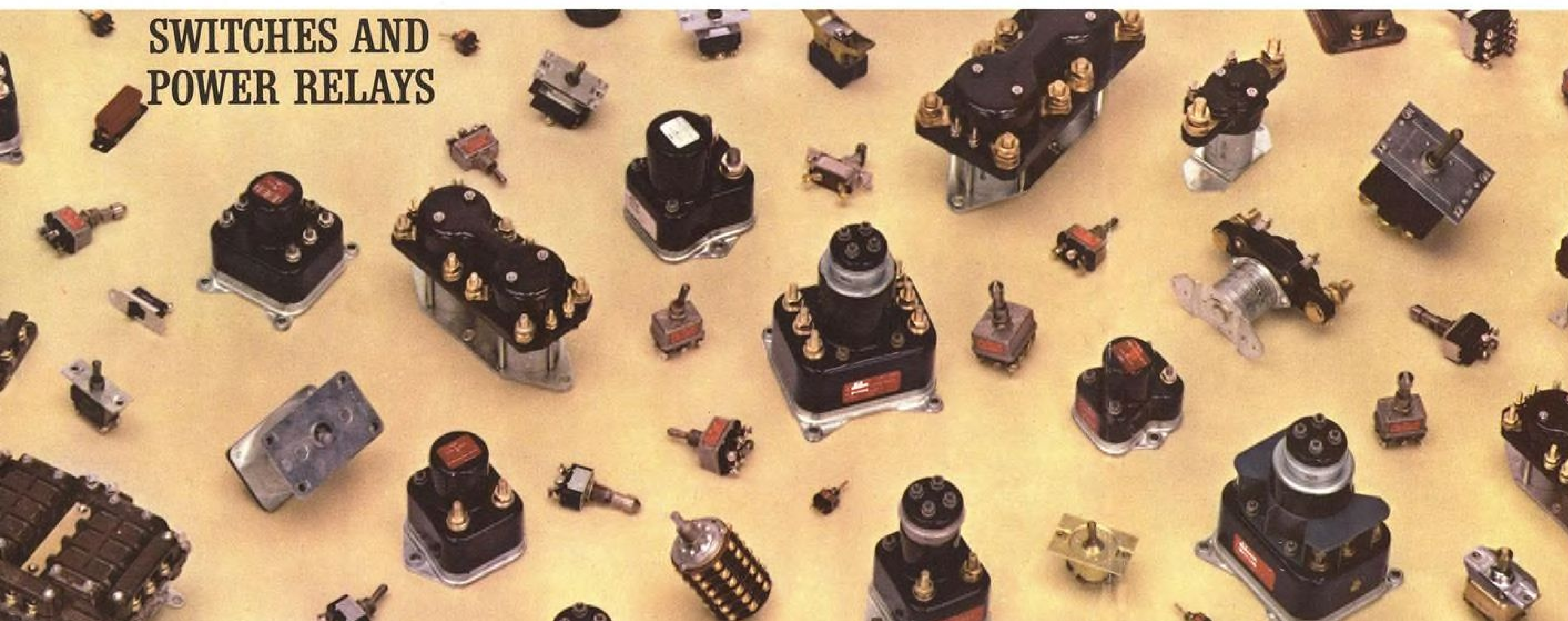
Each line has been exactly designed—each device is critically manufactured, assembled, inspected and rigorously tested. Whether it's a switch, a circuit breaker, a Class O or hermetically-sealed power relay—you're assured of Cutler-Hammer's years-ahead design, manufacturing excellence, consistent quality, positive performance and rapid availability.

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## AT RADIATION, IDEAS BECOME REALITY

*Example: Telstar's 8 lb/112 channel PCM telemetry system*

Bell System's Telstar's continuing success—in a space environment that intersects the Van Allen Belt—not only proves the feasibility of world satellite communications, but also the reliability of a new transmission technique. PCM telemetry has now won its spurs as the most advanced method of checking satellite performance.

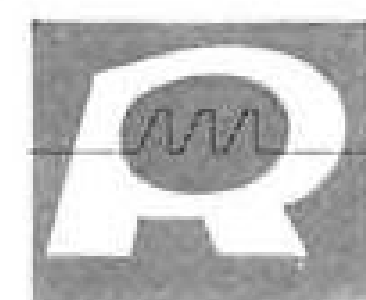
Telstar's PCM system, built by Radiation-Melbourne for Bell Telephone Laboratories, weighs only 8 pounds, requires less than 450 milliwatts of power . . . yet provides 112 information channels with highest accuracy available today. Channel allocations: 16-voltage; 40-temperature; 9-current; 27-radiation experiments; 2-pressure; 10-solar aspect; and 8-relay status.

First analysis of Telstar's telemetry data—received by the Radiation-designed and built command-tracking antennas—indicates the canister pressure is still above 5 lb./sq. in., showing that the canister has not been punctured; average temperature inside of 75°F; average skin temperature of 32°F; solar cells delivering 0.5 amp at 13.5 W; and a radiation-

induced decrease in current output of 10% ( $\pm 2$ ) with 20 mils sapphire shielded semiconductors and 5% ( $\pm 2$ ) with 25 or 30 mils sapphire shielding.

This important new telemetry technique is only one of many advanced projects on which Radiation scientists are now working. If you like to explore advanced concepts, you'll find a stimulating and challenging environment at Radiation . . . where ideas become reality. Send your resume or write for more information. Personnel Director, Dept. AW-11R, Radiation-Melbourne, Melbourne, Florida.

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Communications systems — Data acquisition and processing — Automatic checkout — RF systems — Manufacturing

acting as the working fluid, also has an internal shielding use. If a fuel element should spring a leak, an auxiliary blower can be used to increase the volume of air circulating and prevent overheating for a longer time than the circulating water system.

### Gas Turbine Version

"The 630A, although designed to fit present merchant ships with little modification, can easily be adapted to a gas turbine version in the future. The hot air coming from the reactor will be used to directly power a turbine instead of producing steam.

"In this version, the powerplant can be made small enough for use in high-speed hydrofoil boats and in ground-effects machines."

Cost of the 630A is lower than current pressurized water systems, Blumberg said. The 630A will cost about \$3 million as compared with \$5 million for the system powering the N. S. Savannah, world's first nuclear powered merchant ship.

The Savannah's engine weighs 2,452 tons and develops 22,000 shp.

### ANP Termination

Blumberg said GE decided to develop a maritime engine incorporating the best parts of its aircraft engine designs soon after the ANP program was terminated in April, 1961. After the Maritime Administration expressed interest in the first proposals in June, 1961, GE undertook a feasibility study which was completed in February, 1962. Development of basic components was carried on through the summer, with final assembly being accomplished at AEC's Idaho test station.

Blumberg said the Maritime Administration is now meeting with shipowners to develop a nuclear conversion program which will solve many of the administrative and control problems which have delayed the N. S. Savannah program.

### AFOSR Grants

Air Force Office of Scientific Research has recently awarded 37 grants and contracts to colleges, universities, non-profit research institutions and industrial laboratories in this country and abroad.

#### GRANTS:

University of Wisconsin, Madison, Wis.—\$10,095 for research on addition and displacement reactions with unsaturated hydrocarbons.

New York University, Washington Square, New York, N. Y.—\$46,862 for study of forces in hydrogen-bonding; \$25,409 for measurement of attitude and attitude change.

National Academy of Sciences, Washington, D. C.—\$10,320 for conference on transport theory.

Northwestern University, Evanston, Ill.—\$14,340 for study of gas viscosities up to 1,000 atmospheres.

University of Utah, Salt Lake City, Utah—\$6,741 for research on identification of

creative and scientific talent in pre-scientists age groups; \$33,568 for study of recrystallization and grain growth in magnesium and chromium.

University of Georgia, Athens, Ga.—\$15,336 for chemical and enzymatic studies on the conversion of chemical energy to light.

Ohio State University, Research Foundation, Columbus, Ohio—\$15,869 for research on value acts and situational variables in organizational behavior.

Hamline University of Minnesota, St. Paul, Minn.—\$7,114 for study of general Gaussian processes.

Yale University, New Haven, Conn.—\$27,360 for research in differential equations.

Mellon Institute, Pittsburgh, Pa.—\$197,653 for study of electronic collision cross section.

University of Colorado, Boulder, Colo.—

\$57,621 for research on quantum field theory and elementary particles.

University of Illinois, Urbana, Ill.—\$47,050 for the photoproduction of mesons in liquid hydrogen bubble chamber.

National Institute of Optics, Arcetri-Florence, Italy—\$9,000 for basic research on retinal mechanisms and responses.

Documentation, Inc., Bethesda, Md.—\$13,835 for studies in modal logic.

University of Pennsylvania, Philadelphia, Pa.—\$15,000 for advisory services to the Directorate of Information Sciences, AFOSR.

Herter and Co., Washington, D. C.—\$13,912 for basic research resumes.

Electronic Communications, Inc., Advance Technology Div., Goleta, Calif.—\$13,833 for study of the effects of an unstable motion on the descent trajectory of bodies.



LYCOMING'S T53 FUEL NOZZLE

## A PRODUCT OF DELAVAN EXPERIENCE

The Lycoming T53 small gas turbine engine is currently in use on helicopters, observation aircraft and in Marine and industrial applications. This is the fuel injection nozzle developed by Delavan for the T53.

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perience in large scale manufacturing of the intricate and precise parts that make up a fuel nozzle, and experience in controlling the quality and performance of these devices on a mass scale.

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## MMRBM Guidance Techniques Described

By Philip J. Klass

Techniques which may be used for mobile medium-range ballistic missile (MMRBM) guidance and to determine the position of its transporter-erector vehicle at launch were described recently by engineers from General Precision's Aerospace Group, which holds the contract for program definition phase on the Air Force MMRBM.

Choice of technique used to determine the location of launch vehicle affects the requirements for the missile's guidance system, and vice versa.

Determination of the position of a mobile missile launcher of the MMRBM type using a combination inertial-odometer system was described in a report by Richard C. Galle and J. P. Spitz of General Precision at the recent Northeast Research and Engineering Meeting (Nerem) in Boston.

Transporter-launch vehicle would be equipped with a gyro-stabilized platform which is slaved to the local-gravity vector by means of pendulums or other types of accelerometers. Starting from a presurveyed location whose position was precisely known, the vehicle's navigation system would use dead reckoning to provide the launch crew with a continuous indication of its position.

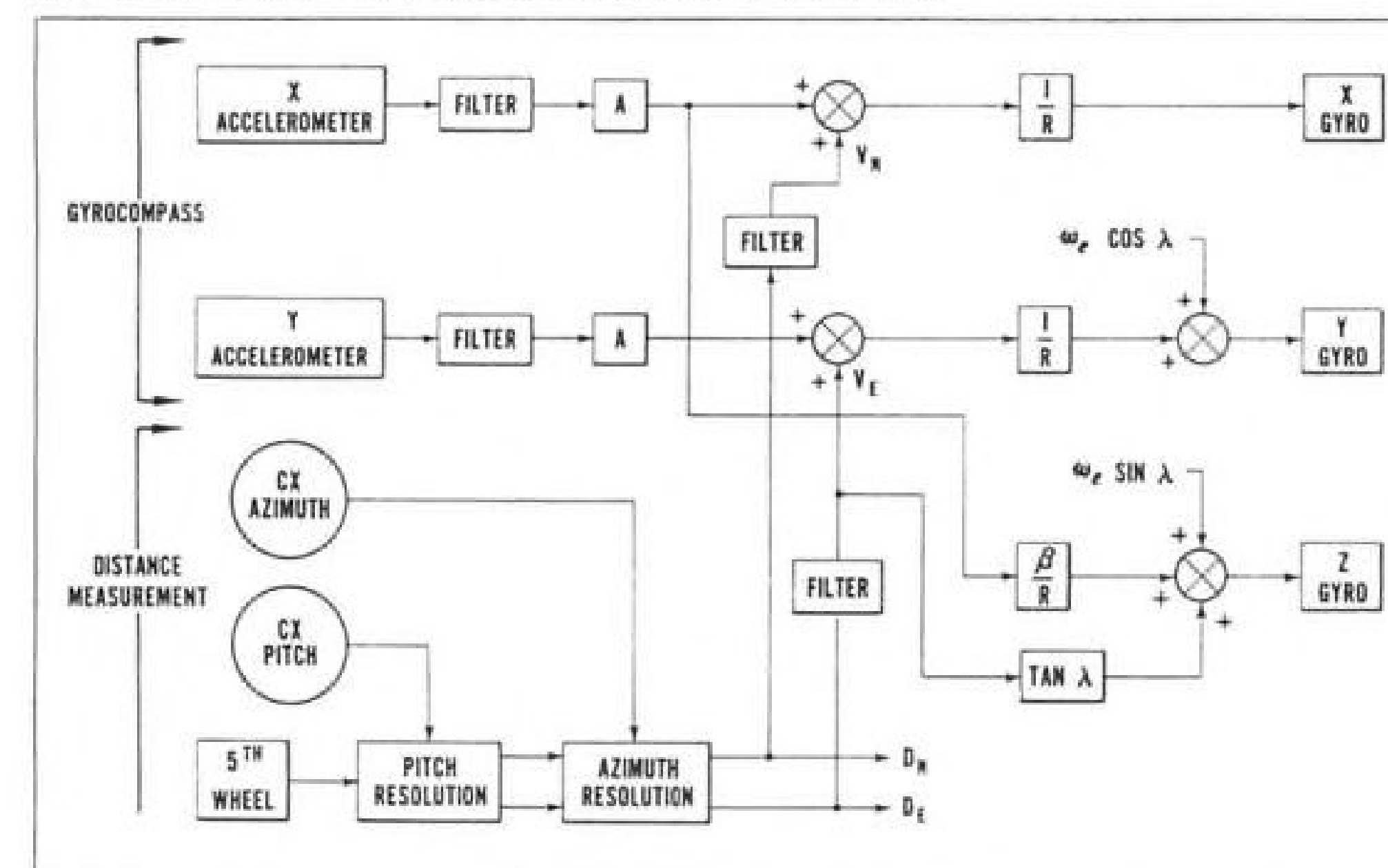
Fifth wheel type odometer would measure the vehicle's movement. Because non-level terrain would introduce a spurious indication of distance covered relative to a spherical earth, it is necessary to use a stabilized platform to measure the vehicle's tilt angle and to multiply the odometer-measured distance by the cosine of the tilt angle to obtain distance traveled over a smooth earth.

This horizontal distance must then be resolved into east-west and north-south components. The General Precision engineers suggest that this can be accomplished using a north-seeking gyro mounted on the stabilized platform. Such a gyro determines the direction of true north by sensing earth rotation and aligning its axis parallel to the earth's spin axis. It is a technique that has long been used in shipboard gyro-compasses and more recently to align tactical surface-to-surface missiles in azimuth.

However, when a north-seeking gyro of this type is mounted on a moving vehicle, as it would be for the MMRBM, it can not distinguish between vehicle motions and those due to the earth's rotation. This requires the use of a compensating signal propor-



**NAVIGATION SYSTEM** for an MMRBM missile transporter-launcher, using a fifth-wheel type odometer in combination with a gyro-stabilized platform to measure vehicle tilt angle, reported by General Precision engineers, is based on earlier tests conducted by company and Chrysler Corporation engineers, shown in photo above.



**BLOCK DIAGRAM** of a land-vehicle navigation system using odometer sensor in combination with gyro-stabilized platform which measures vehicle tilt angle and provides directional reference for resolving distance traveled into east-west and north-south components.

## accurately tests gyros in .0001%/hr. drift rate class

The Model 252 Test Table is a highly reliable instrument. It provides extreme accuracy and repeatability for the test of gyros, accelerometers and guidance platforms. A major reason why: its design eliminates stiction-producing elements. Instead of a mechanical or liquid film bearing, the table "floats" on air. The 252's direct drive AC torque motor eliminates the problems of hysteresis effects of DC torque motors and of periodic errors and friction inherent in gear drives. Servo-driven slip rings further reduce stiction in the table system. Directly coupled electromagnetic transducers take the place of readout micro switches. A precision instrument—and one whose modular design allows you the luxury of choosing features compatible with your test requirements. For example:

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**TILT AXIS** can be driven manually or by torque motors for testing 2 axis gyros.

For more information on the Model 252 Test Table or for assistance with your guidance systems test requirements, write to the J. W. Fecker Division, American Optical Company, 4709 Baum Boulevard, Pittsburgh, Pennsylvania.

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tional to vehicle velocity in east-west and north-south directions which can be obtained by measuring the rate-of-change of distance traveled, Galle said.

An alternative design approach is to use a Schuler-tuned inertial navigation system for the transporter vehicle, similar to ones used for aircraft and submarines, which automatically establishes vehicle position. However, in this type system the stabilized platform oscillates about the vertical with an 84-min. period so that it is precisely correct only once every 42 min.

#### System Errors

Fifth-wheel odometer-inertial platform system errors accumulate only as a function of distance traveled and not as a function of time, as with a Schuler-tuned system.

Thus, when the vehicle is stopped, the error buildup also stops.

Periodically, the MMRBM transporter's route is expected to take it past one of many presurveyed checkpoints, at which time accumulated errors can be eliminated.

Combining of stellar and inertial techniques in a single guidance system promises to provide "significant improvement in accuracy, versatility and response time," Bernard Lichtenstein of GPI's Aerospace Group said at the recent Inertial Guidance Test Symposi-

um that was held at Holloman AFB.

However, these potential advantages introduce problems not encountered with all-inertial systems, Lichtenstein indicated. For example, a stellar-inertial system intended to provide guidance during the boost phase of a ballistic trajectory cannot be effectively evaluated by rocket sled tests, a convenient method long used to test all-inertial systems.

For an MMRBM application, stellar corrections to the inertial system would begin at altitudes of about 80,000 ft. and continue until burnout at heights ranging up to 300,000 ft., an environment that can not be simulated effectively in a terrestrial sled.

#### Flight Testing

At these higher altitudes, atmospheric density, refraction, absence of scintillation and the intensity of sky background illumination are markedly different from those at or near sea level. Also, vehicle velocities at these high altitudes are already beyond levels which can be obtained with existing sled technology, Lichtenstein said.

This means that flight testing "must be introduced much earlier into an evaluation program than is customary with conventional inertial systems," he said.

Lichtenstein said that the Guid-

ance Evaluation Missile which will be developed under USAF Missile Development Center sponsorship, appears to be ideally suited for the evaluation of stellar-inertial systems.

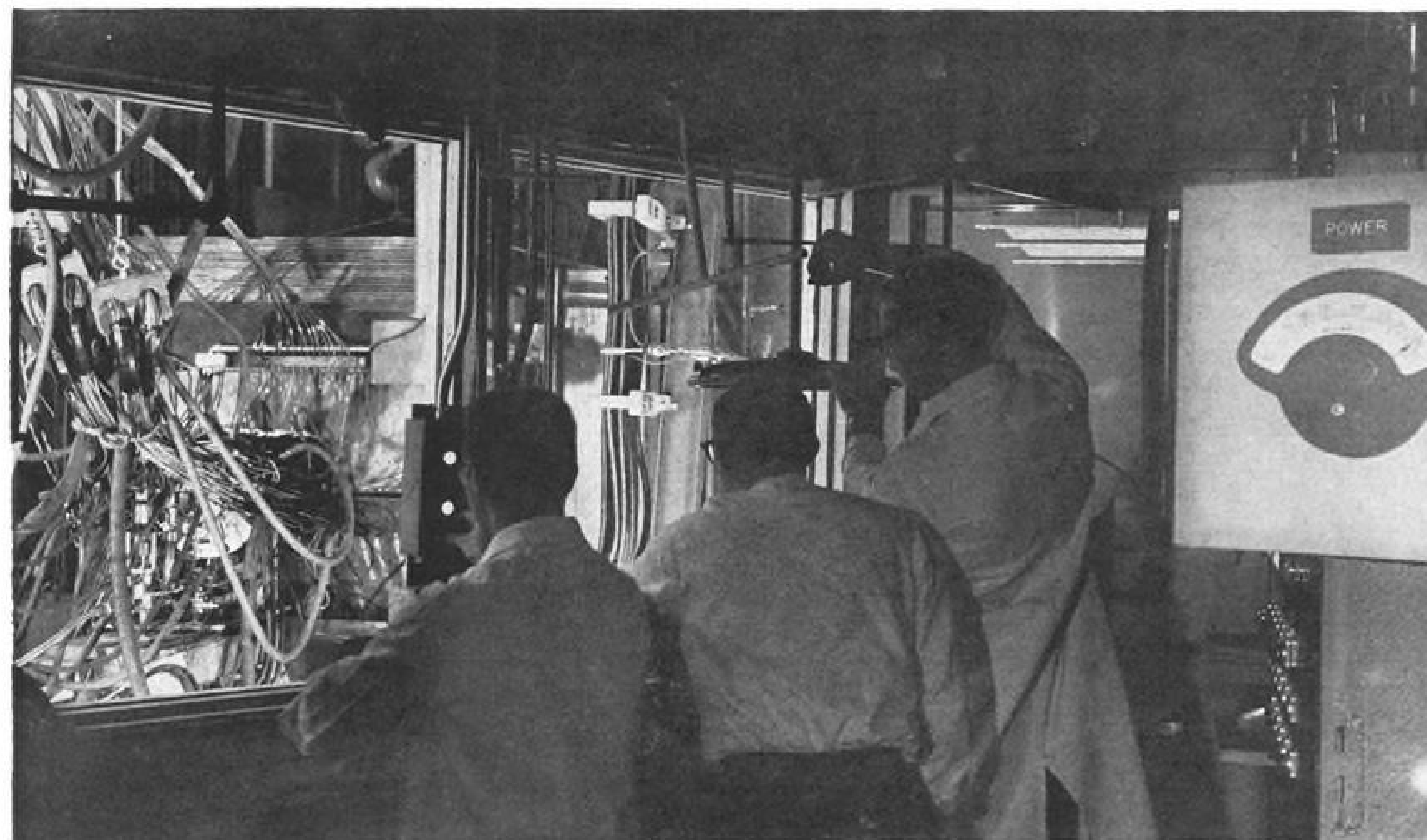
Stellar-inertial system requires that the star tracker(s) be able to view the required stars through a window in the missile which is strong enough to withstand high temperature, shock and vibration but which still offers extremely low distortion of the line-of-sight. Errors introduced by the windows must be limited to a few seconds of arc, Lichtenstein said.

#### Single Window

This suggests the use of a single large flat window or one consisting of segmented flat sections to form a curved surface.

The latter allows the star tracker to view a larger volume of the celestial sphere, but with occasional blind spots due to structure.

There are two basically different techniques for combining stellar-inertial techniques for a guidance system, Lichtenstein pointed out. In one, the stabilized platform functions only as an accurate horizontal and azimuth reference for making measurements of star altitude and azimuth in a manner similar to the traditional celestial navigation technique, except that measure-



### MHD Generator Produces 1,350-kw. Power

Magnetohydrodynamic (MHD) generator which has produced 1,350 kw. of power, the highest yet reported and more than 100 times the power developed by earlier model, has been operated for more than 140 hr. by Avco Everett Research Laboratory. Interior channel is water cooled to withstand 5,000F temperature of conducting gases produced by commercial powerplant fuel seeded with potassium to make it an electrical conductor. Avco is building 20,000-kw., self-excited MHD generator under Defense Dept. contract.

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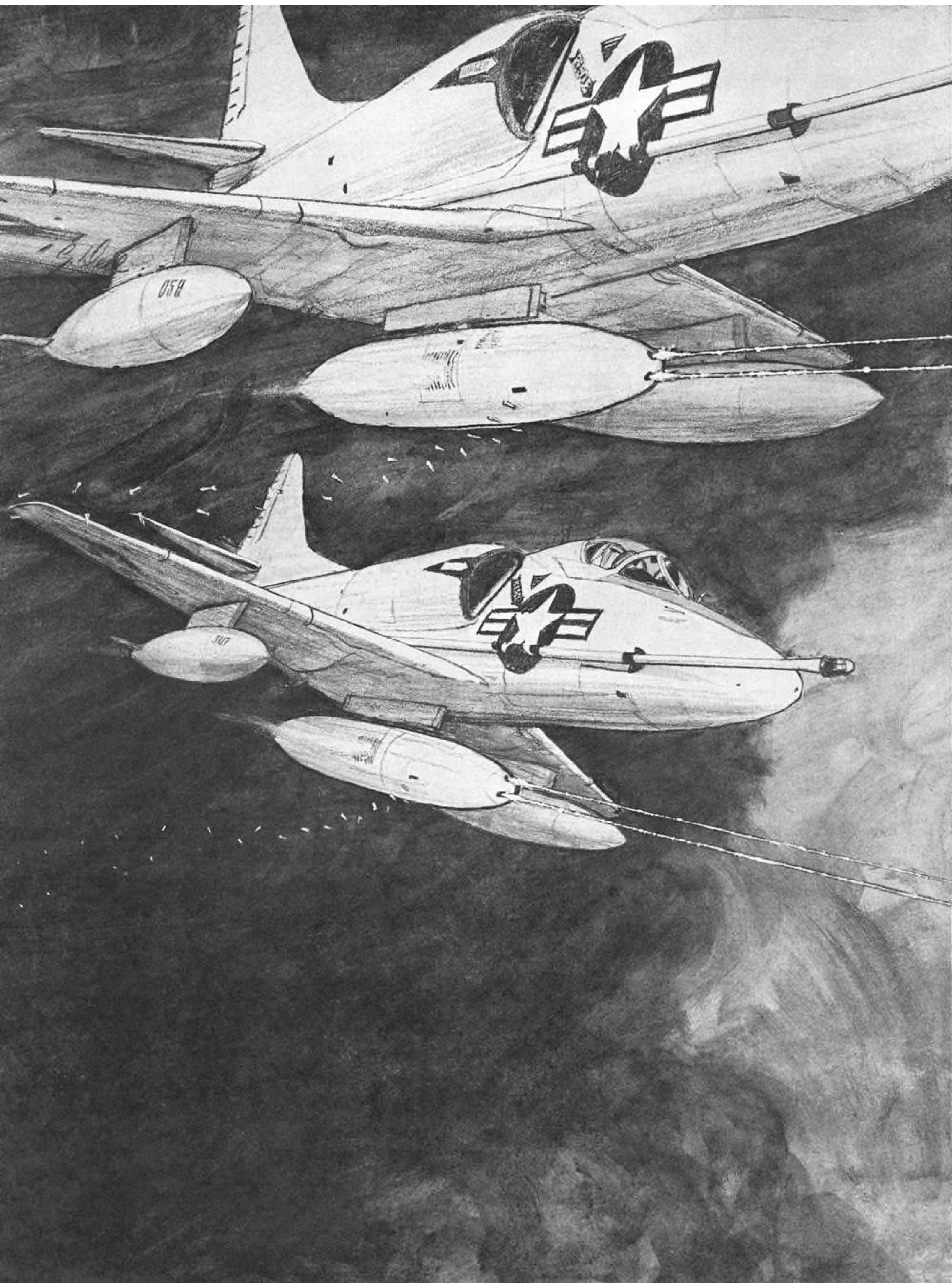


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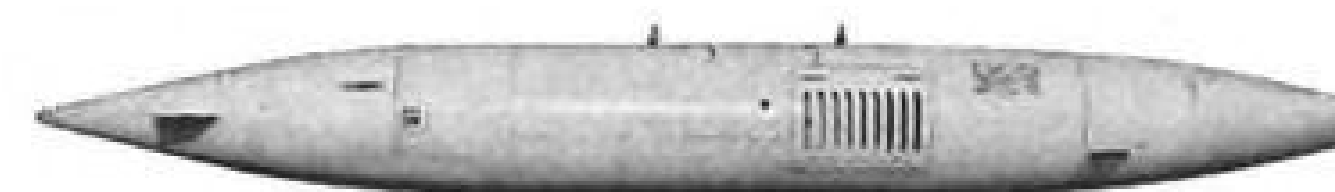
# Hughes makes news in armament!

**Minor brushfire or major conflict**—today's air-to-surface tactical missions require new flexibility in armament. There are a greater variety of small, hard-to-see targets which must be attacked at short range from aircraft flying at low altitudes. Total time to fire is shorter.

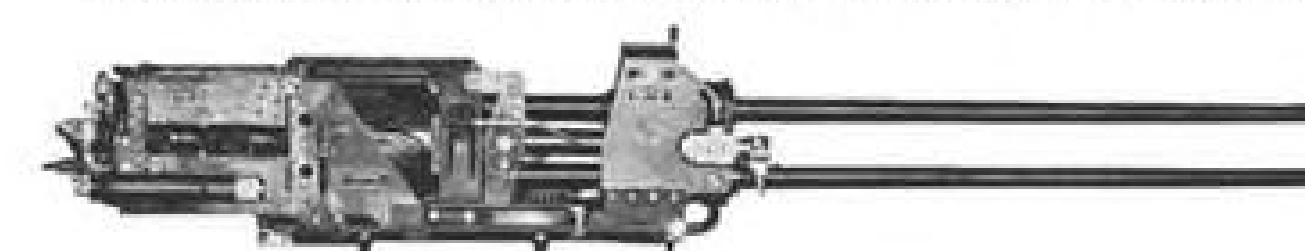
The optimum weapon in this difficult environment is the high-rate-of-fire gun. It is extremely accurate. It reacts instantly. It has high lethality against a wide range of targets. Other advantages are low cost, logistic savings, over-all simplicity and reduced pilot exposure.

Gun Ordnance has been a major activity of the Hughes Tool Company—Aircraft Division for more than twenty years. This continuing gun development and production capability has culminated in advanced weapons—ideally suited for today's requirements.

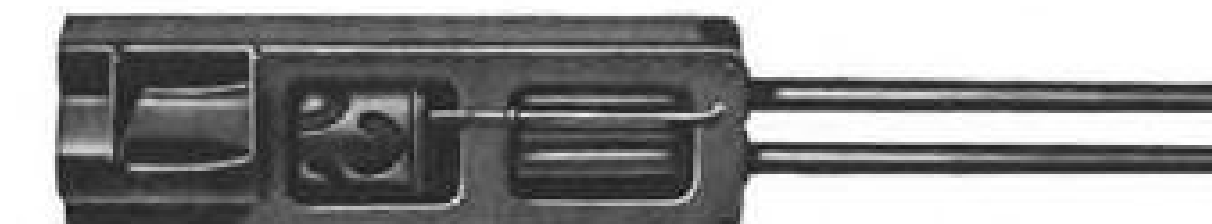
Hughes gun ordnance capability includes the complete system—the gun, its installation, controls, gunsight and specialized ammunition. These systems are tailored to the individual missions of fixed wing aircraft, helicopters and ground vehicles.



**Hughes HIPEG—20mm gun pod**—Unique in the field of external armament stores, HIPEG is a complete, high performance gun system. Its Mark 11 gun fires 4000 rounds per minute—the highest firepower rate per pound of all 20mm guns. It comes up to rate instantly and fires the most powerful 20mm round available. The HIPEG system combines the gun and 750 rounds of ammo in a supersonic enclosure. Developed for the U. S. Navy, it is now available for application on a wide range of fighter and attack aircraft as well as helicopters. Advantages of Hughes HIPEG: It can be removed for servicing and replaced by loaded pods for quick turn-around. Alternately, the pods can be left off to allow the aircraft more versatility in non-gun missions. HIPEG provides more missions per aircraft—greater aircraft utilization. As required, Hughes HIPEG pods can be installed in multiples to provide greater firepower density or longer duration.



**Hughes ammunition developments** include 20mm armor-piercing rounds specialized for use against ground targets as delivered from fixed wing aircraft, helicopters and ground vehicles. Also in development, a new 20mm salvo round for the MK 11 gun against area targets.



**Hughes Heligun has 4000 round-per-minute firepower at only 30 lbs. weight**—seven times more firepower per gun than current weapons. Designed specifically for aircraft where heavier guns are precluded, Hughes new Heligun utilizes principles proven in its 20mm counterpart—the HIPEG. Firing the 7.62mm NATO round, the Heligun will provide dense firepower from helicopters, fixed wing aircraft or ground vehicles. Features include: Self power. Instantaneous rate. Low frontal area. Positive protection from cookoff, hangfire and double feed. Pneumatic or cartridge charge, low velocity ammo feed from standard M13 links and only 190 lbs. average recoil.

**Helicopter Armament Systems**—Hughes gun packages—designed for LOH use—can also be easily adapted for other helicopters. One package has a pair of M60 machine guns and offers: elevation control, quick installation, low drag, special gun sight. Alternately, the new Hughes Heligun could replace existing guns to offer a fourfold increase in firepower and a five times reduction in drag. A fixed wing version would contain the Heligun in an external pod. An interchangeable package contains the XM-75 grenade launcher.



◀ Hughes HIPEG 20mm Pod with MK 11 Gun (4000 round-per-minute firepower) gives the Navy's A4D maximum effectiveness against small targets such as tanks and other ground vehicles.

**Twenty years of experience** applied to expansion of the state of the art...complete engineering laboratories, enclosed firing ranges and manufacturing activities in one compact facility. These are the factors which have made Hughes unique as a producer of advanced armament for free world defense. Individuals with a need-to-know are invited to request further information. Please contact the Vice President-Marketing, HUGHES TOOL COMPANY, Aircraft Division, Culver City, California.





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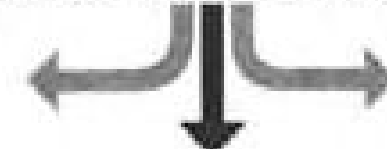
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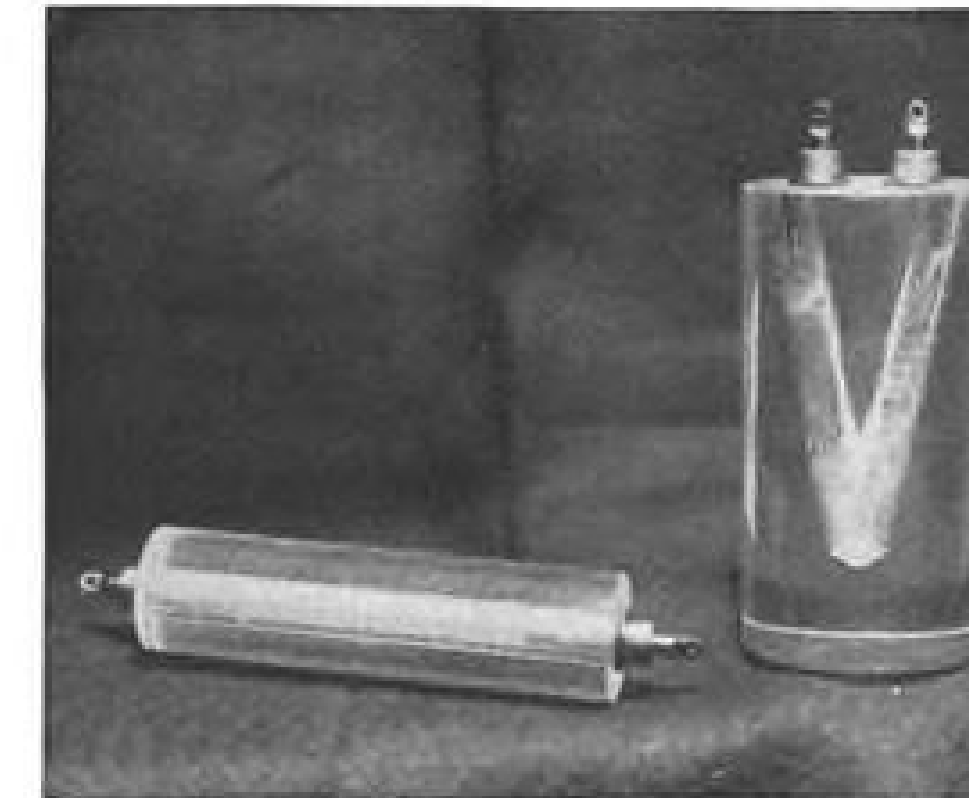
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### Laser-Lamps Developed

Laser-lamps, in which laser crystal serves as envelope for pumping lamp to provide more efficient coupling, are product of Semi-Elements, Inc., Saxonburg, Pa. In operational models, crystal surfaces are dielectrically coated to full reflectivity except at one end where beam is emitted. The integral lamp significantly lowers threshold at which laser action occurs, firm says.

ments and computation are performed automatically.

Second approach, which is better suited to ballistic missile guidance, uses the star sights to correct for any initial misalignment of the platform gyros as well as any drift that occurs during the boost phase. Sighting on one star provides a means for correcting gyro drift along an axis at right angles to the line of sight.

Using separate sightings on two stars separated by an angle approaching 90 deg. provides information to align the stable platform precisely about both axes as well as provide a heading reference.

Two separate star trackers can be used to obtain the two star sightings simultaneously. However, a single telescope can be used to sight both stars alternately with the guidance computer automatically making allowance for the different sighting times.

For an application such as the MMRBM, where size and weight are extremely important, the single tracker is preferred.

In operation, when the missile has reached a suitable altitude, the computer (AW Nov. 12, p. 118) will aim the tracker so that the star should be centered in its field of view if there is no error in the stabilized platform. Any deviation between the position predicted by the guidance computer and the actual star position generates a signal which is used to shift gyro and platform into correct alignment.

This assumes that the celestial star field is the ultimate reference. However, presumably the computer will be designed to guard against momentary erroneous readings from a star tracker so that if the deviation between computed

### A RELIABLE ROAD TO RELIABILITY



(Or: A helping hand for the harassed)

The effects of mentioning the word "reliability" in the presence of a manufacturer doing business with a military customer can be predicted with a high degree of probability.

The initial phenomenon is a rapid coloration of the face to the condition known as "purplish," accompanied by darkly lowered brows and clenched teeth. After a short ignition period, the teeth quickly part to permit the explosive release of a variety of high-energy expletives.\*

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\*Many of which represent decided advances in the state-of-the-art. Sorry that postal regulations prevent us from printing the outstanding examples we have collected in recent months.

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and actual star position exceeds a reasonable amount by which the gyros might have drifted since the last sighting, the reading will be ignored.

#### Solid-State Trackers

Solid-state type star trackers, currently under development, are expected to offer the high response speed of a photoconductive vidicon with the sensitivity of the photoemissive photomultiplier tube in a unit smaller than either, Lichtenstein said. The tracker will use a mosaic of photoconductor cells, made of materials such as cadmium sulfide or lead sulfide, which can be electronically scanned. The pattern of pulses obtained during the scan will indicate the position of the star within the field of view.

The tracker itself will be mounted as an integral part of the inertial reference cluster, with two degrees of freedom.

Use of stellar techniques in combination with inertial demands higher performance tolerances on the inertial portion of the system rather than lower, as might at first be surmised, Lichtenstein said. The servo system used to maintain gimbal alignment to the gyro references must be tighter, with less "hangoff angle" (static error) than in an all-inertial system. To minimize errors due to backlash in the gearing, direct-drive-type torque motors are used both to position the inertial platform and the star tracker.

Measurement of platform and star tracker angles must be extremely accurate, which suggests the use of digital type pickoffs, particularly since the guidance computer is of a digital design.

The stabilization gimbal outputs are used for flight control (autopilot) rather than as part of the inertial computations.

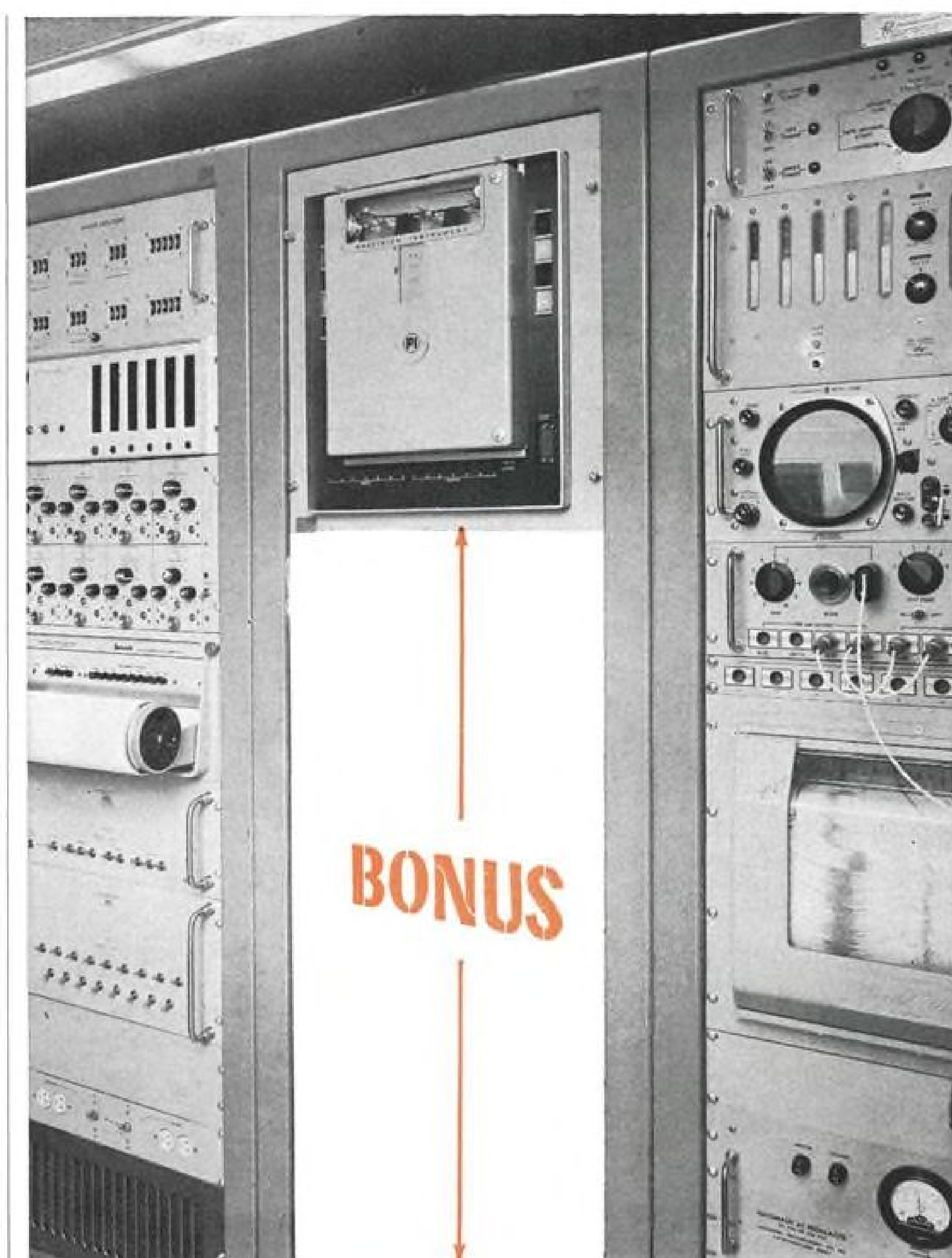
This eases the accuracy requirement somewhat, leaving it dependent only upon the needs of the flight control system.

#### Error Limits

All of these errors, including those introduced by the viewing window in the missile, must be limited to "a few seconds of arc," Lichtenstein said. At the earth's surface, an angle of one second of arc corresponds to 100 ft. A total of 10 sec. of arc accumulated error from all sources could result in a miss of 1,000 ft.

This figure of 1,000 ft. is believed to be the CEP (circular error probability) goal for the mobile medium-range ballistic missile.

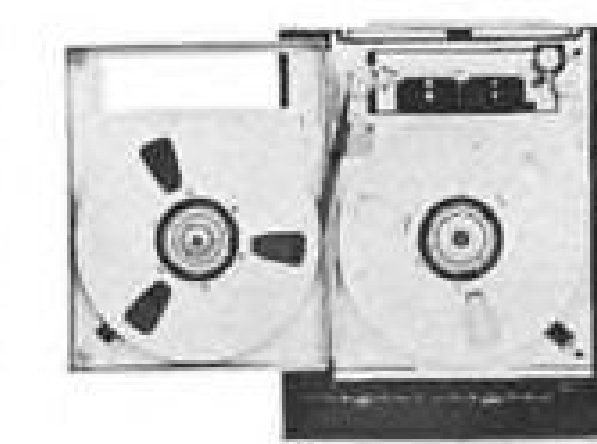
Building and testing a stellar-inertial system to this degree of accuracy will demand a major upgrading of instrumentation to assure that it meets design objectives, Lichtenstein concluded.



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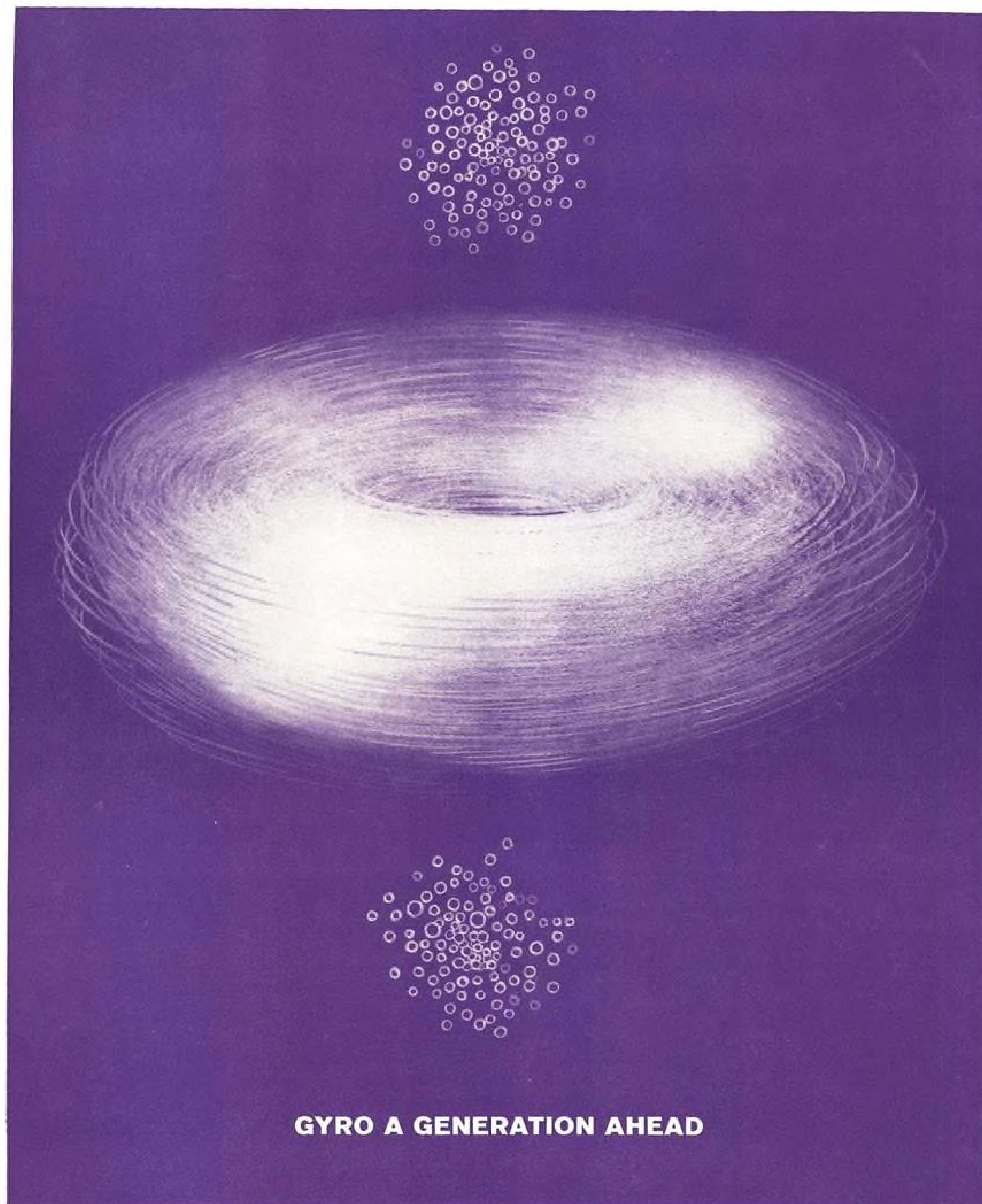
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## GYRO A GENERATION AHEAD

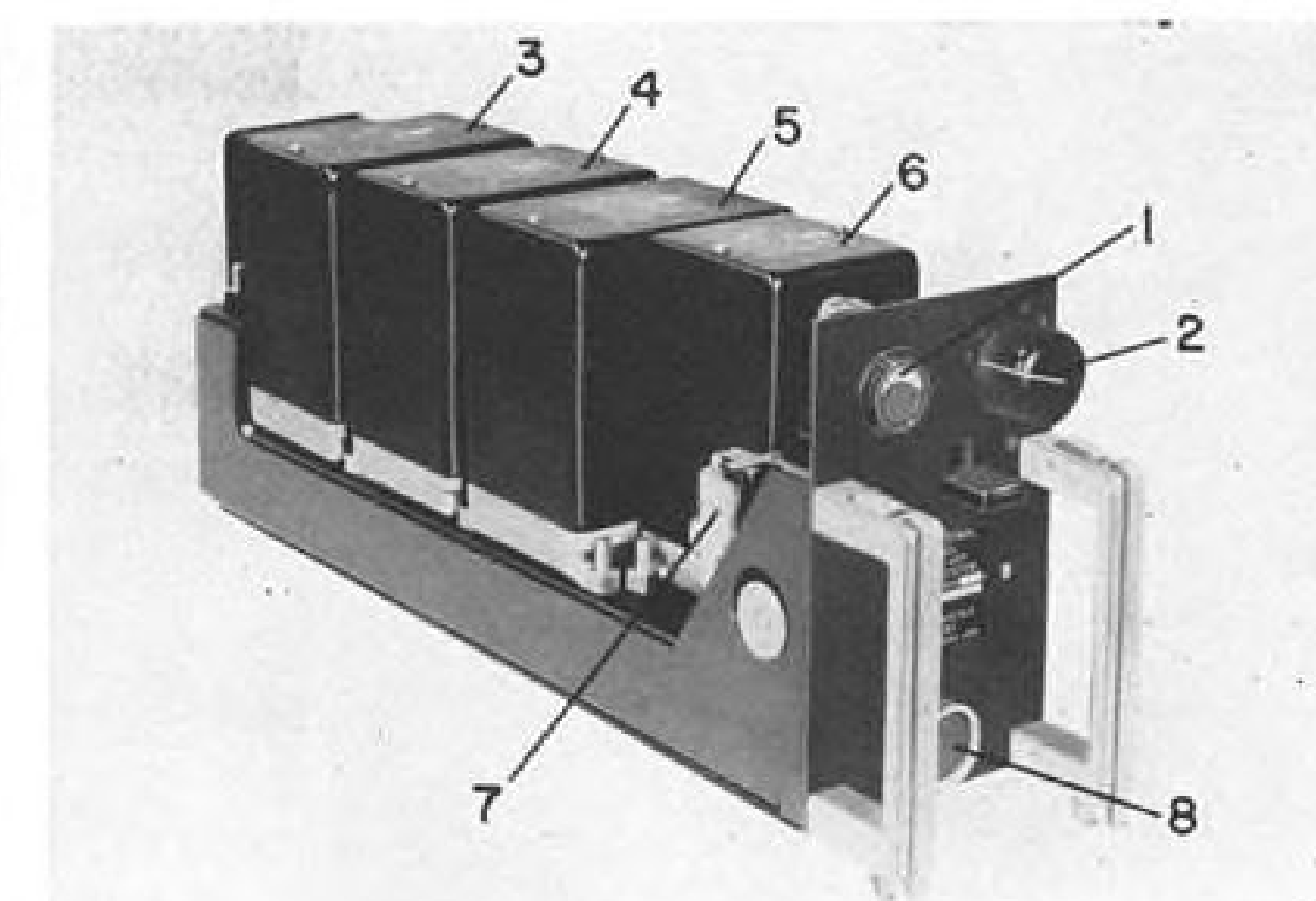
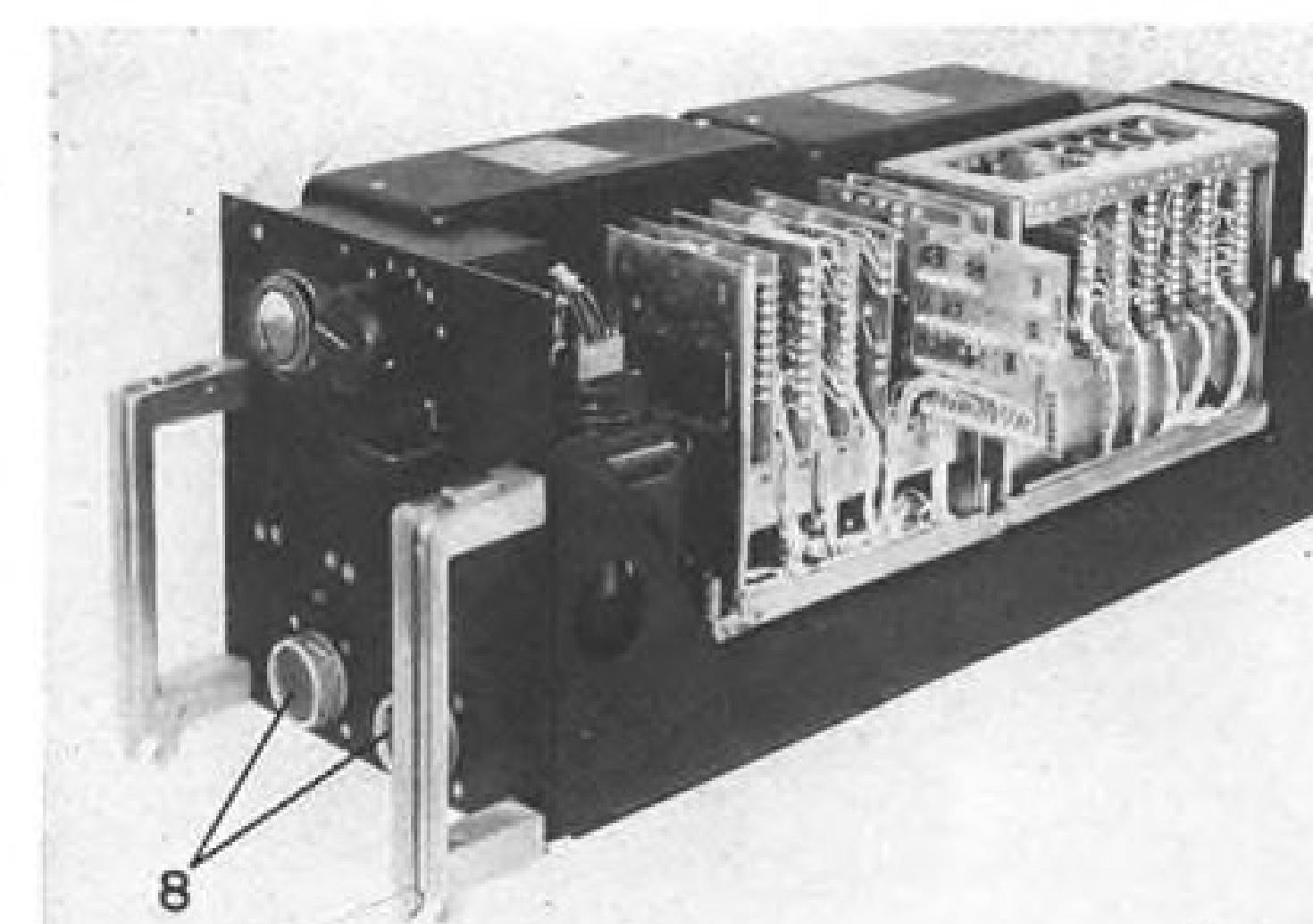
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It is the Mark I, Mod 3 Gas Spin Gyro produced by Sperry Gyroscope Company for purposes of inertial navigation.

**SPERRY**

SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N. Y.



**CONTROL RACKS** for pitch (left) and roll (right) channels of SP 50 autopilot, now in production and scheduled for use in at least 128 Boeing 727 short-to-medium range jetliners, have quantitative and qualitative self test capability, the indicators and selectors for which are shown (1 and 2). Others items in view include pitch calibrator (3), vertical path coupler (4), trim coupler (5), pitch servo amplifier (6), rate gyro test damper (7) and system test set connectors (8).

## Sperry 727 Autopilot Stresses Reliability

By Barry Miller

**Phoenix, Ariz.**—Automatic flight control systems designed and being produced here for the Boeing 727 short-to-medium range jetliner will reflect an unusually heavy emphasis on reliability in an effort to cut maintenance costs, boost pilot confidence and eventually make possible lower IFR minimums.

Autopilots, designated SP 50 and being manufactured by Sperry Phoenix Co., will incorporate a glideslope extension mode to give the airliners an all-weather, low-approach capability aimed at achieving a minimum altitude goal of about 125 ft. This is the same glide slope extension capability being offered to operators of the Douglas DC-8 as an autopilot improvement for that aircraft (AW Dec. 11, p. 85).

While the SP 50 includes a number of technical advances, the stress in its development appears to center on reliability from the component to the equipment level. The desire to simplify maintenance and minimize down time also figures prominently in the design philosophy. Thus, the autopilot is packaged in separate racks for yaw, pitch, roll and air data sensor equipment with provisions on each rack for go/no-go self-tests.

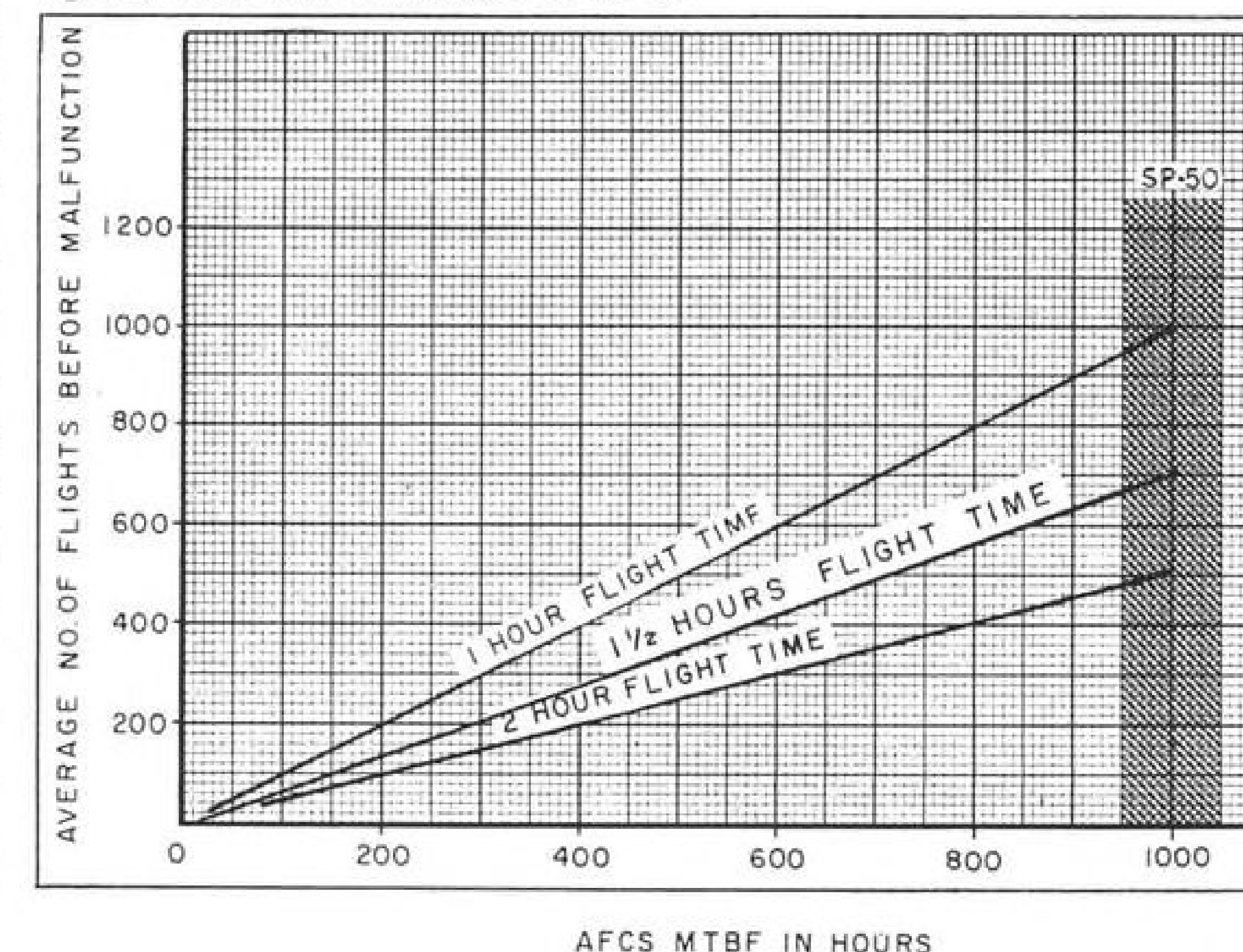
This emphasis contrasts somewhat with that of the company's SP 30 autopilot (AW Nov. 26, 1956, p. 76), which introduced many innovations to meet rigorous stabilization requirements posed by the emergence of commercial jet transports.

Now that the company has acquired its jet transport autopilot experience, the new autopilots do not appear technically as startling.

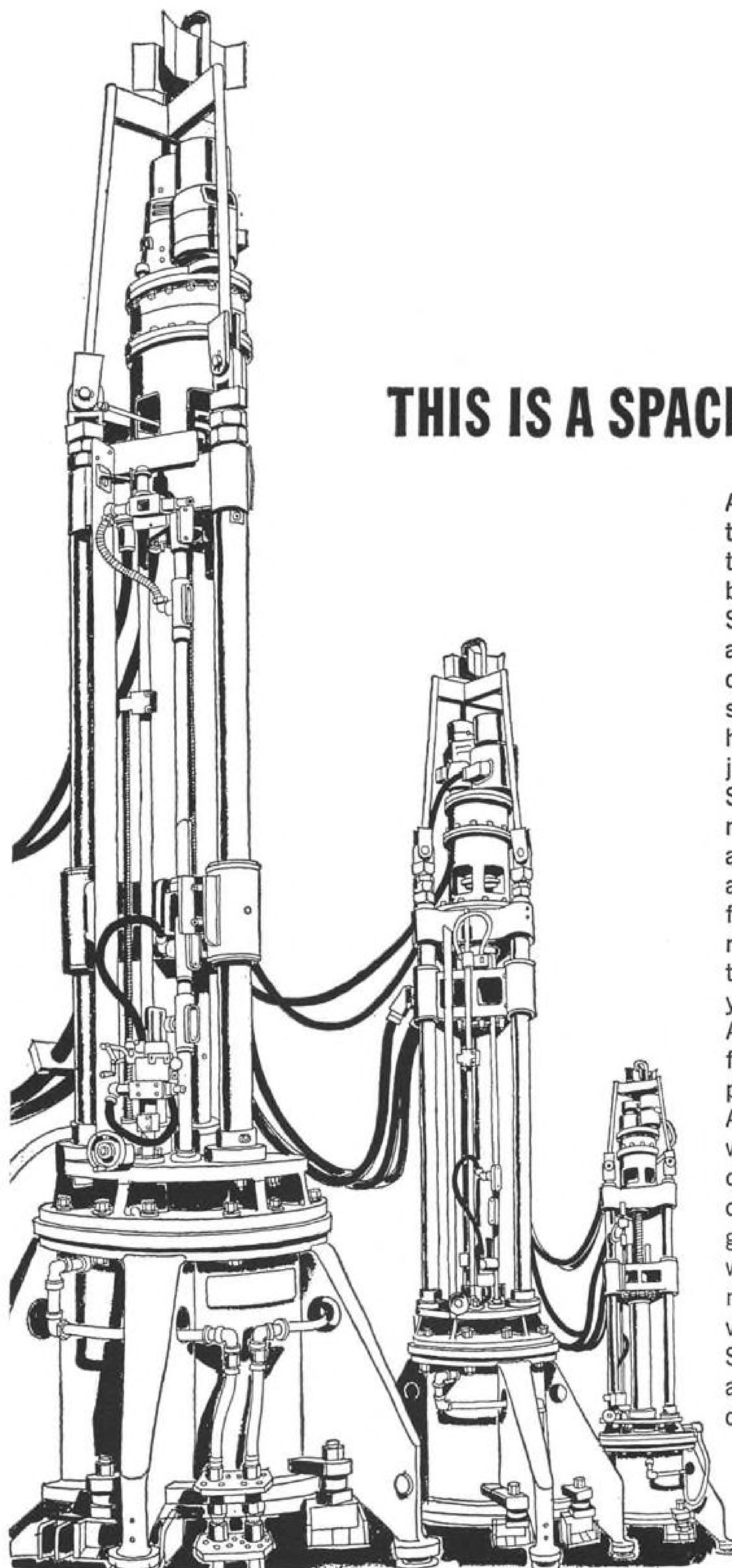
One notable innovation of the SP 30 had been the use of inertial stabilization, which substitutes accelerometers



**AUTOPILOT CONTROL PANEL** for SP 50, above, has single integrated turn and pitch knob. Switches are designed primarily for ruggedness and reliability. Below, graph shows unusually high mean time between failures for the SP 50.







## THIS IS A SPACE AGE STEEL MILL

At first glance these units appear to be small missiles, secure on their launching pads, awaiting blast off. But they're furnaces, Space Age steel furnaces located at Latrobe Steel Company. ♦ Out of these furnaces come Vac Arc® steels, the special high strength, heat resistant alloys needed for jets, missiles, rockets and other Space Age products. Ingots are remelted . . . drop by drop . . . under a high vacuum to remove gases and impurities from the alloys before they are sent on to the rolling mills and forging presses. ♦ Latrobe Steel, currently in its 50th year of business, entered the Space Age in February, 1959, when the first arc was struck in the company's first vacuum furnace. In August, 1961, a second furnace was installed and in 1962, with the demand for the super alloys produced by Latrobe's furnaces so great, both a third and fourth unit were added. ♦ These new furnaces are just one step in the diversification and growth of Latrobe Steel, a company long recognized as the leader in quality tool and die steels.

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for rate gyros and eliminates feedback of control surface position.

Approach was not employed in the SP 50 for several reasons. Principal among them was the desire for channelized packaging, with its simplified maintenance and reduction in wiring. The channelized approach lends itself to the use of rate gyros which can be installed in each channel package. Accelerometers would have to be located remotely from the channel racks.

Besides the cited advantage of separate channel packaging, each flight axis of the autopilot can be engaged and operated independently, thus permitting split axis operation, i.e., manual control in pitch and automatic in yaw.

SP 50 employs dual yaw dampers connected through separate actuators to the aircraft's split rudder, thereby giving the aircraft a measure of fail-safe operation. In the event of failure in one, there effectively is a redundant yaw channel. The system has potential for growth to additional dual channels on the other axes, a move toward increasing pilot confidence in going to lower minimums.

Yaw damper can be in operation throughout flight, including takeoff and landing. With a series actuator tie-in to the manual controls, damper control actions are not reflected at the rudder pedals, according to the company. The pilot will be able to maneuver the aircraft with his rudder control without experiencing an opposing force from the yaw damper.

### Other Features

Other technical features of the autopilot include:

- Improved crosswind correction capability.
- Automatic stabilizer trim monitoring.
- Automatic localizer/VOR capture permits pilot to set intercept angle.
- Better maneuverability through integrated turn and pitch controller.

Sperry has made several efforts to improve autopilot reliability. First, electrical components were selected with reliability and stability as major considerations. Only four types of transistors are used, and these are high-quality parts.

In one case a component type evolved from the extensive reliability improvement program for the guidance system of the Minuteman ICBM (AW Oct. 29, p. 57).

Wherever possible, solid-state components or switches were substituted for potentially more troublesome electro-mechanical parts.

Resistors are derated so they do not exceed 50% of their rated dissipation limit at 71°C. Capacitors are operated at half, or less, of the specified operating voltage rating, semiconductor components at less than 50% of manufactur-

er's maximum rated power dissipation for heat sinks employed.

Company says its estimates indicate the complete autopilot, including dual yaw damper, will have a mean time between failure (MTBF) of 1,000 hr., about three times higher than field equipment.

An extensive reliability audit was conducted, under which all parts are evaluated to determine their ability to meet system requirements. Before approval, each part underwent environmental and life tests conducted by the parts vendor or Sperry. Then, individual circuits were checked, operating levels of each part measured with respect to its ratings and derating calculated on the basis of standard reliability data for the parts. This information was audited and incorporated in manufacturing drawings.

Average component circuit card in the system, according to Sperry calculations, has an MTBF greater than 100,000 hr. with the lowest figure, for the modulator-demodulator card, of 65,000 hr. Only one of every three cards will malfunction during the average 10-year operating period of an aircraft, the company says. System reliability is computed from summation of component failure rates.

Other factors expected to raise system reliability include a one-third reduction in the parts count of the system compared with other transistorized autopilots, more extensive use of internal feedback for long-term stabilization, reduction in the number of inertial connectors and relays, and more rugged mechanical construction.

Following steps were taken to improve maintenance:

• **Construction**—Racks containing equipment for each channel consist of a number of plug-in modules, each corresponding to a complete function or several functions. Within the modules, 3-in.-sq. aluminum circuit cards, on which components are mounted, can be rolled out and energized while the equipment is in place. This gives technicians a chance to trouble-shoot equipment in an energized state. Each module has a trim potentiometer for controlling its tolerances. Neither hermetically sealed circuit modules nor printed circuits are employed as another step to bypass potential trouble areas.

• **Self tests**—Go/no-go meter and self-test indicator located on the face of each rack provide for self-testing of installed equipment at a high confidence factor. Indicators are interlocked to the autopilot warning light, which will insure that the indicator is properly disengaged.

• **Life test**—On the front of each channel is a line test set connector which permits a technician to make nearly 100 tests with the aid of a portable, semi-automatic line test analyzer in about 15 min. and with a 95% confidence factor, according to Sperry.

SP 50 has its own central air data sensor, rack-mounted like individual channels and completely independent of any central air data computer aboard the aircraft.

The sensor, which obtains altitude information, may be used for monitoring the glideslope extension.

First of at least 128 production SP 50 autopilots has been delivered and is expected to be certified late next year.



### Photometers Detect Nuclear Debris

Optical photometers, developed by Geophysics Corp. of America, detect presence of nuclear debris from high-altitude nuclear explosions by observing scattering of sunlight from debris and identifying spectral lines of trace amounts of debris elements.



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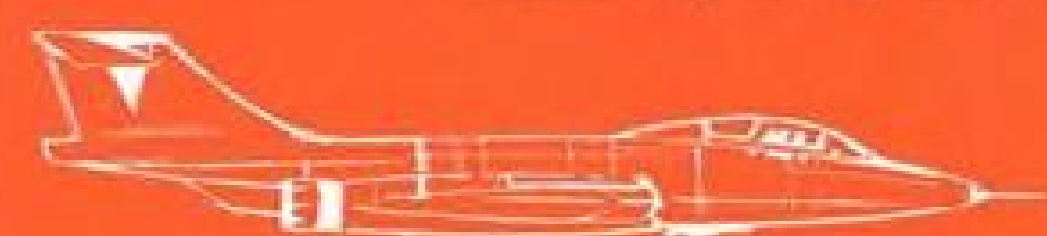
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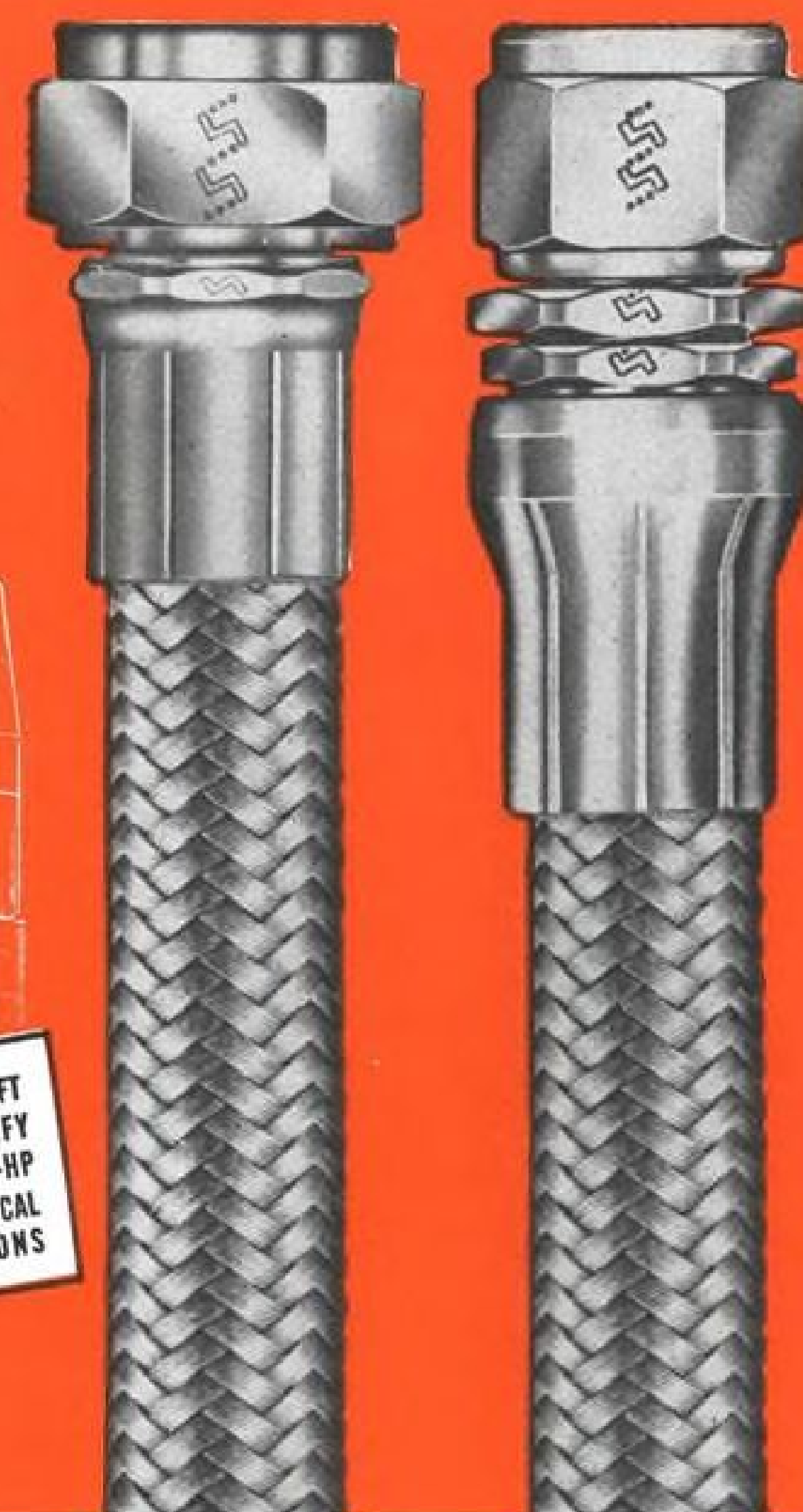
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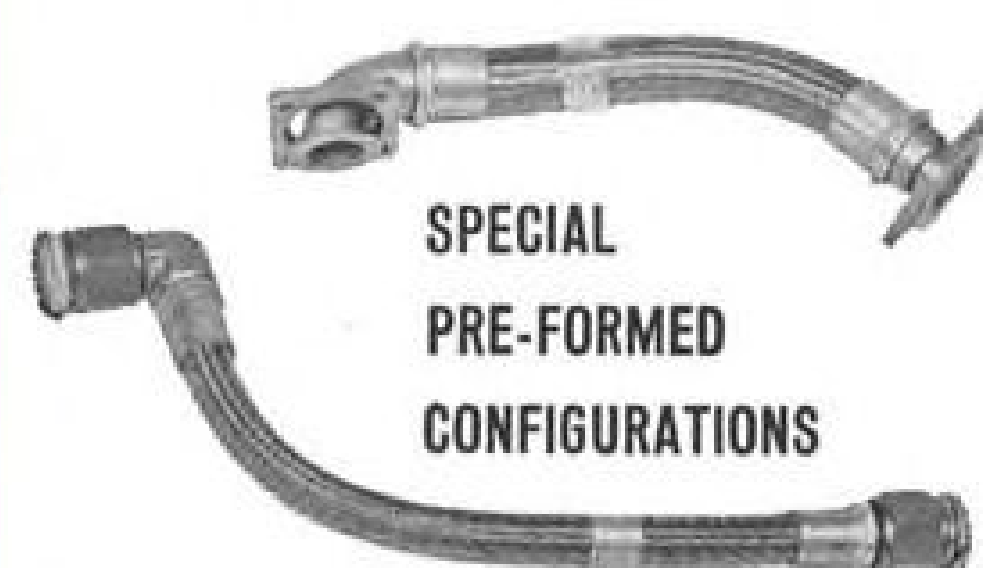
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► **Microcircuit IFF Transponder Program**—Bureau of Naval Weapons is seeking companies with competence in both microcircuitry and IFF identification transponders to develop a unit weighing 15 lb. or less, with delivery required in 10 months. Qualified contractors must contact BuWeps by Nov. 22.

► **Launch-Phase Precision Trackers Planned**—Program to develop techniques suitable for a precision ballistic missile tracker to be used during early launch phase at altitudes of 500 ft. to 60,000 ft. is planned by Rome Air Development Center. Program objective calls for system to measure missile velocity to within 0.02 ft. per second.

► **Orbital Attitude Sensing System Sought**—Nine-month study program to develop technique for an earth-based system which can be used to measure accurately the attitude of spacecraft in orbital flight or returning from a lunar mission is planned by Rome Air Development Center. Objective is to provide means for evaluating accuracy of spacecraft's self-contained guidance and attitude sensors. Desired accuracy of measurement is to within 0.25 degree.

► **Jupiter Radiation May Be Maser Action**—New theory to explain the long wavelength (decimeter) radiation from the planet Jupiter suggests that it may be the result of stimulated emission produced by solar radiation impacting on electrons in the planet's atmosphere. The proposed theory, advanced by Dr. Leon Landovitz of Yeshiva University in New York and Dr. Leona Marshall of New York University, suggests that normal solar radiation keeps more than half of the electrons in a high energy state. A burst of solar radiation shifts the alignment of electrons with respect to Jupiter's magnetic field causing them to fall to a lower energy state and emit an intense burst of decimeter radiation, the theory holds. If proven, this theory opens the way to predicting the presence and intensity of magnetic fields of other planets. Based on this principle, the New York scientists calculate that Jupiter's magnetic field has a strength of about 6.4 gauss, roughly 13 times the strength of the earth's field.

► **Transistor Unit Prices Drop**—U.S. semiconductor manufacturers sold 158.8 million transistors during first eight months of this year, an increase of 35% over the same period last year, but dollar volume of \$193.8 million was down

about 3% for same period despite increased volume. Average per unit price for first eight months was \$1.22, while average price during last month of the period was \$1.19.

► **Telstar Data Tests Successful**—Data transmission tests using Telstar communication satellite have demonstrated extremely low error rates. During one test from France to the United States there was only one bit-error in a total transmission of nearly one billion bits at a rate of 875,000 bits per second.

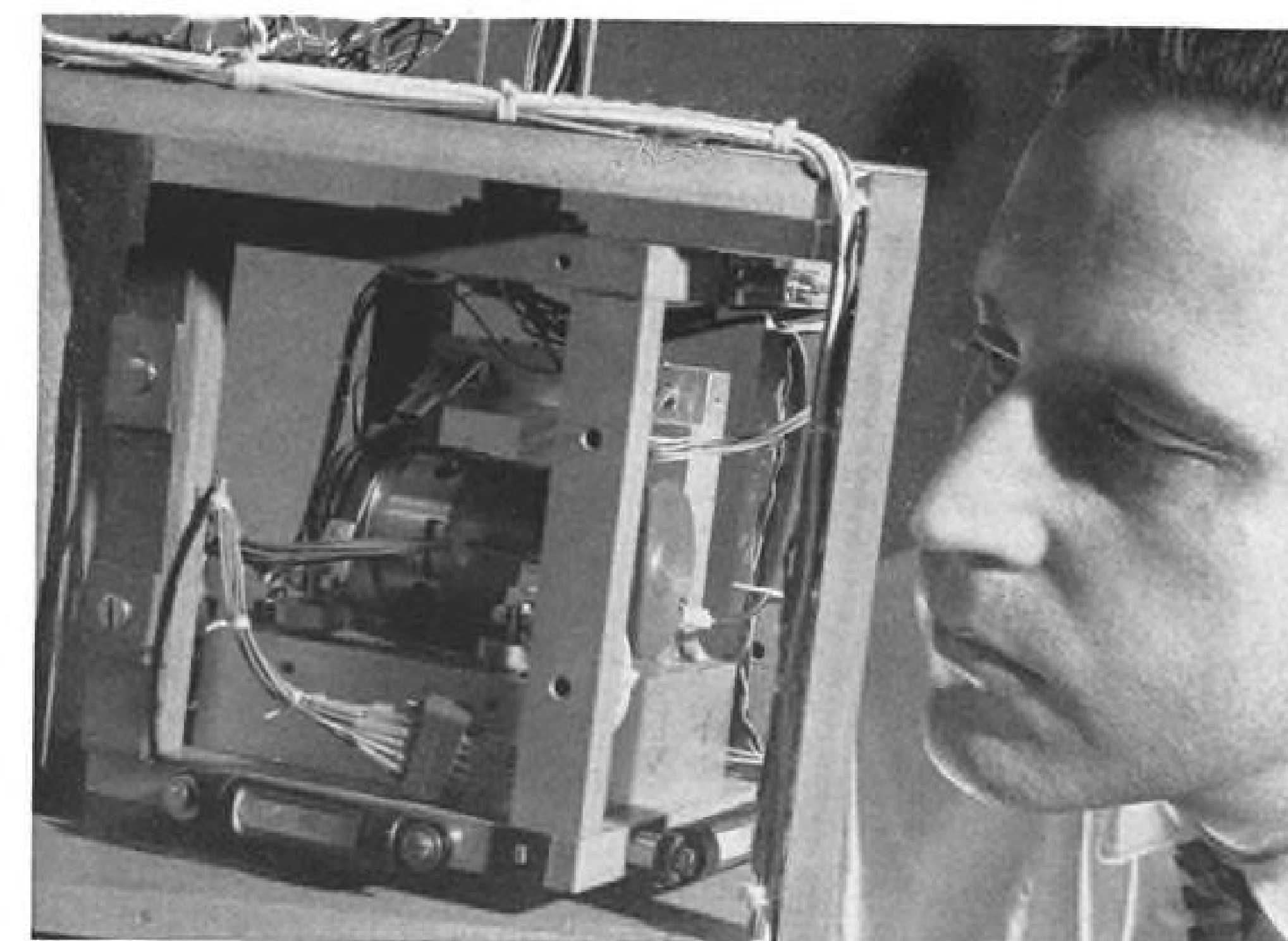
► **Low-Noise Parametric Amplifier**—Parametric amplifier using commercial quality gallium arsenide varactor diode, operating in a bath of liquid helium at a temperature of 4.2K, has exhibited a noise temperature of less than 10K, far lower than previously achieved for paramps and comparable to the performance obtained from masers, according to Lincoln Laboratory. The device operates at a signal frequency of 1.3 gc. (kmc.) using a pump operating at 13.5 gc. Operation at signal frequencies up to 15 gc. with noise temperatures including circulator of about 20K appear feasible, according to Carl Blake, Lincoln Laboratory Radar Division.

► **New Cryogenic Thermometer**—Gallium-arsenide diode, which exhibits an

extremely linear temperature-voltage characteristic at cryogenic temperatures, is the most useful sensor yet developed for such use, according to Bell Telephone Laboratories. Zinc-diffused gallium arsenide diodes have a sensitivity of  $3\frac{1}{2}$  mv./deg. K at room temperature and about  $1\frac{1}{2}$  mv./deg. K at temperature of 1.4K, BTL reports. Resolution to within 0.01 degree can be obtained.

► **New Device Measures Spectrum Signature**—Equipment designed to make a complete spectrum signature of a radio or radar equipment, covering the spectrum from 250 to 40,000 mc., is being developed by the Sperry Microwave Electronics Co., Clearwater, Fla., under Rome Air Development Center sponsorship. Prototype of the new AN/MSM-63 is scheduled for delivery next summer. The development is part of Defense Department program to analyze and minimize possible interference between various military equipment and civil equipment (AW July 23, p. 55).

► **Atlas Guidance Gets New Memory**—Inertial guidance computer memory for Atlas models "E" and "F" is being replaced with new bi-aperture magnetic core type operating on coincident flux principle which will permit rapid reprogramming of computer to handle change of target. New type memory also will not lose stored data in event of power interruption or data read-out, according to American Bosch Arma Corp. which is supplying the units for its Atlas inertial system.



## New Rotorace Gyro Offers Decreased Drift

Improved Rotorace gyro, Type SYG-600, using contra-rotating bearing races, has drift of only 0.01 deg./hr., an improvement of 25:1 over accuracy of earlier models (AW Feb. 17, 1958, p. 78). Non-floated gyro operates over temperature range of  $-65^{\circ}$  F. to  $200^{\circ}$  F., reaches operating speed within 1 min. Manufacturer: Sperry Gyroscope, Great Neck, N. Y.



# When you follow these welding instructions— you can perform wonders with "T-1" Steels

USS "T-1" Steel, and "T-1" type A, are two of the most versatile steels ever developed. They combine very high yield strength (100,000 psi minimum), outstanding toughness, and ready weldability. Designers have taken advantage of this remarkable combination of properties to build stronger, lighter structures of many types, and to improve the performance of an impressive array of heavy-duty equipment.

Achieving great strength and toughness in a steel is not an earthshaking event. But combining these properties with weldability *is*, as in the case of USS "T-1" and "T-1" type A Steels. It is this weldability that permits the designer to take full advantage of the strength of "T-1" Steels.

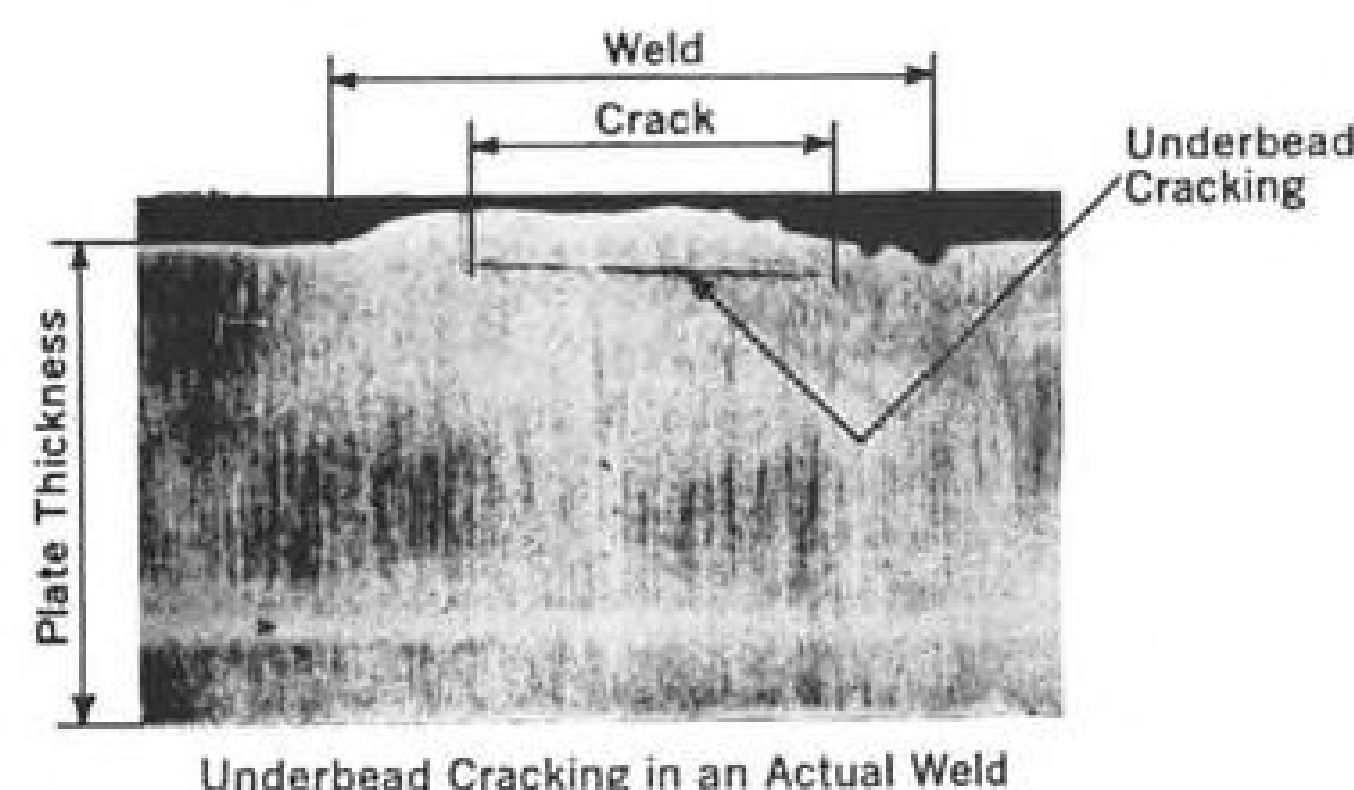
Being heat-treated constructional alloy steels, USS "T-1" Steels require different welding techniques than other high strength steels. They are not difficult to weld, just different. Strong, reliable joints are obtained when the following three precautions are followed. We invite you to read them as a guide to realizing the full benefits of USS "T-1" Steels. They are detailed in a booklet which includes a Welding Heat-Input Calculator, and in our new welder-training film, "How to Weld USS 'T-1' Steels" (see coupon).

## RULE 1—Use the proper electrodes

When manual-arc welding "T-1" Steels, use only electrodes with low-hydrogen coatings. Or, use a welding method which is "low hydrogen" such as inert-gas shielded-arc or submerged-arc welding.

Hydrogen is the number one enemy of sound welds in "T-1" Steels, as in all alloy steels, because it causes underbead cracking, resulting in unreliable joints.

To be sure you have selected the correct electrodes, remember that low-hydrogen coatings are designated by the last two numbers of the electrode classification as 15, 16 or 18. None other. For example, E8015, E9016, and E11018 are satisfactory for welding USS "T-1" Steels.



Underbead Cracking in an Actual Weld

When you want to be positive that the finished weld will be as strong as the parent "T-1" Steel, use E11015, -16, or -18 rods.

Never use electrodes or wire-flux combinations containing vanadium to weld "T-1" Steels if the weldment is to be stress relieved. Weld metal containing vanadium is likely to be made brittle by stress relief. (Stress relief is only necessary with "T-1" Steels when re-

quired by codes and one or two other special cases.)

When welding "T-1" Steels to a lower-strength steel, use low-hydrogen rods of the strength level recommended for the *lower*-strength steel.

Proper handling of electrodes is also important. When exposed to air, low-hydrogen coatings will pick up moisture which is a rich source of hydrogen. Keep your electrodes dry. Make it a practice never to open more than 30 minutes' supply of rods at a time. A sure way to keep rods dry is to keep them in a 250-300°F oven. If your rods have absorbed moisture, hot bake them in an oven according to the manufacturer's recommendation. One hour at 800°F is average.

To sum up Rule 1, for manual welding use low-hydrogen electrodes and keep them dry. For submerged-arc or inert-gas shielding arc welding, use thoroughly dry fluxes and water-free shielding gases.

## RULE 2—Use correct welding heat

On most kinds of structural steels, high heat input results in superior welds. With "T-1" Steels, just the opposite is true. The best welds in "T-1" Steels depend on *never getting over a certain maximum amount of heat*. Less heat is used so the weld will cool quickly which, in "T-1" Steels, results in good, tough welds. Thus, *you must closely control the amount of heat put into the weld*.

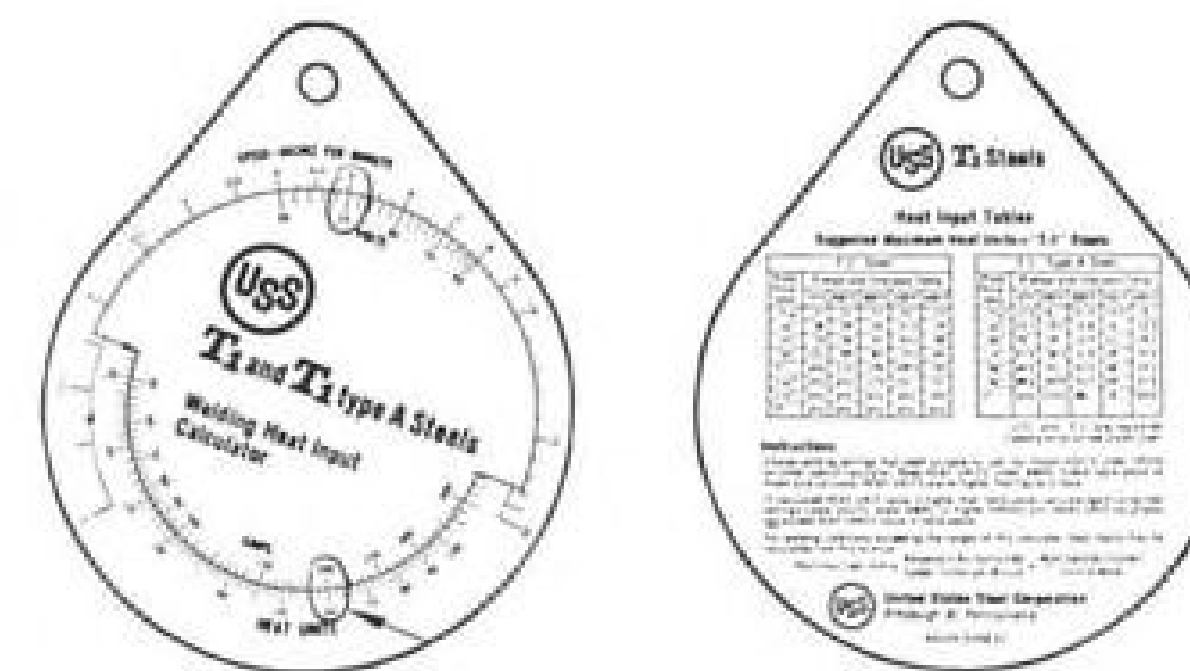
For this reason, never preheat "T-1" Steels except in special cases. Preheating means more heat to get rid of and a longer cooling off period, which can be harmful to welds on "T-1" Steels. The cases in which preheating is necessary are those in which the steel must be warmed to get rid of excessive moisture (a hydrogen source), where the piece is so restrained it doesn't have room to shrink after welding, or when thick pieces over 1" are being welded. Much of the time, however, preheating isn't necessary, and *never preheat "T-1" Steels on hunch alone*.

The heat you put into a weld depends principally on amperages and the speed at which the arc travels along the joint. The higher the amperage, the more heat input. The slower the speed, the higher the heat input. Controlling heat input requires keeping amperage below certain ceilings and keeping the speed of arc travel above certain speeds.

There are two other important items to keep track of: steel thickness and temperature. Thicker sections can safely soak up more heat than thinner ones, so you can use more amps and slower speed. As for temperature, the section may have been heated up by preheating or by previous passes of the electrode. So if the section is already hot, you must cut down on amps or increase speed to avoid excessive heat input.

## Heat Input Calculator.

There's an easy way to determine the safe heat input for USS "T-1" Steels: the circular Heat Input Calculator which is provided with the book offered in the coupon. With it you can quickly find out what amount of heat will result from any given setup, and determine how much more you can safely put in. It is a



circular "slide rule" which tells, on the front side, how much heat will be put into the joint if you know the amperage, voltage, and arc speed. On the back side of the calculator are tables showing the safe heat inputs for "T-1" Steels in several different thicknesses at different temperatures. This handy device is designed to help you get good welds every time. Heat inputs may also be calculated from this formula:

$$\text{Heat Input per inch} = \frac{\text{Amperes} \times \text{Arc Volts} \times 60}{\text{Speed, inches per min.}} = \frac{\text{Watt Seconds (Joules)}}{\text{Per inch of weld}}$$

## RULE 3—Use recommended welding procedure

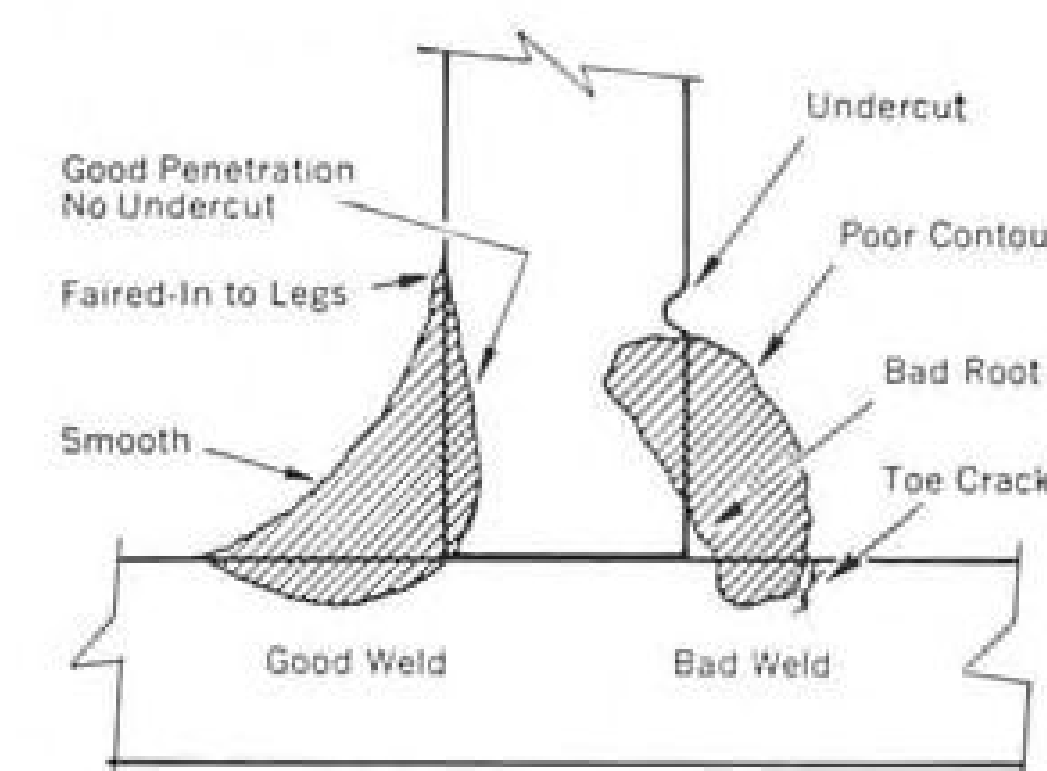
The straightforward stringer bead method is preferred for welding "T-1" Steels. *Do not use the "full weave" method*. Weaving heats the metal more because the arc travel speed is slower and may cause excessive heat input. The proper method is to fill the groove with a succession of stringer beads.

Before a bead can be laid over an earlier bead, the flux, scale, or oxidation must be removed.

**Back gouging.** The preferred method is arc-air gouging followed by clean-up grinding. *Do not use an oxyacetylene torch*. There is danger of overheating which may cause an unsatisfactory joint.

**Speed.** Whether you control speed by machine or hand, control it closely. The Heat Input Calculator described above is your guide to the proper speed to avoid excessive heat input.

**Fillet welding.** Good fillet welding technique is more important with "T-1" Steels because the joints are usually required to withstand greater forces. Fillet welds in "T-1" Steels should be smooth, correctly contoured and well faired-in to the legs of the pieces to be joined. The layers of each weld should be made so that there is good root penetration but no undercutting. The weld shown on the left is ideal, the one on the right is to be avoided.



When thick pieces are joined, and when the weldment is to be stress relieved, fillet welds can be troublesome because of toe cracking. There are several

ways to eliminate toe cracking near fillet welds on "T-1" Steels. In the case of Tee or Ell joints where lower strength welds are often the rule, use low-hydrogen rods of the E90, E80, and E70 classes. Being lower in strength and more ductile, they are less likely to "pull cracks" at the toe of the fillet weld.

Air hammer peening of the weld can also be very helpful in preventing cracks, especially if the weld is to be stress relieved. Joints made even with the higher strength rods (E100, E110 and up) should be free from toe cracks if peened. Sometimes it is necessary to peen each pass; at other times, peening only the toe passes will prevent cracking. After peening, the fillets should be smoothly ground to fair the fillet into the legs of the joint.

Other methods that can prevent cracking include use of a soft wire pedestal, machine grooving the base of the upright piece, and laying down "butter" welds in toe areas. The first two methods allow the upright leg to "shrink down." The "butter" weld strengthens the "T-1" Steel in the area where a toe crack may start. It is ground off prior to actual fillet welding and must be located so that the toe passes of the fillet will be laid right over the strengthened zone.

**Free Welding Help.** The above information is spelled out in greater detail in our free book "How to Weld USS 'T-1' and 'T-1' type A Steels." Included in the book is a Heat Input Calculator that helps the welder choose the proper welding machine settings. We'll gladly furnish enough free copies for your shop personnel. Also, you'll find our 18-minute, 16mm color motion picture of the same name a big help in demonstrating to your welders the proper techniques for welding USS "T-1" Steels. Send the coupon. USS and "T-1" are registered trademarks.

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## SPACE TECHNOLOGY

# Vestibular Screening of Astronauts Urged

By Cecil Brownlow

Paris—Reliable means of detecting and weeding out or curing space flight candidates with a marked susceptibility towards vestibular disturbances during flight, such as those experienced by Russian Cosmonaut Maj. Gherman Titov, are under urgent study in both the Soviet Union and the United States.

Lack of any feeling of nausea or visual imbalance on the parts of Maj. Andrian Nikolayev and Lt. Col. Pavel Popovich possibly indicates that the special pre-flight physical training evolved for the two (AW Oct. 8, p. 38) may help in reducing this susceptibility, although some scientists apparently feel it may be largely a matter of individual resistance to the phenomenon.

### Planetary Measurements

Mountain View, Calif.—Ames Research Center will participate in a new sounding rocket program aimed at making infrared and ultraviolet measurements of the planets Mars, Venus and Jupiter during their periods of peak brightness in the next several years.

Full details of the program and exact division of responsibility for it between Ames and a sister National Aeronautics and Space Administration facility, Goddard Space Flight Center, have not been settled. Launch vehicles, however, are expected to be either the attitude-controlled Aerobee 150 or 350 rockets capable of carrying 150 lb. payloads to altitudes of 150 and 290 mi., respectively.

Tentative plans call for firings during peak intensity of the planets:

- Jupiter—October, 1963, and November, 1964.
- Mars—February, 1963, and March, 1965.
- Venus—May, 1964, and July, 1964.

Ames' role in the NASA program will probably include the experiments which will be handled by the center's recently organized Space Sciences Division, headed by Charles Sonett, who transferred here two months ago from NASA headquarters in Washington.

The rocket probes may be launched either from Wallops Island or White Sands. Payload recovery is under consideration.

Ames hopes that data secured during the experiments will reveal a better picture of the temperature and pressures of the planetary atmospheres.

Experts in this field among the approximately 180 delegates here for an international symposium on "Basic Environmental Problems of Man in Space" all agreed, however, with Dr. Ashton Graybiel, of the U. S. Naval School of Aviation Medicine, that "in space travel it is essential that no man be sent aloft who will experience vestibular sickness."

A report presented at the conference by Soviet bioastronautical scientists M. D. Emelyanov and E. M. Yuganov said such sickness probably results from "disturbances in the physiological interplay of the sensing mechanisms governing the perception of space." Their opinion, they said, has been confirmed largely by experimental investigations they have conducted concerning "the interplay of visual, vestibular and motor mechanisms and of the appearance of spacial illusions."

Individual vestibular thresholds, they added, "vary within broad limits under the influence of certain visual excitations or static and dynamic muscular tensions."

### Titov Illness

While they did not refer directly to the illness Titov experienced during his 17½ orbits in August, 1961, which at times corresponded with the frequency of his head movements, Emelyanov and Yuganov concluded:

"The most frequent spacial illusions and their accompanying vegetative reactions appear as a result of excitations of the vestibular apparatus when the subject is in a state of balance on an unstable support or when his eyes follow continuously moving objects."

"Static muscular tension and visual concentration on a fixed object considerably inhibit the appearance of these phenomena. The degree to which disorders in the perception of space are expressed depends also on the individual peculiarities of the subject."

Scientific selection and training of astronaut candidates the paper added, "are the most effective counter-measures against these disorders."

Titov's illness, which touched off new worries and areas of research in both the U.S. and USSR, was mentioned directly by Dr. Graybiel. He said the Soviet astronaut apparently sustained a "characteristic illusion" during his transition into a state of weightlessness, feeling momentarily disoriented as though his body were in a somersault.

During the seventh orbit, Graybiel

continued, after Titov had taken over manual control of the Vostok on the sixth and had swung the capsule through a series of left, right and complete turns, the astronaut suffered periods of dizziness and nausea.

"It would be a matter of importance," he said, to know whether Titov may be naturally susceptible to vestibular sickness. He added that he "gathers" from what Soviet scientists have said that this might be the case.

A member of the Russian delegation said it was his understanding that U. S. astronaut Marine Lt. Col. John Glenn, had "fainted" during his three-orbit flight and asked "how long did this vestibular condition last and what were the symptoms?"

### Glenn Faint Denied

Graybiel denied any such knowledge and, on invitation, Dr. S. C. White, of the National Aeronautics and Space Administration's Manned Spacecraft Center, said from the floor that he also was unaware of any such incident.

Graybiel explained that Glenn had suffered no feelings of sickness during flight but that after landing he did experience "some stomach awareness" during his stay in the water before retrieval and afterwards aboard the recovering destroyer. This feeling, "which didn't bother him very much, disappeared when Glenn arrived on the more stable deck of an aircraft carrier, Graybiel said.

### Ranger Schedule

Ranger 6, first of at least four Ranger lunar spacecraft which will carry special television payloads consisting of a package of six vidicon cameras for obtaining high-resolution photographs of the lunar surface before the spacecraft crash-lands on the moon, will be launched from Cape Canaveral, probably between Jan. 13 and 16.

Ranger 7, another spacecraft in this series, will follow in March, Ranger 8 in the spring—possibly in May—and Ranger 9 in late summer (AW Oct. 29, p. 38).

Ranger 10, the first of five more spacecraft recently added to the series, is scheduled for a launch late next year, probably in November. Four remaining shots in this supplemental series, Rangers 11 through 14, will be launched on a staggered schedule in 1964, concluding by the end of September.

White added that Glenn "never demonstrated fainting or unconsciousness" during flight and had, in fact, "not felt" his stomach. This, he said, extended to the point where Glenn experienced no feeling of hunger.

Predicting susceptibility to vestibular sickness poses a problem, Graybiel admits, since it is impossible to simulate weightlessness for long periods under terrestrial conditions. He adds, however, that "there is good evidence that susceptibility to symptoms in one type of gravitational-inertial force environment has predictive value for exposure to another type."

It is almost a truism, he said, that "all motion sickness is vestibular sickness, but some vestibular sickness is not motion sickness."

Studies conducted thus far by the Naval School of Aviation Medicine under controlled conditions began with the comparative symptomatology between normal and deaf subjects. The motion tests were conducted primarily in a "slowly-rotating" room, a counter-rotating room located in Toronto, Canada, and aboard aircraft in flight.

These experiments, "though far from complete indicate that persons with labyrinthine defects are relatively insensitive to psychic insults and bizarre or nociceptive stimuli, which may cause symptoms in healthy subjects."

### Test Pilot Resistance

He also noted that test pilots examined seem to have a greater resistance than normal to vestibular disturbances and suggested that this may indicate an ability to adapt one's system to a particular environment since, until now, this point has not been a criterion in the pilots' selection.

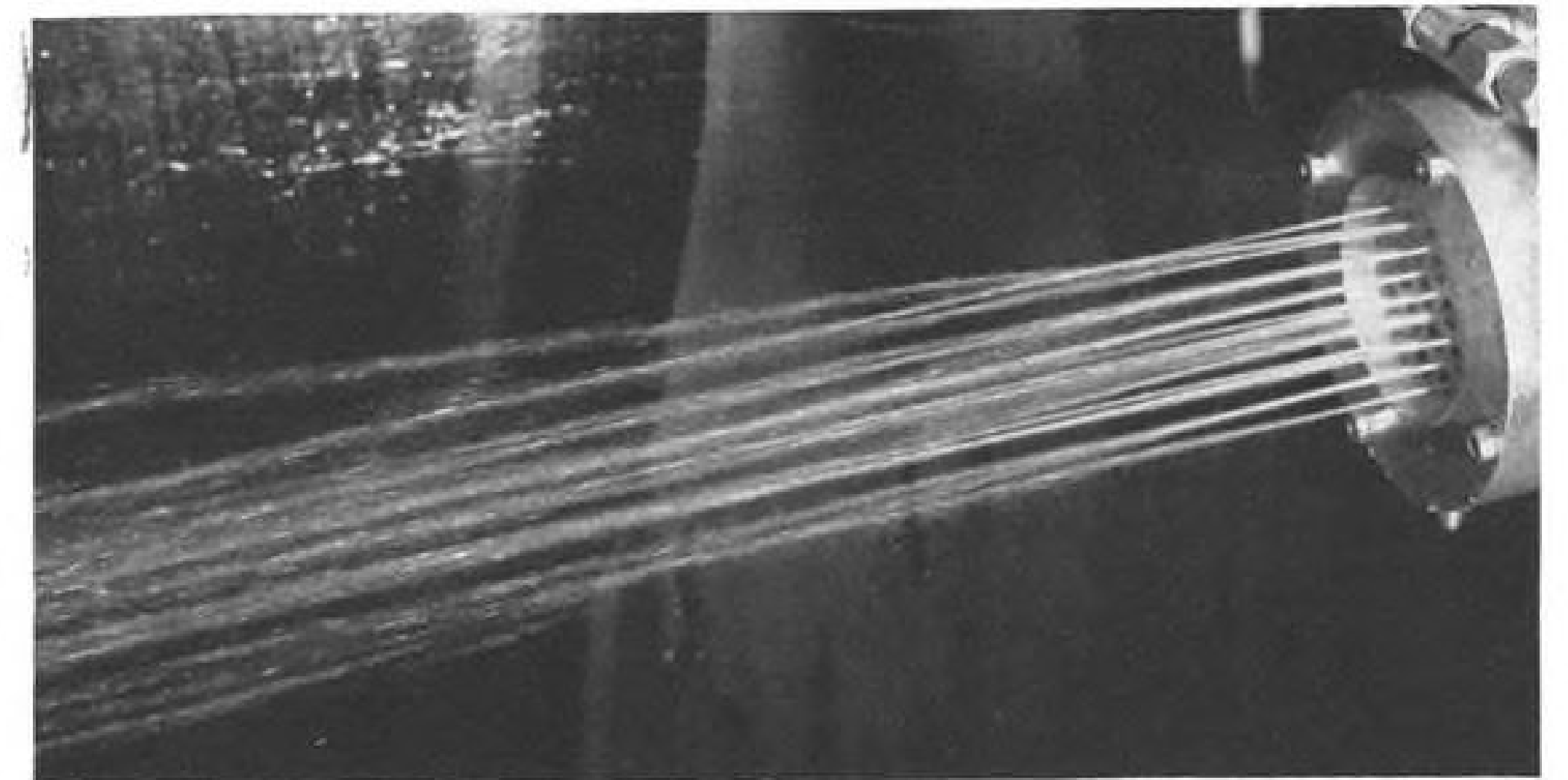
He warned, however, that adaptation may be highly selective in nature. In the tests, he found that a subject could on occasion adapt to one type of head motion but not to others. At times, the adjustment to one type of motion made the subject more susceptible to others.

Graybiel concluded that so long as astronauts are selected from pilot groups with a large number of flying hours, "you almost automatically eliminate those with more than a small susceptibility."

A bigger problem, he added, will come in the selection of scientists with little or no previous flying experience to participate in multi-man flights.

W. R. Lovelace II of the Lovelace Foundation for Medical Education and Research, which played a major role in selection of the Mercury astronauts, said scientists will need to undergo a minimum of one year's training before flight. He added:

"Prior to their examination and selection, these men will not have been



### Standard Injection, Aeration Throttling Compared

Conventional propellant injection (top) is compared with United Technology Corp.'s aeration throttling system (bottom), which the company has tested in about 100 hot firings (AW Nov. 5, p. 27). UTC development is designed to reduce thrust—by injecting an inert gas into manifold to cause spray-type ejection—to 1% of operating value and still maintain combustion stability. Aeration throttling system has been offered for Apollo lunar excursion module and space station uses.

exposed to the stresses of flight so their reaction to such stresses will be unknown and, thus, the selection process will be more difficult. The Gemini program will be most helpful in the final selection, indoctrination and training of scientists as they can go along on orbital flights with an experienced astronaut."

Report delivered by Don Flickinger, former head of the U. S. Air Force's bioastronautical research program and now a research consultant in Washington, and co-authored by W. Ross Adey, of the University of California's Space Biology Laboratory, suggested that "as a critical measure of the effects of vestibular disturbances, the monitoring of the brain's electrical patterns through scalp recordings may prove vitally important."

The wide variation in individual susceptibility to vestibular stimulation, the report added, plus its "debilitating effects in the highly susceptible would appear to make further application of EEG (electroencephalograph) evaluation of the highest importance, particularly in astronaut selection."

To carry out these and other measurements in a space environment, Flickinger and Adey have developed a series of lightweight biomedical devices capable of being fitted into a standard space helmet. In the design of the equipment, the report said, particular attention was given towards development of a recording technique that would represent an essentially "non-interference" approach to the problem. It added:

"... the transducing of brain electrical activity from the scalp should, if possible, avoid any direct attachment to the scalp by adhesive electrodes, and, in particular, should avoid the penetration of the scalp by any form of needle electrode. It should be compatible with any normal haircut, and epilation should be unnecessary."

Studies made on a number of animals by the two scientists also indicate that prolonged periods of weightlessness may preclude a "major reduction in sensory influx" from muscle and joint receptor mechanisms in prolonged weightlessness but that "approximately normal activation will occur" in the astronaut's





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auditory, visual and cutaneous receptor mechanisms. Psychic effects related to the reduction of sensory influx, the report said, "may therefore be expected to occur in space only under exceptional circumstances."

One such circumstance might be prolonged absence of light and the necessity of existing in an environment of total darkness for a prolonged period of time.

To test the possible effects of this condition, Flickinger and Adey raised a series of six rhesus and cynomolgus macaque monkeys in total darkness and white (random) noise from shortly after birth for periods exceeding three years in some instances.

#### Monkey Experiments

These animals, the report related, "appear to sleep very little and display in most cases a ceaseless activity, with constant pulling and pushing at objects in the environment. They exhibit bizarre and distorted behavior patterns, with smacking of their own heads, chewing of their own limbs and ritualistic movements of limbs not actively employed in concurrent activities, such as feeding. Eating food such as a banana may be accompanied by violent head shaking from side to side, with growling noises resembling a dog."

These and other tests also indicate that hallucinations may occur, with the test animals pawing and clawing at unseen objects. The report said that "whether the degree of sensory reduction in the space environment, even if prolonged, may reach a threshold level, remains to be tested."

#### Accelerated Research

Dr. Lovelace, in his report, made a plea for "an accelerated research program on an international basis" to establish realistic environmental simulators to test the effect of single as well as combined stresses that occur in the space environment.

He said that these thresholds of performance degradation in man should come under study:

- **Degradation** from fine performance.
- **Gross degradation** with reversible tissue damage.
- **Short and long-time degradation** with irreversible tissue damage.

Lovelace also suggested the establishment of an International Scientific Advisory Council representing the various clinical and scientific disciplines for "disseminating existing knowledge and examining the progress and future requirements of all research concerned in examination and selection of astronauts, care of patients with disease or injury while in space, the effect of single and combined stresses in space, with particular respect to performance degradation of the crew."

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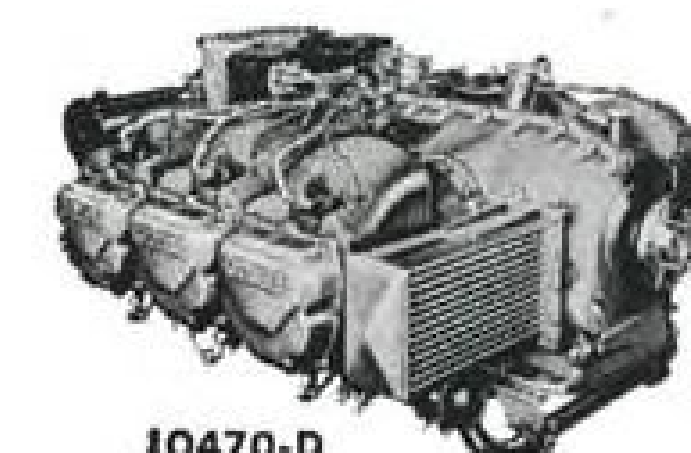
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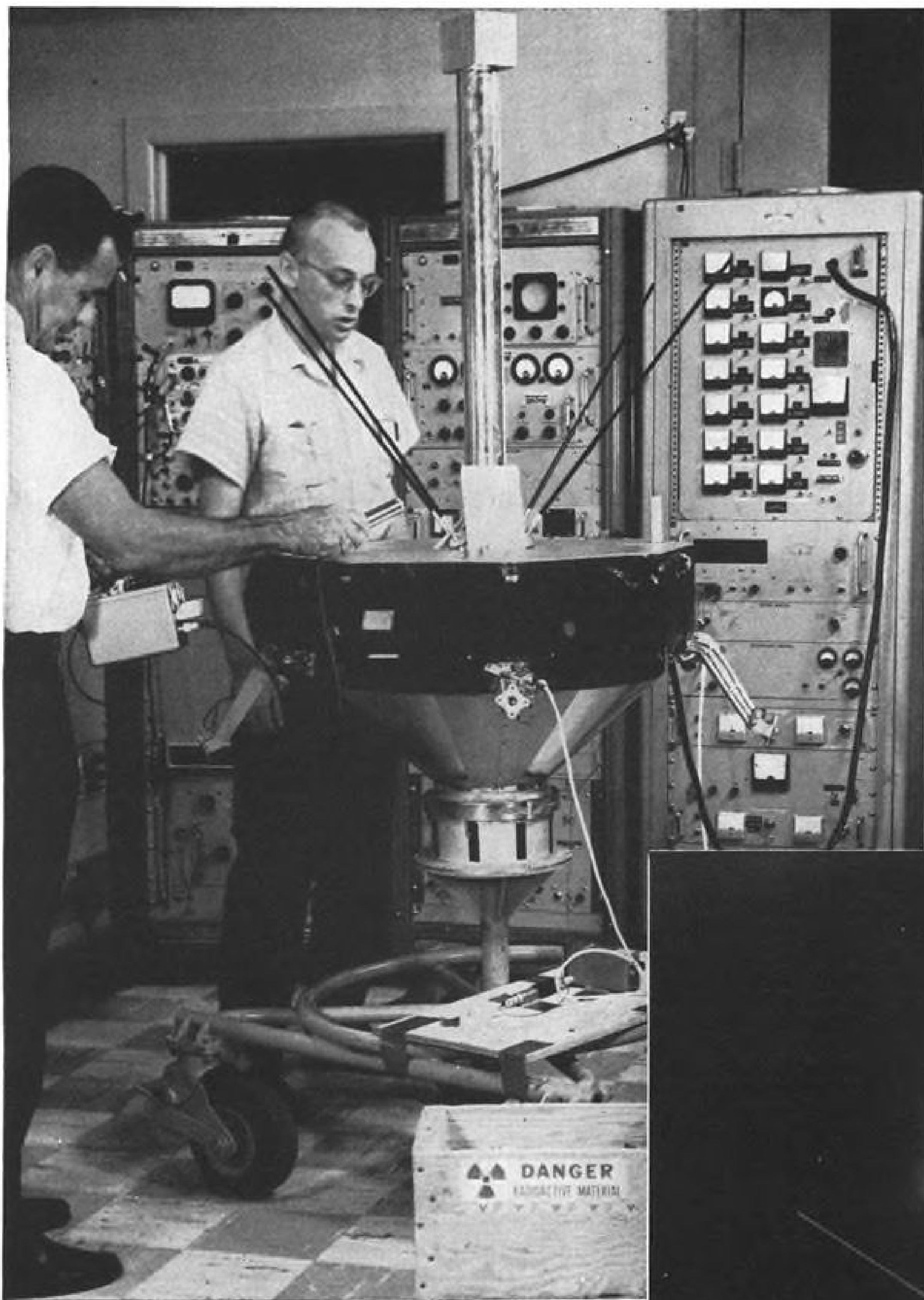
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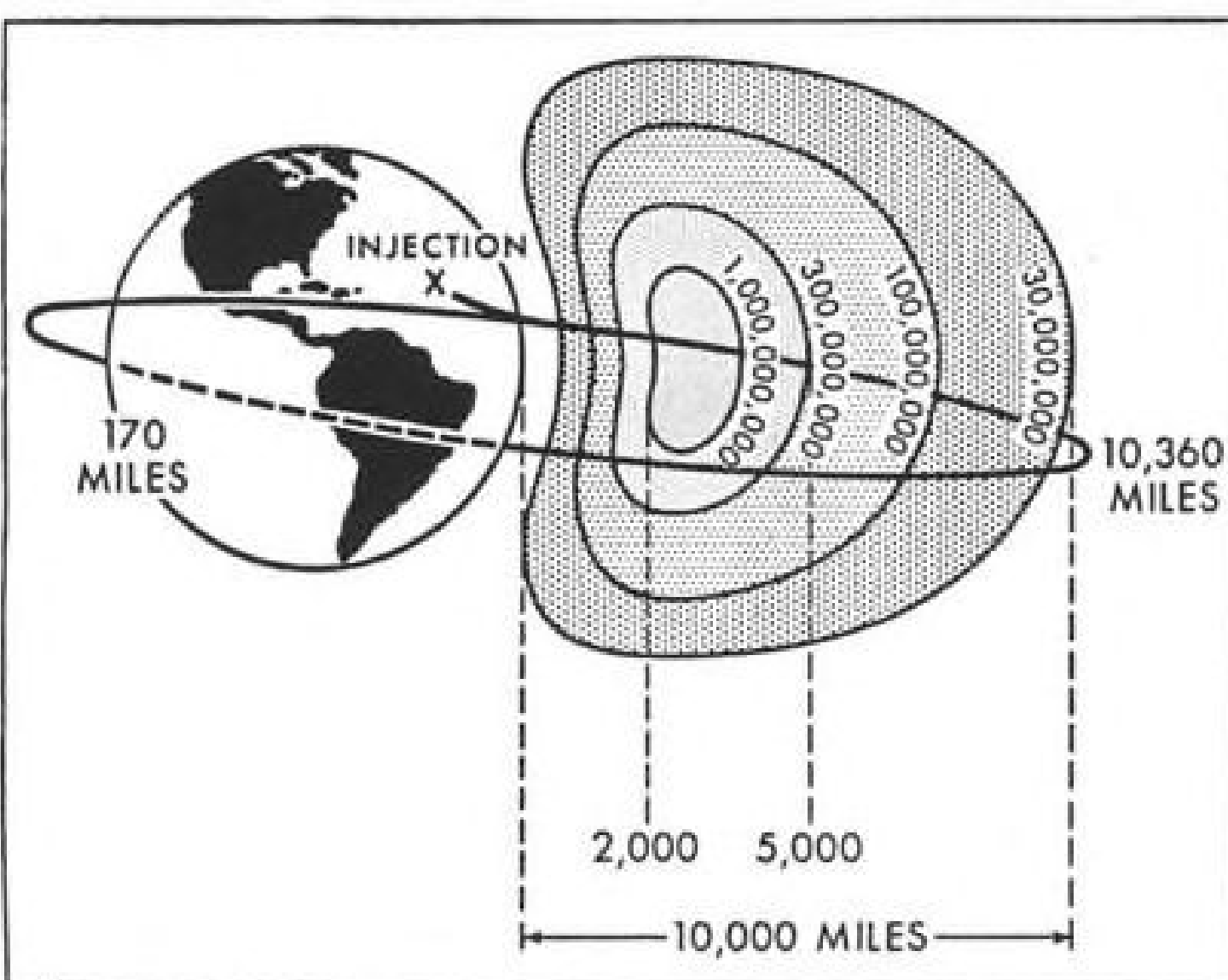
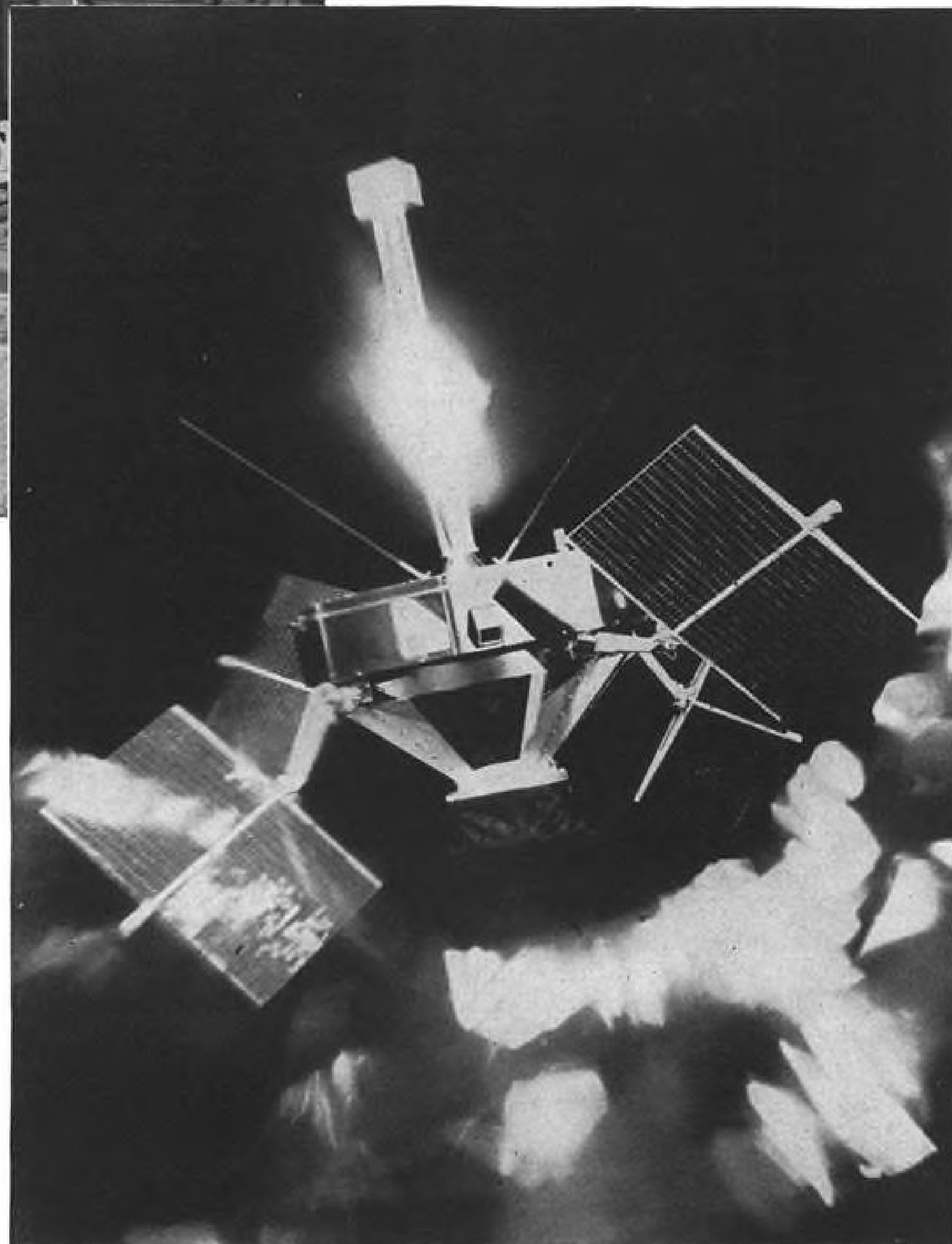
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## Explorer Studies Earth's Artificial Radiation Belts

At left technicians check out Explorer 15 Energetic Particles Satellite (S3B) which was successfully launched from Cape Canaveral, Fla., Oct. 27. The satellite was launched by a three-stage Thor-Delta vehicle. Principal experiments aboard the 99.6-lb. satellite were an electron energy distribution device, electron and proton omnidirectional detector, electron angular distribution determiner, and electron directional detector. The satellite is transmitting useful data although its high-spin rate appeared to be adversely affecting some of the satellite's functions (AW Nov. 5, p. 42). Bottom photo shows S3B photographed in a simulated space environment.



Mission of Explorer 15 is to study the artificial radiation belt created by high-altitude nuclear explosions over the Pacific last July 9. Satellite perigee is 193.7 mi., apogee, 10,760 mi. Figures in chart are those NASA programmed.

## University Space Support Role Expands

By Warren C. Wetmore

**Chicago**—Dependence on universities to provide manpower and fundamental research for the U.S. space program is shaping a new relationship between the government and colleges, according to Dr. George Wells Beadle, president of the University of Chicago.

Beadle recently acted as spokesman for the university viewpoint at the first National Aeronautics and Space Administration-University Conference on the Science and Technology of Space Exploration here (AW Nov. 12, p. 26).

Purpose of the conference was to inform college administrations and faculties of NASA's need for higher caliber research and better trained students to meet national goals in the exploration of space. NASA hired about 600 engineering and science graduates last June and will increase this number next year to fill its expanding needs.

Beadle praised NASA's efforts and policies in its programs with the universities, but referred to the controversy in academic circles about the value of some aspects of the space program, particularly Project Apollo.

"Speaking of landing that man on the moon," he said, "there are many people in academic institutions who wonder, 'Should we do this, or wouldn't it be better to do something else?' I think this is certainly a debatable point."

### Research Support

Role of the government in supporting basic research and providing laboratory facilities is necessarily growing, Beadle said. Only the government can afford the large sums of money required for expensive facilities and equipment, he added.

He also pointed out that economists, social scientists and lawyers, many of them from academic institutions, will be needed to resolve peripheral problems arising from the space program.

Beadle stressed the necessity of developing more effective lines of communication between the three corners of the scientific triangle—government, industry and academic institutions, as well as better means of collaboration and communication within the academic community.

The latter, he said, is being accomplished by the 32 colleges and universities in the Associated Midwest Universities, an organization created to utilize the nuclear research facilities of the Argonne National Laboratories in Illinois. More cooperative laboratories of this sort are necessary, since no single

institution could afford the facilities that would be available to all in a jointly-operated installation, Beadle said.

While commentary from delegates on the NASA program of university support was largely favorable, there were some reservations. One delegate felt that in making these grants the government would inadvertently usurp a measure of the universities' traditional freedom. He also complained that the emphasis on space is disproportionate, and that the field is getting the best university graduates in science and engineering, to the eventual detriment of other, non-space fields.

Another delegate feared that, with huge amounts of funds being made available, the quality of research might suffer and that some non-worthy projects would be funded due to the increased work load of NASA contract monitors. Research contracts are becoming an academic status symbol, he said, and university administrations are often more concerned with whether the research is sponsored, rather than with the scientific value of the investigations.

In another session, the delegates were told that space exploration will cause a reunification of the various scientific disciplines and a turn away from specialization. Dr. Robert Jastrow, direc-

tor of NASA's Institute for Space Studies in New York, said that because of its fundamental nature, physics provides the main reservoir of students who go into space sciences, but that there must be more emphasis on such subjects as astrophysics for physics majors and on atmospheric physics in the earth sciences.

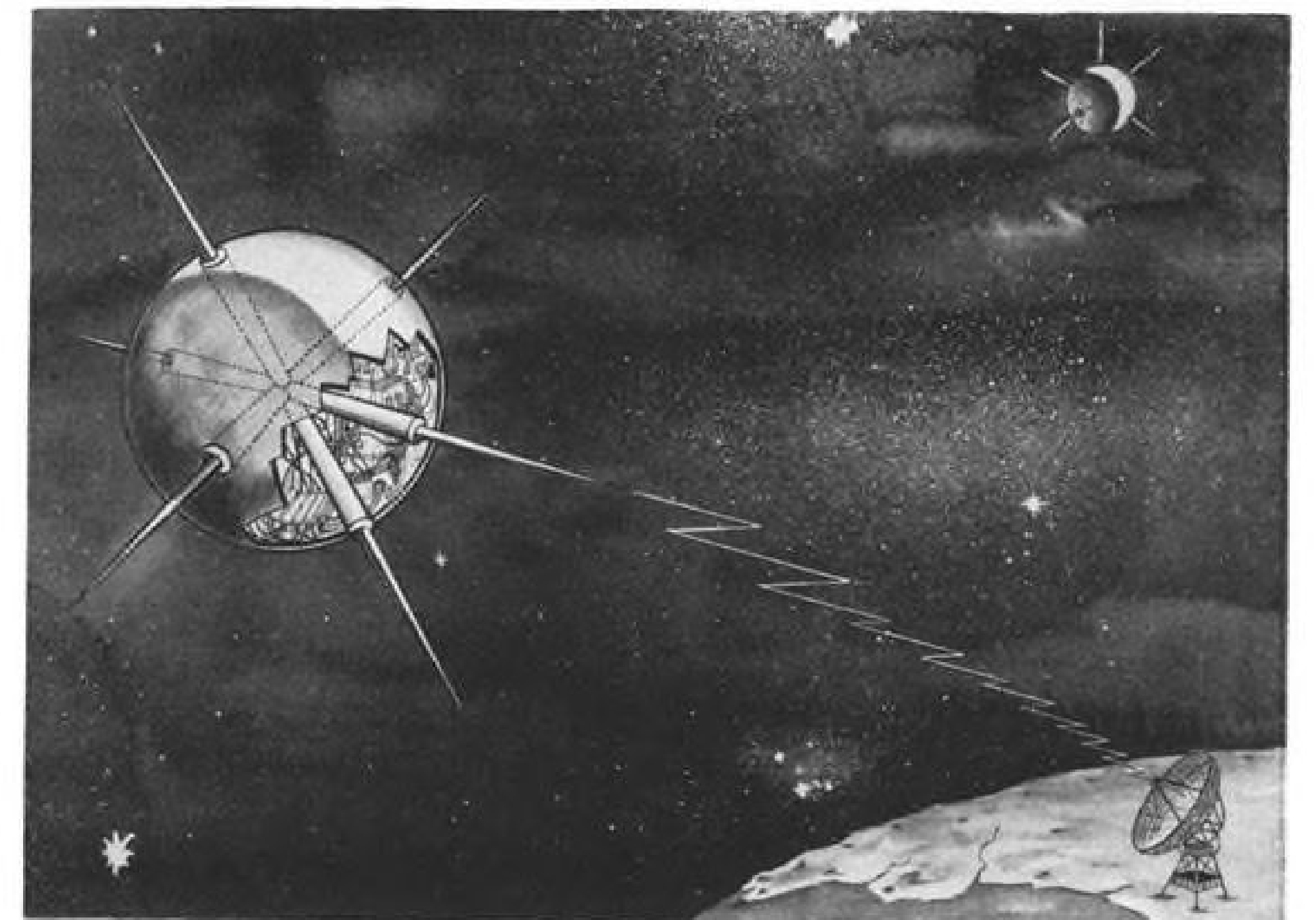
It would be a mistake to create independent space sciences departments, he said, since students should first learn the basic, traditional concepts.

### Interdepartmental Committees

The solution, Jastrow said, can be found in the creation of interdepartmental committees, whose function would be to advise students and plan courses of study for those interested in space sciences.

Course in space physics, for example, could be initiated along traditional lines but with strong emphasis on non-descriptive astronomy. Such programs, he added, would provide a broad base for future developments.

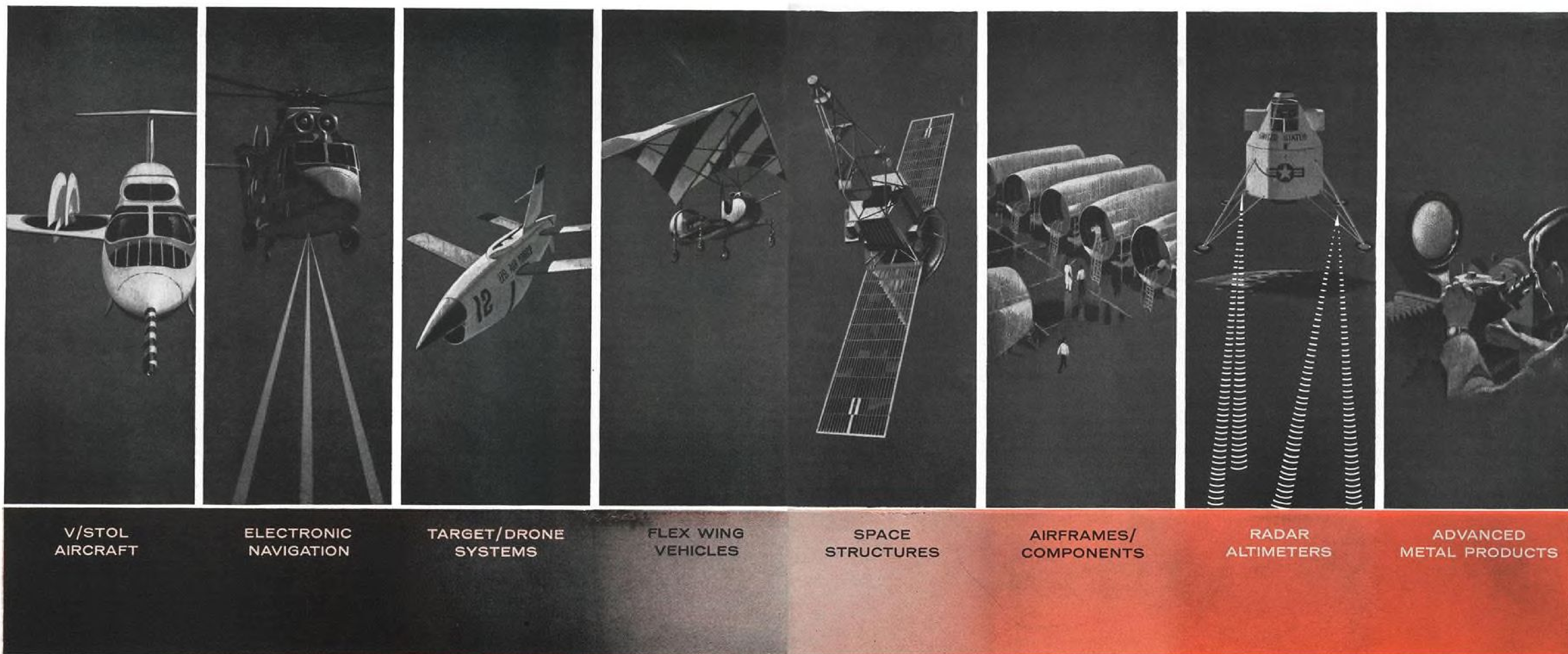
Dr. Thomas L. K. Smull, director of NASA's Office of Grants and Research Contracts, said that in addition to project-type research—the total dollar value of which has doubled each year since NASA was organized in 1958 and probably will more than double in Fiscal



### Satellite Communications Relay Antenna Developed

Lightweight aspect and polarization-insensitive high-gain antenna array has been developed by Space-General Corp. for use on satellites for relaying communications between spacecraft on interplanetary flights and earth stations. Array has two sets of three orthogonal antennas coupled with amplifier powerful enough to increase intensity of signals from spacecraft and relay them to earth. Antenna system would automatically point toward transmission source while receiving signals, company says.





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# ADVANCED THIN FILM MICROCIRCUITRY PROVIDES NEW DIMENSIONS FOR LSI INSTRUMENT DIVISION PRODUCTS



Typical Thin Film Microcircuits



Microcircuit modules perform complex electronic functions formerly requiring assemblies many times their size and weight.

**The Task:** To provide the aerospace industry highly reliable, miniaturized electronic systems and components utilizing economical, mass produced thin film microcircuitry.

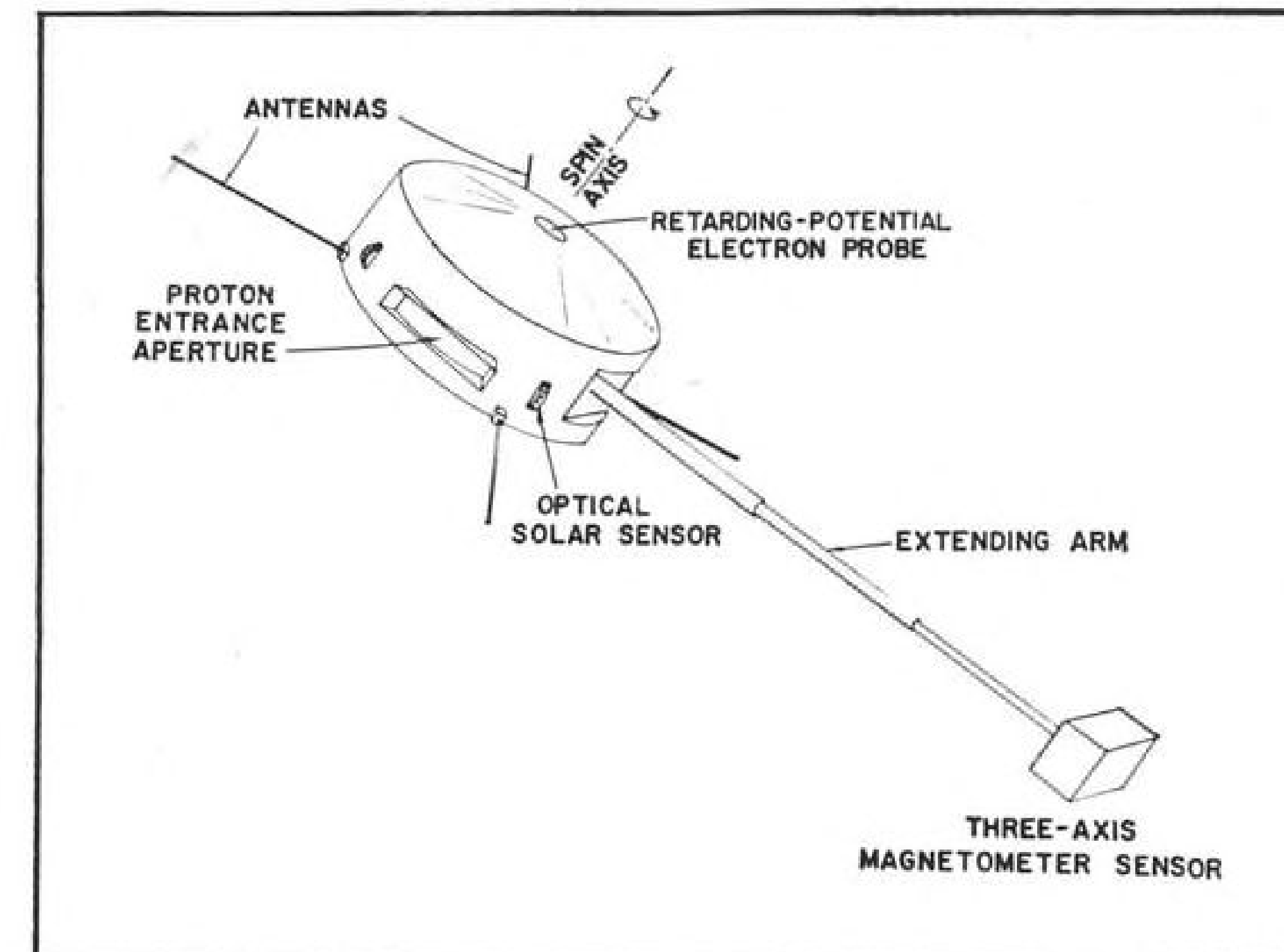
**The Solution:** A new, semi-automatic high vacuum deposition system developed by LSI for volume production of thin film microcircuitry...now in full scale operation at the Instrument Division. This highly precise production technique, coupled with a unique ability for extreme accuracy in the layout of electronic circuits, offers great flexibility in the design of Instrument Division electronic systems since it combines significant miniaturization with unusual performance and reliability characteristics. Instrument Division customers are being provided products with the many benefits which this unique microcircuitry production process affords, including substantial size and weight reduction, as well as greatly increased performance, reliability and extreme environmental characteristics. This is a portion of the LSI Instrument Division's continuing program to provide the next generation of aerospace guidance and control equipment, as fast or faster than requirements become known.

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## USAF to Study Solar Winds

Experiment to study interface of solar winds and earth's magnetic field and determine distortion of field by sun plasma will be launched on Air Force/Chance Vought Blue Scout. Payload developed at USAF Special Weapons Center, N. M., will have axis perpendicular to earth-sun line, with optical solar sensor triggering all measurements and telemetry transmissions. Complete telemetry frame is registered every  $\frac{1}{4}$  of a revolution of experiment.

1963—NASA has initiated recently the Sustaining University Program to "enlarge significantly the university participation in space science and technology and complement the expanded research activity of NASA."

University program includes the following:

- **Training grants** (AW July 2, p. 357), which will increase the future supply of professional technical personnel required in space-related science and technology.
- **Facilities grants** (AW Oct. 1, p. 27) to provide adequate facilities necessary for space research.
- **Special-purpose research grants** to strengthen academic institutions and permit them to increase support of NASA programs through encouragement of creative investigations in scientific disciplines, and to develop new capabilities and permit consolidation of activities and stabilization of funding.

### Manpower Shortage

Prime NASA concern is the impending shortage of highly-trained technical manpower, Smull stated, and since many of these personnel will be engaged in space-related efforts, NASA wants to accelerate the production of doctoral degrees in both science and engineering fields.

Under this phase of the program, the university receives a training grant and then selects the trainee. The awards,

reimburses for any reasonable expenses incurred in training grantees.

Initial program, started in September (see box, p. 115), involves 10 students at each of 10 universities. A substantial increase in the program is planned for the next academic year, with the inclusion of an additional 600 to 750 pre-doctoral students, Smull told the delegates.

### Laboratory Shortage

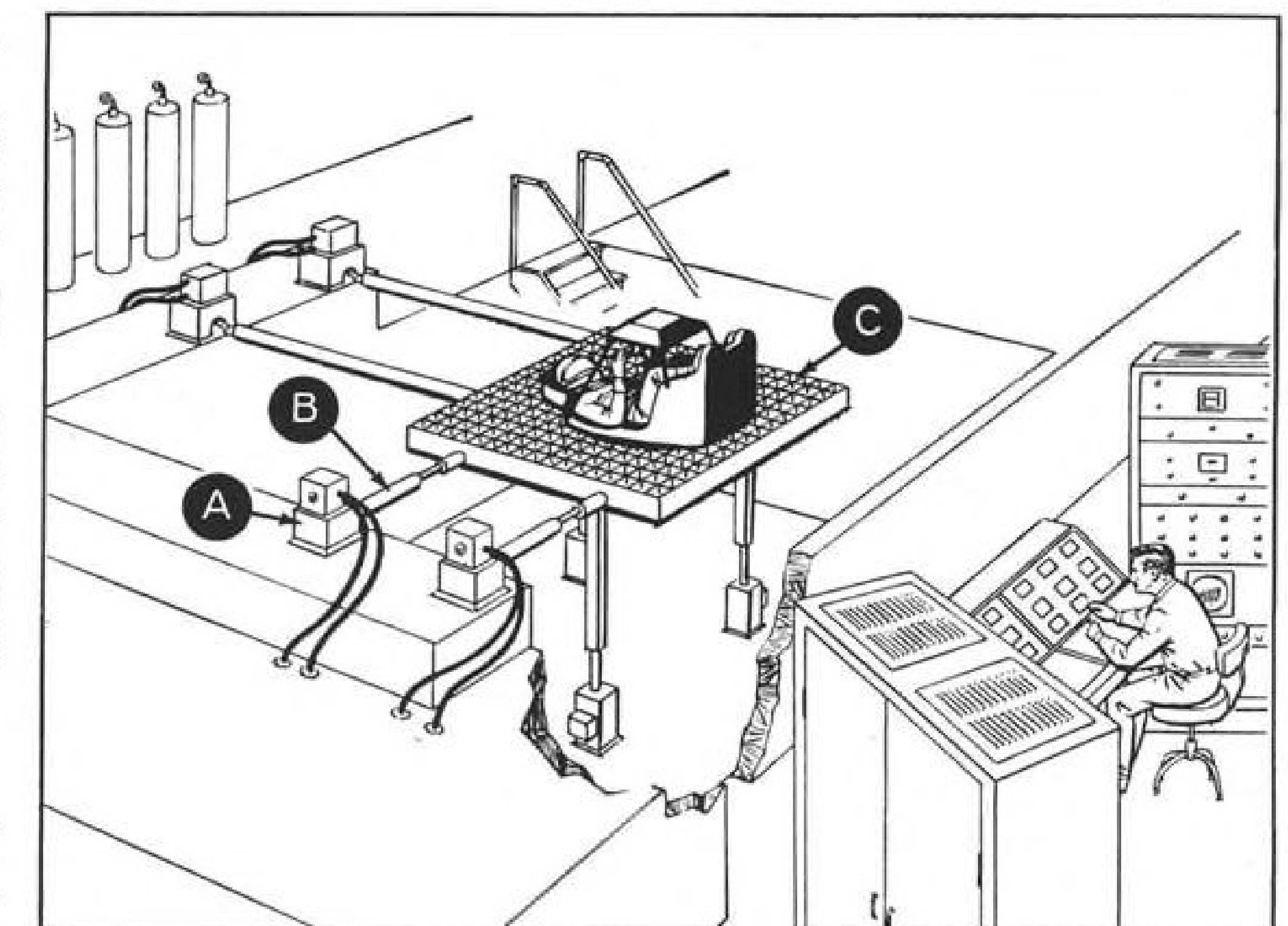
In carrying out its activities, NASA saw the need for alleviating the acute shortage of laboratory space in the universities.

Grants will be made to academic institutions and to non-profit research organizations to purchase or build additional facilities for research in space-related science and engineering.

Dollar values of these facilities grants will be determined by NASA, and may be as much as the full cost of the proposed structure. The title to a laboratory or other research facility will be vested in the government, unless the NASA administrator determines that the national space program will be served best by transferring the title to the grantee.

Smull said that the first grants under this program were awarded in September to five universities, and title to the facilities was turned over to the recipients.

Special-purpose grants—designed to help the universities help themselves—will be made to increase competence



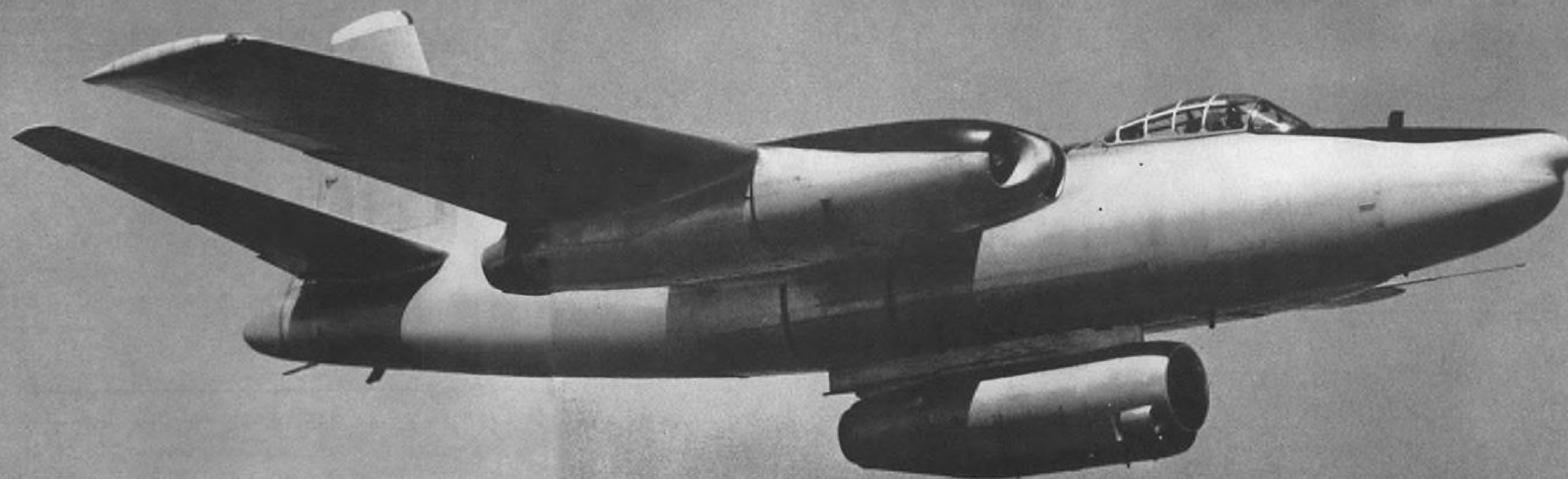
## Six-Degree-of-Motion Astronaut Trainer

MB Electronics will build six-degree-of-motion astronaut training simulator at Wright-Patterson AFB, Ohio, under USAF-NASA contract. Components shown in drawing include hydraulic shakers (A) which actuate pushrods and universal joints (B) to vibrate magnesium test platform (C). Simulator will accommodate 2,000-lb. load and induce vibrations up to 30 cps. and g-loads as high as 20.

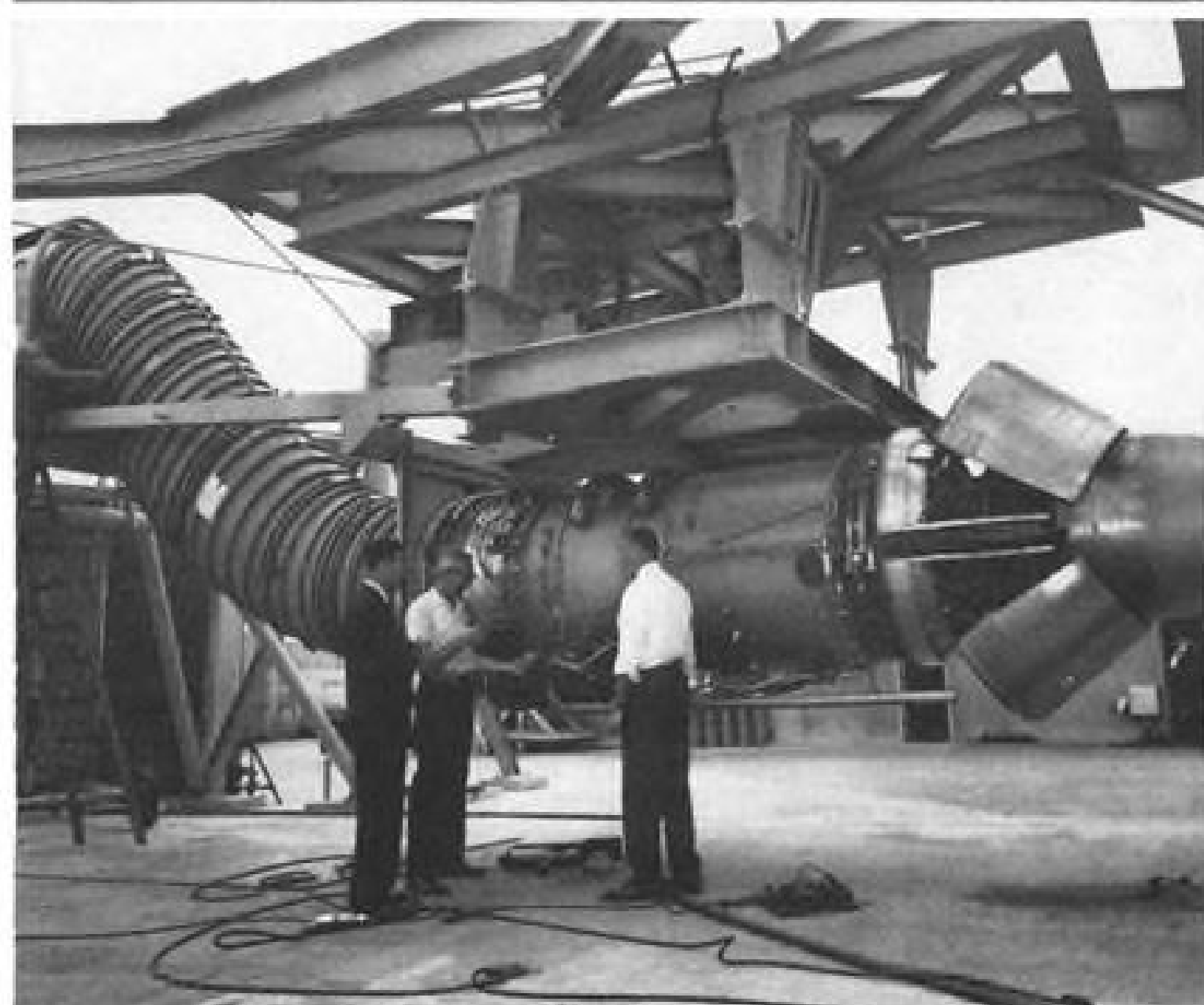




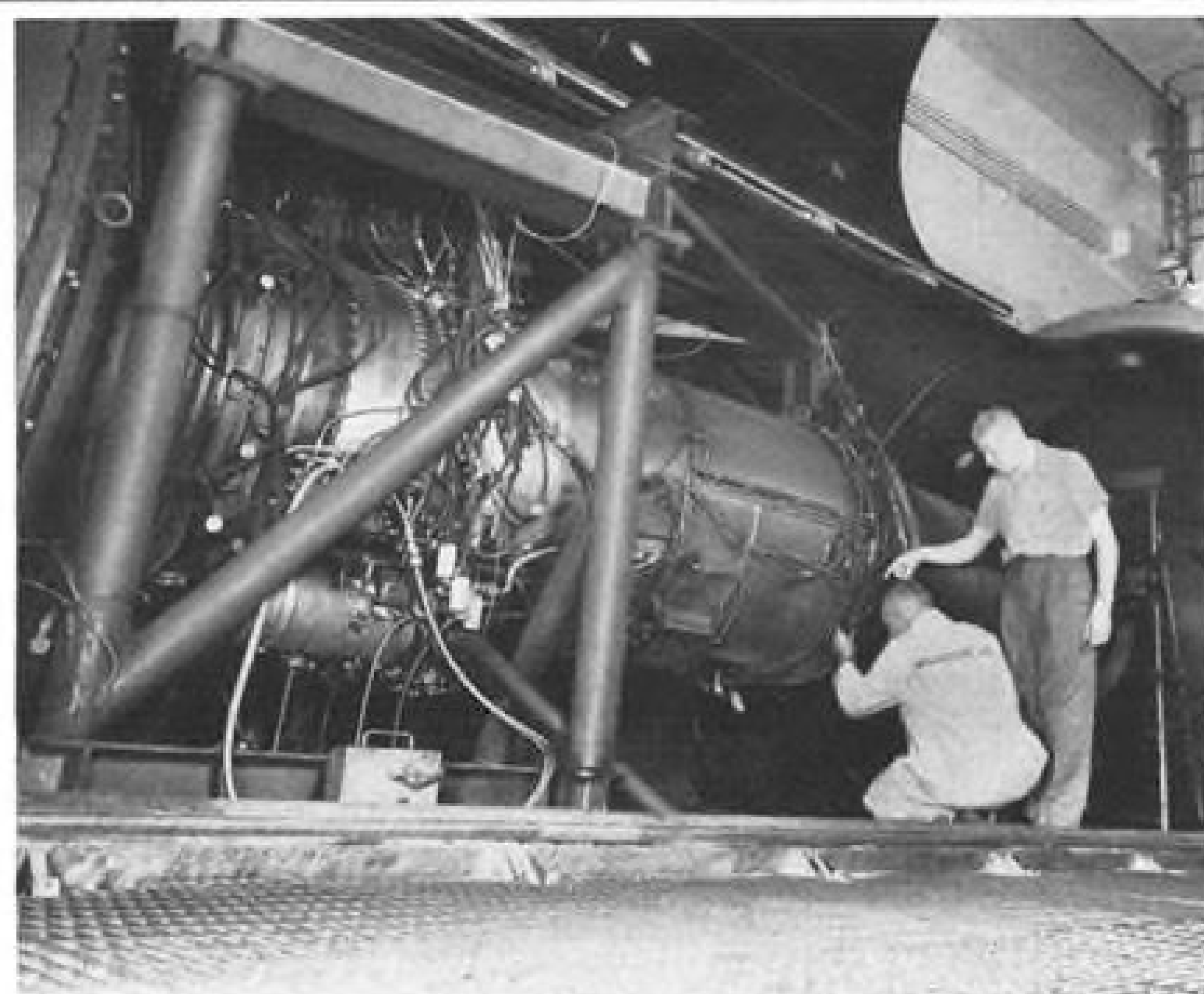
A report on economical shorter-haul power



JT8D, shown here in a flying test bed, promises economical power for shorter-haul jets. The JT8D has logged more than 60 flight hours to date.



Prototype JT8D is being ground tested at Boeing with actual center inlet duct to be used in the three-engine Boeing 727. Lightweight JT8D develops 14,000 pounds thrust.



JT8D met all SFC guarantees in tests at the Willgoos Turbine Engine Test Facility. JT8D ran 460 hours at 25,000 to 35,000 feet at 0.8 Mach, and various temperature conditions.

## JT8D begins FAA certification tests

Pratt & Whitney Aircraft's new JT8D turbopan has begun Federal Aviation Agency tests that will lead to certification of the engine for commercial airline operation. Significant portions of these tests are already completed.

The tests should be completed early in 1963, when Boeing's 727 short/medium-range jet transport begins flying. The 727 will be powered by three of these 14,000-pound-thrust engines.

JT8D development testing began in 1961. Since then, the engine has:

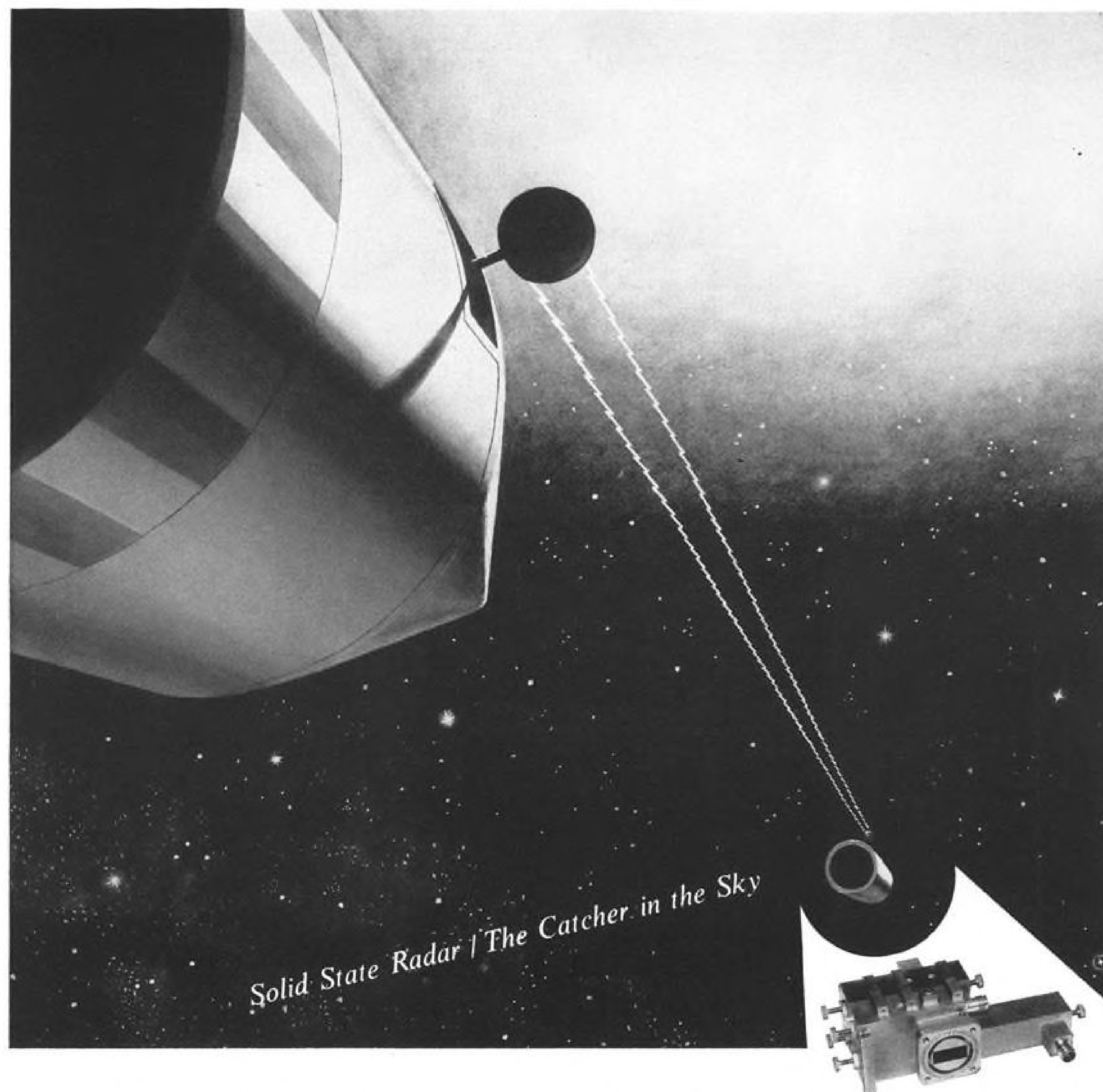
- Completed more than 4,700 hours testing, including 1,000 hours of endurance in accordance with the FAA 150-hour test schedule.
- Completed six company 150-hour endurance tests.
- Logged more than 60 hours in flying test beds.
- Equalled or bettered all specifications in altitude thrust specific fuel consumption.

Seven JT8D's have already been delivered. These advanced powerplants will help the 727 operate from 5,000-foot runways and economically fly 70 to 114 passengers over routes of 150 to 1,500 miles.

**Pratt &  
Whitney  
Aircraft**

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DIVISION OF UNITED AIRCRAFT CORP.  
EAST HARTFORD, CONN.





A new solid state radar system built by STL engineers and scientists can send out and receive signals at X-band frequencies to help man rendezvous and dock vehicles in space. STELATRAC is its name. It is the first solid state system of its kind. The X-band transmitter is shown above. It has successfully passed temperature and vibration tests. STELATRAC can also be used as a command link between vehicles in flight. By altering its module design, the flexible radar system operates as an altimeter and doppler velocity sensor to guide spacecraft safely to the surface of the moon and planets. Today STL is busy on many such projects as STELATRAC. STL is also prime contractor for NASA's OGO and a new series of classified spacecraft for Air Force-ARPA. And STL continues Systems Management for the

Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in Theoretical Physics • Systems Engineering • Radar Systems • Experimental Physics • Applied Mathematics • Space Communications • Antennas and Microwaves • Inertial Guidance • Analog Computers • Solid State Physics • Computer Design • Telecommunications • Space Physics • Digital Computers • Guidance & Navigation • Electromechanical Devices • Engineering Mechanics • Aerodynamics • Propulsion Systems. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, Department A24, One Space Park, Redondo Beach, California, or Box 4277, Patrick AFB, Florida. Your inquiry will receive a prompt reply. STL is an equal opportunity employer.



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in areas where research activity is needed.

Smull added that these grants may be used to consolidate related minor projects whose support comes from varied sources, thus lessening the impact of funding fluctuations.

#### Special Funding

Special funding method will be used for university program grants to stabilize programs extending over several years. The method—known as step funding—involves an initial three-year grant, which provides 100% funding for the desired level of effort during the first year, two-thirds during the second and one-third during the third year of the program.

This money is set aside and then paid according to a pre-arranged schedule.

The project is reviewed annually and if NASA decides to continue its support and supporting funds are appropriated by Congress, the grant will be supplemented each year to bring it up to the agreed level of effort for that year.

Thus, if support is terminated for any reason, the university will have funds coming for another two years and will be able to discharge any obligations it may have incurred in connection with the program.

#### NASA Guidelines

NASA's guidelines for this program represent the most liberal approach ever made by the government in working with the universities to accomplish a specific mission, Smull noted. "As long as universities demonstrate that they are able to carry on these activities in a creative and responsible manner," he said, "these guidelines will remain broad."

Dr. Hugh L. Dryden, NASA deputy administrator, emphasized the agency's desire to work within the existing framework of the universities in the course of accelerating study and research in

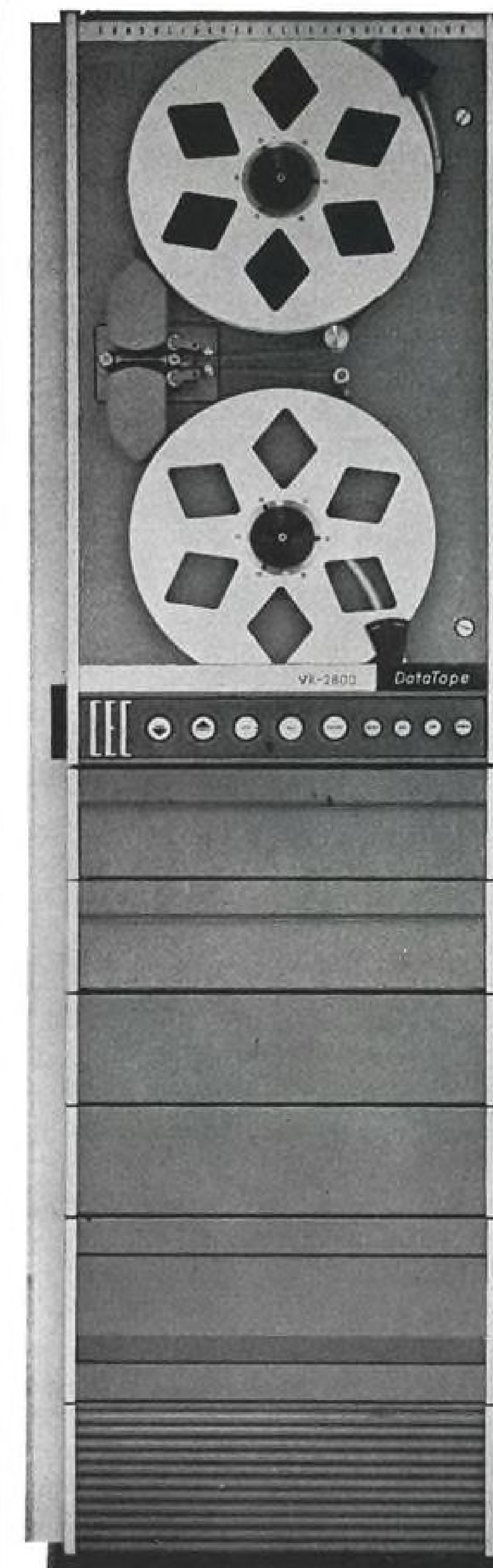
#### Training Grants

Washington—Ten universities have received training grants for the support of ten doctoral candidates each in space sciences and engineering.

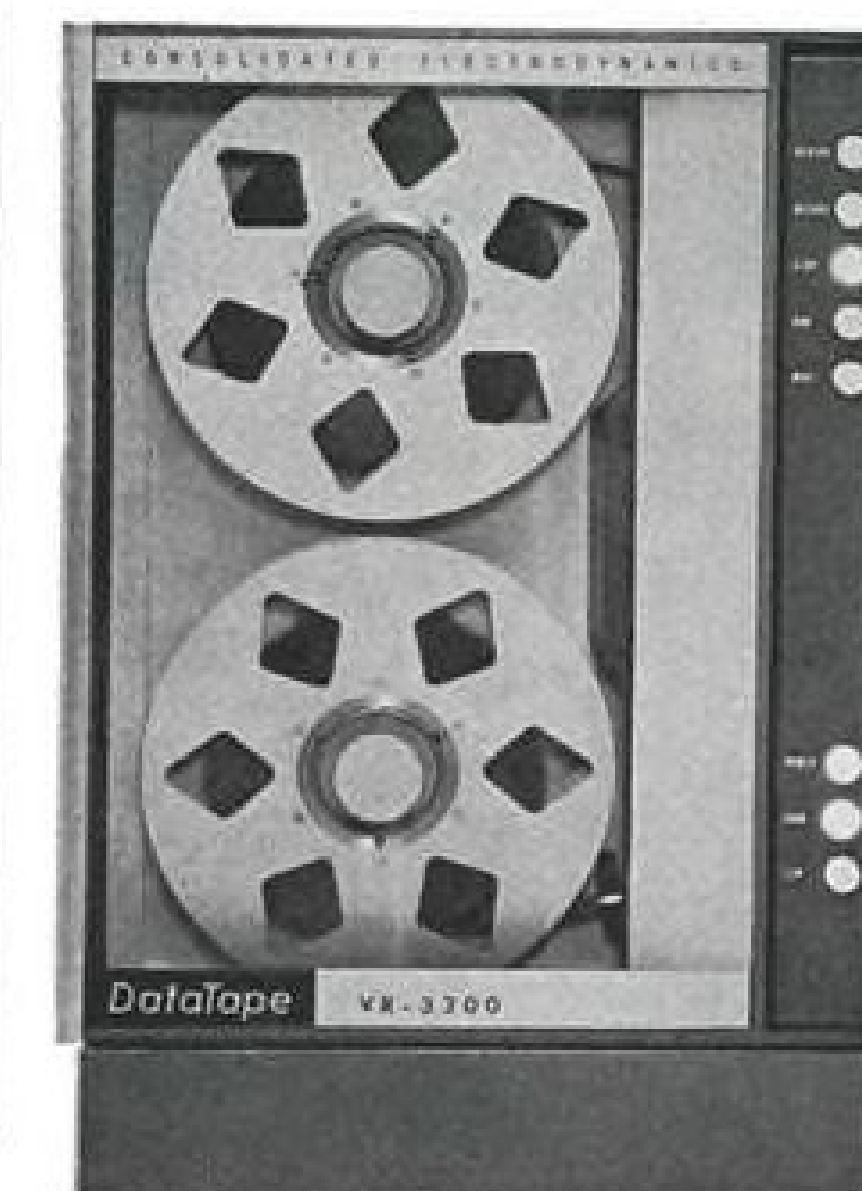
Grants, which are a part of NASA's newly-instituted Sustaining University Program, were awarded to Rensselaer Polytechnic Institute, University of Maryland, Georgia Institute of Technology, University of Michigan, University of Chicago, University of Minnesota, State University of Iowa, Texas Agricultural and Mechanical College, Rice University and University of California at Los Angeles.

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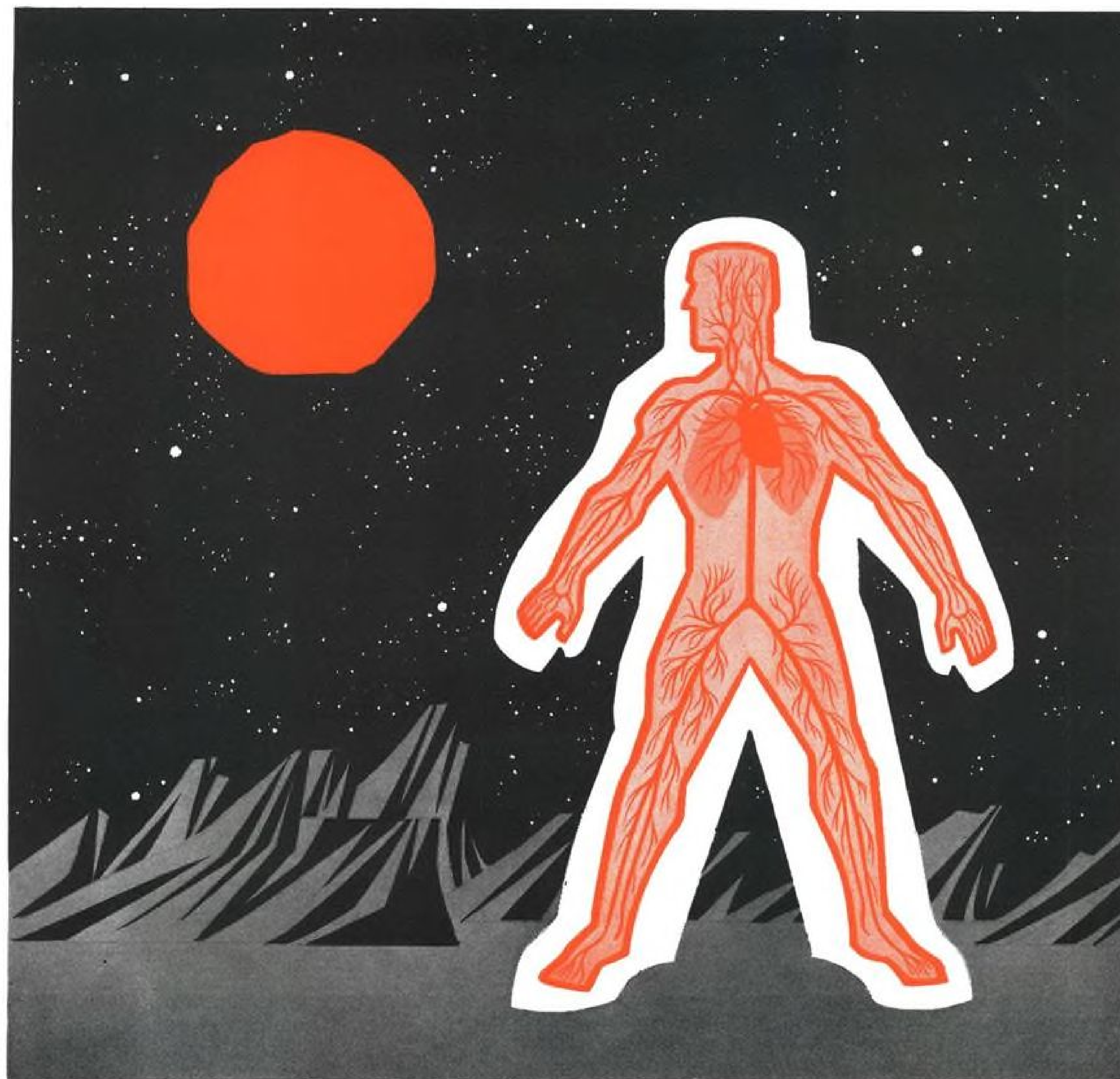


**CEC**

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## APOLLO SUIT

The first integrated space-suit assemblies will be developed by Hamilton Standard for Project Apollo, under contract to NASA. They will provide comfort and mobility for astronauts outside the craft in deep space and on lunar exploratory missions. Hamilton Standard, as prime contractor, will manage the program, and design and build life support packs. The packs must supply oxygen and pressurization and control temperature, humidity and contaminants. Subcontractor for the suits will be International Latex Corporation.

The space-suit project, an important portion of Hamilton Standard's life support program, applies diversified experience in hydraulics, pneumatics, mechanics, electronics, and packaging. Hamilton Standard blends and develops these basic technologies to achieve an integrated systems approach to life support equipment.

**Hamilton Standard** DIVISION OF UNITED AIRCRAFT CORPORATION  
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### Radiation Detector

Device developed by General Electric is designed for air-dropping from helicopters to detect radiation levels in nuclear blast craters. Recording life of recoverable device is a period of approximately 10 days.

space technology. NASA does not want to create independent contractual activity which tends to divert the university professor from the teaching in the performance of his research.

"It has been estimated that by 1970 as many as one-fourth of the nation's trained scientific and engineering manpower will be engaged in space activities," Dryden said. "The university alone is the producer of this talent and, like the logger who has a responsibility of replacing for the future the trees which he harvests, NASA, as a user of university-trained talent, has an obligation to carry a fair share of the load of replacing the resources consumed."

### Program Goal

University program, he said, has as a goal the support of about 4,000 doctoral candidates at 150 universities, and will yield 1,000 new Ph.D.s in space-related fields annually.

Dr. Dryden said that \$40 million of Fiscal 1962 NASA funds was given to academic institutions, of which \$28 million was in support of project research. Special-purpose research grants totaled about \$3.5 million, facilities grants approximately \$6.5 million, and training grants \$2 million. Estimates for Fiscal 1963 show an increase in the total university program, including project research, to about \$85 million.

Not all NASA executives are in full support of the Sustaining University Program. One high official privately voiced criticism of NASA's direct involvement in the program, stating that it is beyond the intended scope of NASA's mission of research and space flight activities.

The official said that the program could be administered better by the National Science Foundation, in keeping with its traditional role in support of academic research and graduate studies in science and engineering.

## Subcommittee Urges Strong Single Manager for New Advent Program

Washington—House Space Sciences Subcommittee has decried the waste and inefficiency in the past management of the Advent communication satellite project and recommended the appointment of "a strong single manager" at Dept. of Defense level to keep the same thing from happening in the reoriented program (AW June 18, p. 32).

The subcommittee, in a year-end report, said there was "little or no evidence of a spirit of cooperation between the Army and the Air Force in the Advent program." It said this is one reason "the nation has very little to show" for the \$170 million it has spent on the effort. The report also said the director of Defense Research and Engineering (DDRE) "might have supervised the Advent project more closely."

DDRE was in over-all charge of Advent when the Army was project manager, and is playing the same role now that Air Force is the program manager. The subcommittee said it agreed with Brig. Gen. Joseph W. Johnston, Army project manager for Advent, who said the only way to do the job efficiently was through a strong manager with authority to cut across service lines.

"The subcommittee rejects the idea that it is impossible for two or more military services, or civilian agencies of the government, to work effectively and harmoniously on a particular development program. Clearly, a single manager endowed with both responsibility and authority is the most effective man-

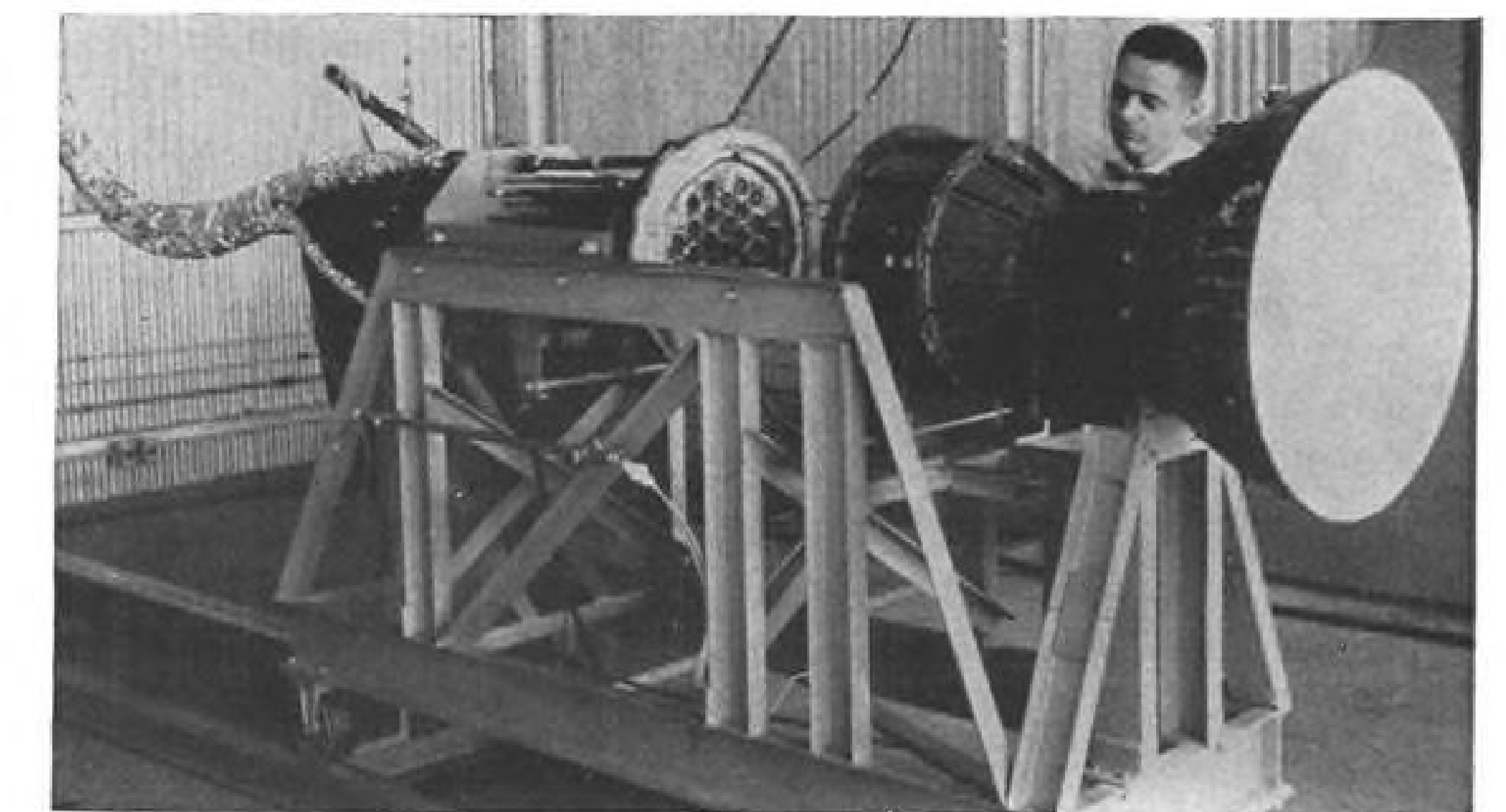
agement organization, and this was lacking in Project Advent," the report said.

As an example of interservice rivalry which proved expensive to the taxpayers, the subcommittee cited the case of the Air Force cancelling its contract with Space Technology Laboratories as soon as the Army signed a contract with STL for the same type of technical guidance on Advent. USAF signed a new contract with the Aerospace Corp. for the work formerly performed by STL.

The subcommittee said the two services should have been able to agree on a single advisory group.

The subcommittee also criticized the Air Force for refusing to let the Army assign its representatives to the General Electric plant where the Advent satellite was being fabricated. This Air Force restriction, the subcommittee said, was "a curious restriction for a participant in such a venture to place upon the agency which has been assigned over-all management responsibility for the program."

The reoriented program calls for launching 24 to 36 medium-altitude satellites, rather than the high altitude synchronous satellite originally planned. The subcommittee cited the inaccuracy of past cost estimates on Advent, and said it wanted to be assured that the costly reoriented program "will be justified by the anticipated volume of military traffic and the specific needs of the military which cannot be adequately satisfied by alternative means."



### X-20 Nose Cap Materials Tested

Materials for Boeing X-20 (Dyna-Soar) space glider nose cap undergo high-temperature tests in special rig which can generate more than 5,000F over periods up to one hour. Rig was built by Ling-Temco-Vought, utilizes 30 welding torches burning oxygen-propane gas mixture. Zirconia shroud spreads heat over specimen to simulate re-entry conditions.



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# UTC DEVELOPMENT THRUST OVER

# CONTROLS 1-TO-100 RANGE !

**STATE-OF-THE-ART ADVANCEMENT**—United Technology Corporation takes pride in announcing what may be one of the most important liquid rocket propulsion technology developments in this decade: variable thrust control over a range of 1-to-100. This company-sponsored development can provide upper stage liquid rocket motors with the levels of operational flexibility demanded for rendezvous, docking, and soft landing missions. UTC's new aerated-thrust motor will permit a spacecraft to hover, translate, and re-orientate with a maximum degree of precision and control.

**COMBUSTION STABILITY**—UTC's variable thrust control system is a model of simplicity. An inert gas is injected into the propellant just before it enters the thrust chamber. A series of linked valves controls the propellant/gas mixture, permitting the effective density of the propellant to be varied over a wide range and provide any desired thrust level. Gas may be taken from the same source used to pressurize propellant flow. This new technique provides UTC's rocket motors with a degree of combustion stability never before accomplished by any thrust control system.

**IMPROVED MOTOR PERFORMANCE**—Hot firing tests of this UTC propulsion device indicate that motor efficiency is improved to 95% of theoretical  $I_{sp}$ . Motor life is prolonged, since the aeration technique prevents unbalanced combustion, channeling, and erosion of thrust chamber walls. The possibility of explosion during motor firing is almost completely eliminated. The safety, reliability, and flexibility of UTC's new system of variable thrust control by aeration make it a strong candidate for use in lunar excursion missions, orbital revision, or module-to-mother-ship docking.



**United Technology Corporation**

Box 358, Sunnyvale, California

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## Mercury Landing System

Full-scale model of Mercury spacecraft designed for one-day mission descends under parachute after airdrop from C-130 transport in qualification tests of spacecraft landing system developed by Northrop Ventura. Ringsail chute will also be used with manned one-day space mission.

## NASA Contracts

National Aeronautics and Space Administration recently awarded the following contracts and research grants:

### MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.

**Aerojet-General Corp.**, Downey, Calif.—\$53,000 for high voltage initiation program for S-1 retrorocket.

**Consolidated Systems Corp.**, Monrovia, Calif.—\$140,000 for high speed telemetry microfilm data processing system.

**American Machine & Foundry Co.**, Stamford, Conn.—\$123,000 for thrust vector actuation system hydraulic test facility, Saturn project.

**Minneapolis-Honeywell Regulator Co.**, Boston, Mass.—\$141,000 for design, development, fabrication and delivery of rate gyros for Saturn.

**Rand Corp.**, Santa Monica, Calif.—\$70,000 for study to predict desirable and attainable propulsion system requirements and characteristics of low-acceleration space vehicles in period 1967-1980.

**Giannini Controls Corp.**, Duarte, Calif.—\$50,000 for friction free potentiometer.

**Moog Servocontrols**, East Aurora, N. Y.—\$75,000 for functional and reliability tests on servoactuators and servovalves.

**Armour Research Foundation**, Chicago, Ill.—\$114,000 for study, research and development of analytical methods, and fabrication of test equipment for determination of hydrocarbon contamination.

**Martin-Marietta Corp.**, Baltimore, Md.—\$111,000 for horizon sensor systems, Saturn.

**Lockheed Aircraft Corp.**, Burbank, Calif.—\$78,000 for study of conceptual design of reusable 10-ton orbital carrier vehicles.

**Hayes International Corp.**, Birmingham, Ala.—\$288,000 for Block 2 launcher arms for Saturn.

**Allis Chalmers Mfg. Co.**, Milwaukee, Wis.—\$6,000 for research and development of open cycle fuel cell system for space vehicles.

**American Cast Iron Pipe Co.**, Birmingham, Ala.—\$52,000 for fabrication of walk-

ing beam assemblies, hydraulic cylinders.

**Robins Engineering, Inc.**, Birmingham, Ala.—\$521,000 for technical services for operations buildings 4250 and 4251.

**Poole & Kent Co.**, Miami, Fla.—\$80,000 for alterations and additions to heating and air-conditioning system in blockhouse building 4570.

**Aerojet-General Corp.**, Sacramento, Calif.—\$11,200,000 to design, develop and test 1,200,000-lb.-thrust nominal vacuum liquid hydrogen-oxygen M-1 engine.

**Skiaky Brothers, Inc.**, Chicago, Ill.—\$125,000 for items for manipulator and precision fusion welding system for Saturn.

**Jones & Lamson Machine Co.**, Springfield, Vt.—\$52,000 for automatic sizing thread grinder.

**Hughes Aircraft Co.**, Los Angeles, Calif.—\$57,000 for flexible automatic circuit tester for Saturn.

**Motorola, Inc.**, Scottsdale, Ariz.—\$83,000 for telemetry set, including RF power amplifier with frequency of 245-260 m.c. AN-DKT (XO-48) for Saturn.

**Amp, Inc.**, Harrisburg, Pa.—\$50,000 for taper pins, program boards and patchboard, Saturn project.

**Amp, Inc.**, Harrisburg, Pa.—\$56,000 for patchcord system programing board for Saturn.

**Ansonia Wire & Cable Co.**, Cumberland, R. I.—\$148,000 for cable, instrumentation, and conductors.

**Motorola, Inc.**, Scottsdale, Ariz.—\$58,000 for spacecraft transponder for Saturn.

**O'Neal Steel, Inc.**, Birmingham, Ala.—\$91,000 for hot-rolled, low carbon steel plates.

**Aluminum Co. of America**, Washington, D. C.—\$474,000 for aluminum alloy plate, Saturn project.

**Systems Engineering Laboratories, Inc.**, Ft. Lauderdale, Fla.—\$86,000 to furnish and install high-speed data acquisition system for Saturn.

**Gulton Industries**, Metuchen, N. J.—\$106,000 for accelerometers for Saturn.

**Tamar Electronics, Inc.**, Pasadena, Calif.—\$56,000 for male plug, fluorolube filled pickups.

**Applied Electronics Corp.**, Metuchen, N. J.—\$56,000 for commutators for Saturn.

**Aeronea Mfg. Corp.**, Baltimore, Md.—

\$98,000 for study of dynamic stability and control of large non-rigid aero-ballistic vehicles.

**Space Craft, Inc.**, Huntsville, Ala.—\$86,000 for electronic filters, power supplies and timers for Saturn.

**International Data Systems, Inc.**, Dallas, Tex.—\$210,000 for channel multiplexers for Saturn.

**Lockheed Aircraft Corp.**, Sunnyvale, Calif.—\$145,000 for comparative study of advanced lunar transportation systems.

**Ford Motor Co.**, Newport Beach, Calif.—\$84,000 for study of early manned interplanetary missions.

**Ling-Temco-Vought, Inc.**, Dallas, Tex.—\$149,000 for comparative study of advanced lunar transportation systems.

**Air Force Systems Command**, Washington, D. C.—\$575,000 for contract AFO4/695/52 with Lockheed Missile & Space Co. for launch services for NASA Agena-B vehicles at Pacific Missile Range.

**Air Force Systems Command**, Washington, D. C.—\$357,000 for propellants and ancillary gases for use by Pratt & Whitney Aircraft under NAS8-2690 and NAS8-2691, Saturn project.

**International Business Machines Corp.**, Huntsville, Ala.—\$63,000 for supply of magnetic tape.

### LAUNCH OPERATIONS CENTER, COCOA BEACH, FLA.

**Ingalls Steel Construction Co.**, Birmingham, Ala.—\$295,000 for fabrication and erection of flame deflectors and construction of facilities for launch Complex 37, Saturn project.

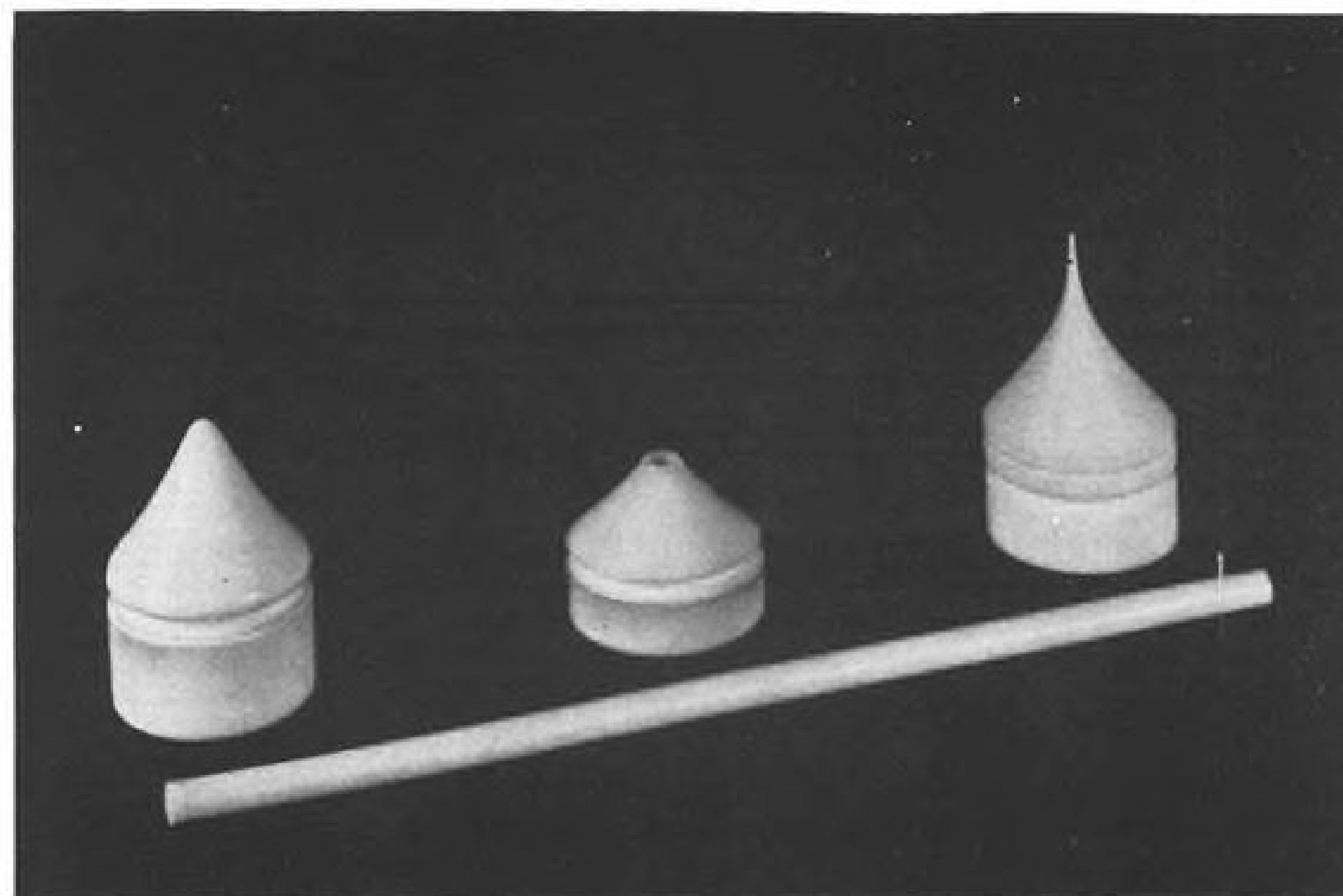
**B & K Instruments, Inc.**, Cleveland, Ohio.—\$88,000 for analyzer and sound pressure level recording system.

**Resdel Engineering Corp.**, Pasadena, Calif.—\$90,000 for converters.

**Pacific Automation Products**, Cocoa Beach, Fla.—\$217,000 for closed circuit TV system for Saturn Complex 37B, AMR.

**Consolidated Electrodynamics Corp.**, Winter Park, Fla.—\$50,000 for oscillograph for Saturn.

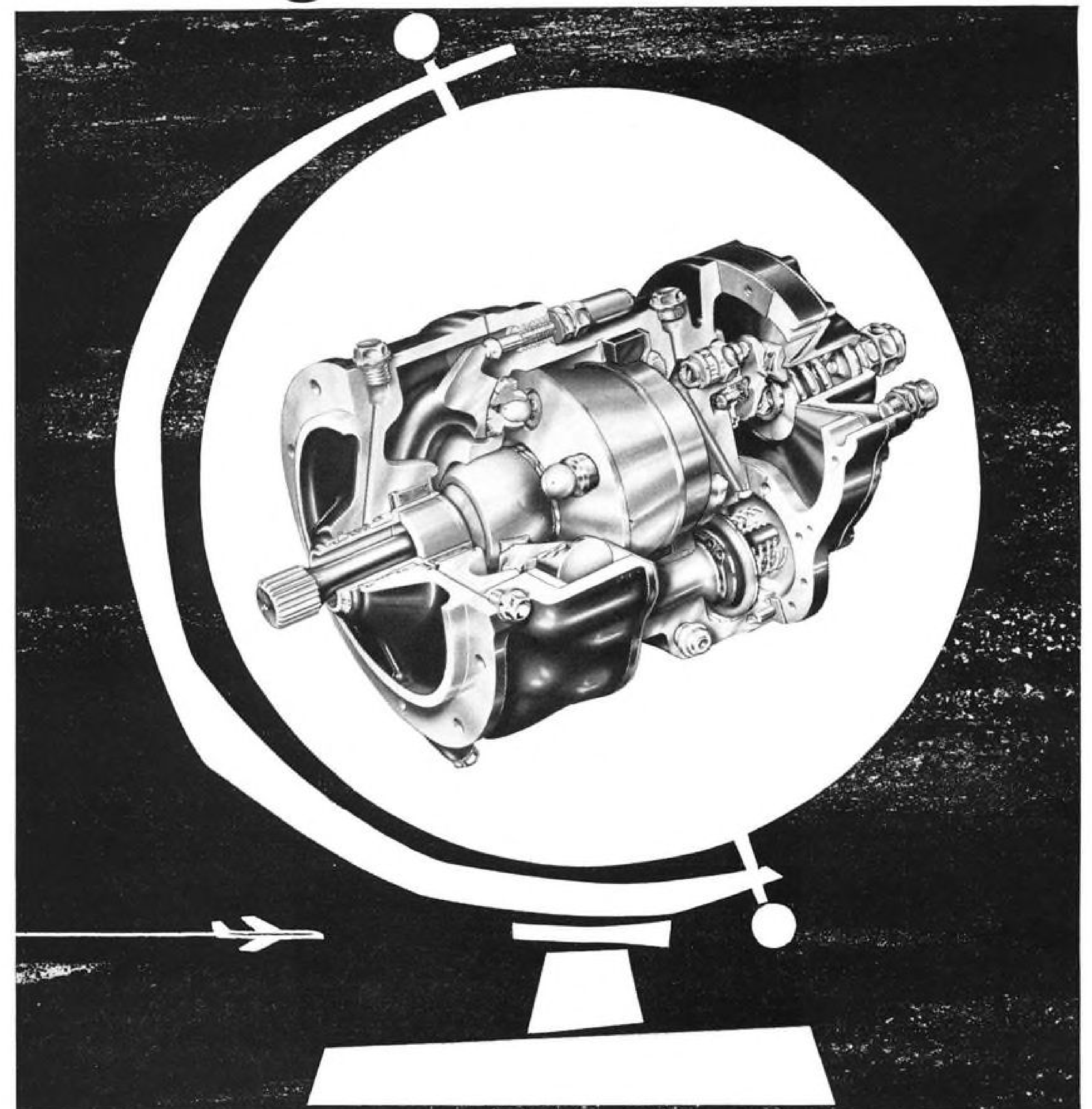
**Army Engineers**, Jacksonville, Fla.—\$130,000 for design and engineering services for Banana River Causeway and communications facilities.



## New Shapes Proposed for Higher-Velocity Re-entry

New shapes for future re-entry vehicles, designed to penetrate earth's atmosphere at near escape velocity after lunar or interplanetary missions, have been developed by Ames Research Center of National Aeronautics and Space Administration. Choice of large-angle cone rather than conventional blunt shape was made because of radiative heating, which increases drastically at higher re-entry velocities. Proposed vehicles would use ablative cooling. Cone at right resembled one at left until hypersonic wind tunnel test showed elongated point was needed to retain conical shape during ablation. Center cone retains shape by feeding ablative rod through apex hole to offset difference between ablation rates of the cone apex and the sides of the cone.

# Throughout the world—



## FROM LUCAS CARE STEMS LUCAS ACHIEVEMENT

In the finest aircraft, throughout the world, Lucas fuel pumps give outstanding performance. Over 100,000 of these fuel pumps are in operation in today's civil and military aircraft. The civil pumps have completed a total of 19,500,000 hours' operation. In many instances Lucas pumps on the North American continent are giving over 3000 hours' service between overhauls. Proof, that from the tremendous care Lucas takes in the manufacture of these pumps, stems the achievement of world-wide confidence.

Lucas Gas Turbine Equipment Limited, Birmingham, England.  
Lucas-Rotax Limited, Toronto, Montreal, and Vancouver, Canada,  
Los Angeles and New York, U.S.A.

Lucas-Rotax (Australia) Pty. Limited, Melbourne and Sydney, Australia.

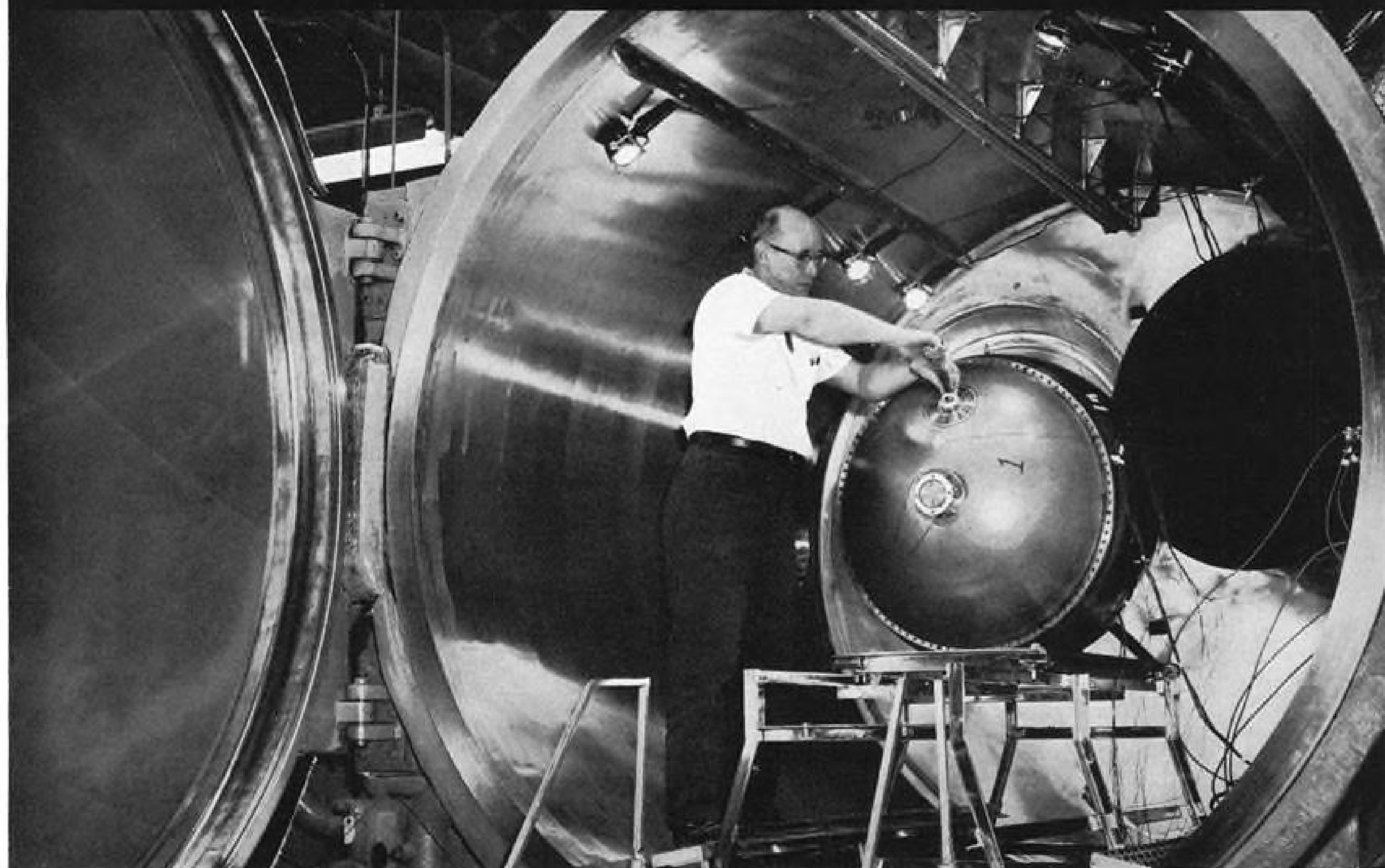
**LUCAS**

FUEL AND COMBUSTION SYSTEMS FOR GAS TURBINE AND RAM JET ENGINES





## "WORKHORSE" FOR GODDARD'S ENVIRONMENTAL TESTING



The 375-pound S-6 atmospheric measurement (135 to 540 miles) satellite being readied to undergo space environmental testing in the Stokes-designed and Stokes-built Goddard "8 by 8".

The Goddard "8 by 8" (8 ft. in diameter and 8 ft. long) horizontal test chamber is one of the key elements in the reliability testing program at NASA's Goddard Space Flight Center, Greenbelt, Maryland.

This Stokes-designed and Stokes-built thermo-vacuum unit was the first true space simulation facility installed at Goddard for testing unmanned vehicles under the fullest possible range of environmental conditions, and is the largest presently in use there. It has a vacuum capability of  $1 \times 10^{-7}$  Torr (200-mile altitude) under full load conditions, and is equipped with a heat transfer system capable of handling radiant wall temperatures from  $-65^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ .

Goddard's "8 by 8" will continue to serve as the touchstone for the Space Flight Center's highly successful reliability testing program until the enormous test and evaluation laboratories now under construction go into service early in 1963. Major space test chambers of this facility, which is expected to set the most advanced standards for spacecraft check-out, are two 35 ft. diameter, 60 ft. high thermo-vacuum environmental simulators. Stokes was selected as a prime contractor to NASA for complete vacuum and cryogenic systems for these huge chambers.

We welcome your inquiries regarding our capabilities and facilities for designing, fabricating, and erecting simulation facilities well in advance of the state-of-the-art, or any portion of a simulation project requiring high-vacuum and cryogenic systems. Space Systems Department, F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.

STOKES INTERNATIONAL: PHILADELPHIA • TORONTO • LONDON

**STOKES**

## PRODUCTION BRIEFING

Boeing Co.'s Vertol Division has been awarded an \$18,475,121 Navy follow-on contract for production of additional CH-46A Sea Knight assault transport helicopters (AW Oct. 22, p. 30) for the Marine Corps.

D. B. Milliken Co., Arcadia, Calif., has received a contract from Space-General Corp., El Monte, Calif., to build 16-mm., split-image motion picture cameras to record deployment and re-entry orientation of National Aeronautics and Space Administration's inflatable micrometeoroid paragrider (IMP). An Aerobee 150 rocket is scheduled to boost the package aloft early next year (AW Oct. 8, p. 32).

Bell Helicopter Co. has been awarded a \$25-million Army contract for production of UH-1B and UH-1D Iroquois helicopters. Contract is initial funding for Army's Fiscal 1963 order, which is expected to total \$75 million for 239 UH-1Bs and 121 UH-1Ds.

Rohr Corp. has received follow-on contracts totaling \$15 million from Boeing Co. for production of jet engine pods, struts and stabilizers for Air Force KC-135s and C-135s.

Fairchild Stratos Corp. will continue development of its AN/USD-5 multi-purpose drone system under a new \$9-million contract from Army's Electronics Command. Contract will carry development of the jet drone, now in preliminary flight test stage, through final flight demonstration. The USD-5, which carries a variety of electronic scouting systems, is zero-length launched from a trailer bed.

Litton Industries' Aero Service Corp., Philadelphia, Pa., will build three-dimensional, terrain-target models for F-105D flight simulators under a \$1,446,000 Air Force contract. Units will be constructed to scale and covered or painted to reflect light in the same proportions as actual terrain-target reflections of radar energy.

Texas Instruments, Inc.'s Metals and Controls Division has received a \$100,000 contract from Air Force's Aeronautical Systems Division to evaluate existing techniques for producing refractory metal alloy foils and to define optimum manufacturing procedures.

Space-General Corp., El Monte, Calif., will modify company-developed guidance subsystem under a \$144,000 contract for NASA's Project Vector. Modification is aimed at design, development and test of a system to stabilize and control launch vehicle upper stage-payload combinations.

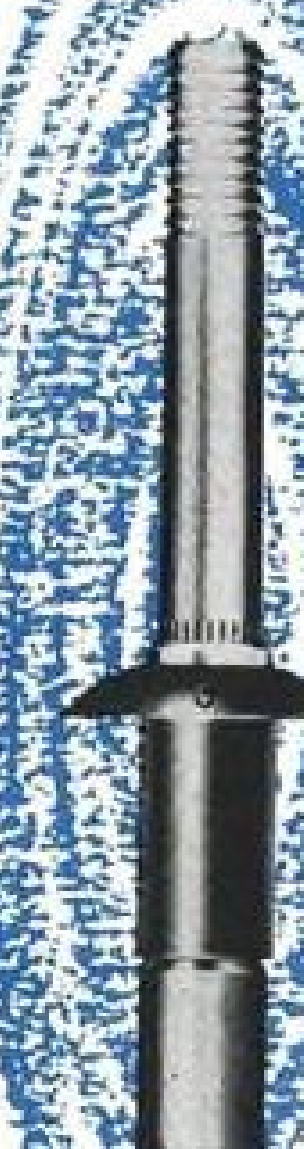
**ACTION MEMO**  
Design Engineering  
FROM: J.M.H.  
TO: J.M.H.

Dep't 41-A

*I understand Cherry can support all the claims they make in this ad - if so, we should be using the Cherrylock. Let's get an evaluation going immediately*  
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\*United States Patent No. 2931532. Qualifies under NAS Specification 1400 and meets Standard Pages NAS 1398 and 1399. For technical data on the Cherrylock "2000" Series rivets, write Townsend Company, Cherry Rivet Division, Box 2157-N, Santa Ana, California.

**Cherry Rivet Division**

Santa Ana, Calif.

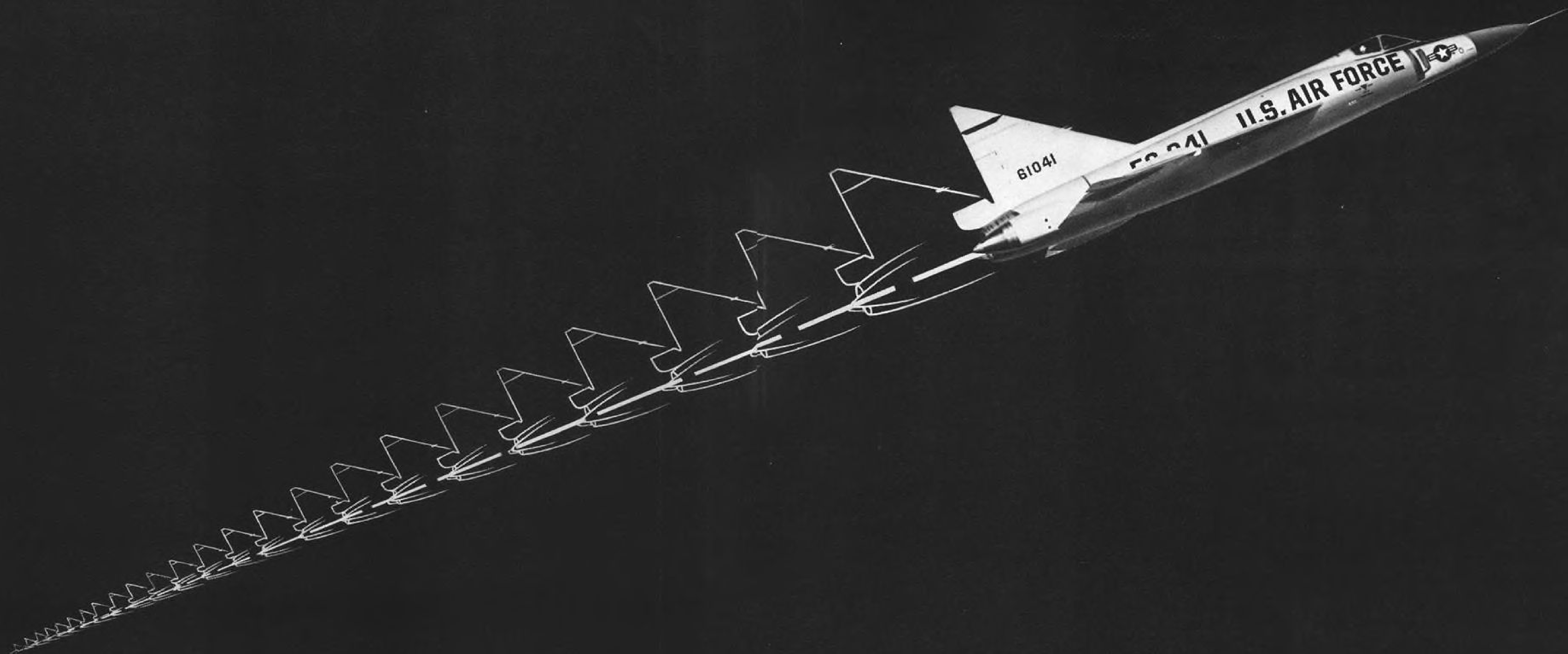


**Townsend Company**

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In Canada: Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario





## A SECOND GENERATION ADAPTIVE CONTROL...

E-P's sampled-data system is a second generation development in the evolution of self-adaptive flight control systems. It features digital logic techniques and the concept of continuous self-testing without the use of external test stimuli. It is flexible enough to meet the requirements of any aerospace vehicle.

Developed by Bendix and supplied to the Air Force under a contract administered by the Flight Control Laboratory,

Aeronautical Systems Division, our sampled-data system has undergone extensive analog computer studies using a variety of vehicle characteristics including the B-58 and Dyna Soar. But most important of all, it has flown and flown successfully on an Air Force F-102 over a range of sub- and super-sonic speeds.

The sampled-data adaptive system measures its own performance against model data each tenth of a second,

predicts the error for each succeeding tenth of a second and generates appropriate servo commands to obtain desired aircraft performance. Literally, the system is continuously one-tenth of a second ahead of itself.

E-P's system does not require that limit cycle oscillations be maintained. This results in more stable operation with greater pilot acceptance. The sampled-data system also lends itself to multiplexing or time-sharing techniques

which provide increased reliability per unit weight over other known types of adaptive systems.

If you have a vehicle that demands the techniques of self-adaptive control, you should have the complete details of our second generation sampled-data system. It is another example on our list of reliable and complete aerospace systems. For information, write or call us at Eclipse-Pioneer Division in Teterboro, New Jersey.

## IS FLYING

**Eclipse-Pioneer Division**



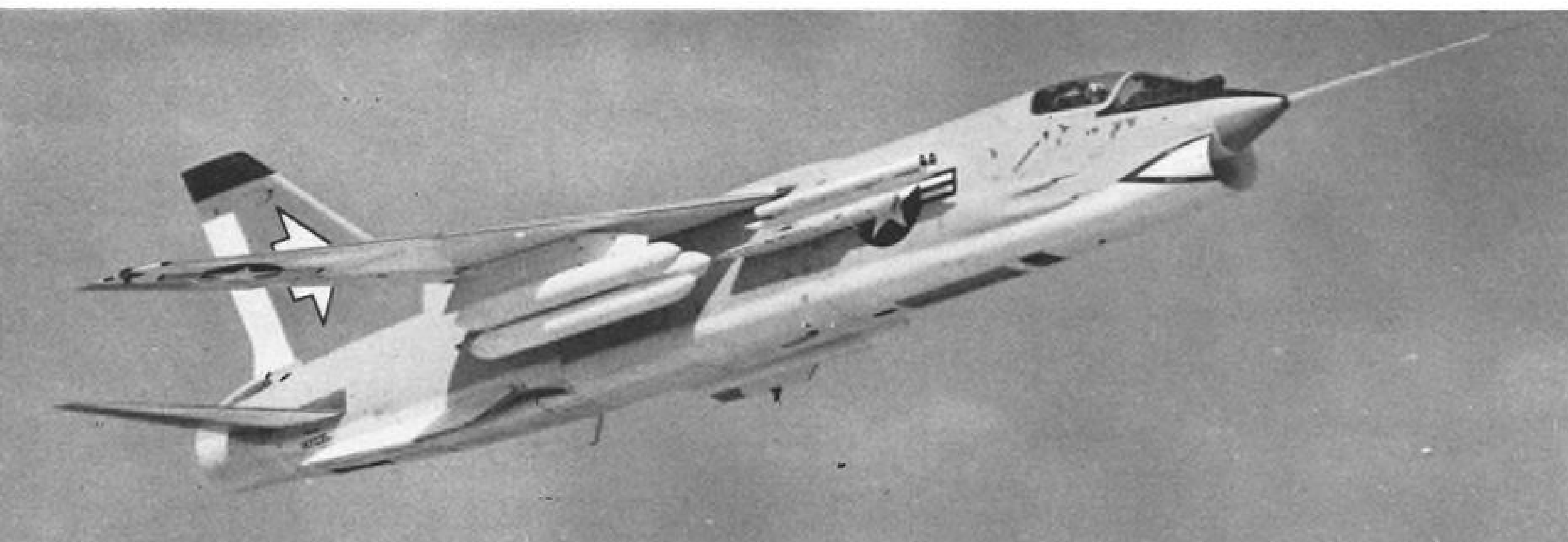
**WHERE IDEAS  
UNLOCK  
THE FUTURE**





Navy is evaluating Chance Vought's F8U-2NE Crusader jet fighter for use as a strike aircraft. Above, the single-jet fighter is shown on an evaluation flight armed with two Bullpup B air-to-surface missiles and eight Zuni all-weather rockets carried in pods.

## F8U-2NE Evaluated for Fighter-Bomber Role



Above, F8U, which has maximum speed of approximately Mach 2, carries 30 Zuni rockets in wing pods. In flight tests, flames from salvo-fired Zunis extended far enough to scorch plane's horizontal tail surfaces, may necessitate fabricating them of stainless steel. Below, aircraft armed with Bullpups and Zunis is parked with wingtips folded in carrier-stowage configuration.



Crusader, powered by Pratt & Whitney J57-P-20 engine producing 18,000 lb. thrust, flares out for landing after flight with four 500-lb. bombs mounted on multi-purpose pylons under each wing. Note that two-position wing has been raised for carrier-type landing.



F8U-2NE is airborne with 10 500-lb. bombs on underwing pylons and eight Zuni rockets in fuselage launchers. Other armament carried during evaluation missions included four 20-mm. cannons for aerial combat and low-level strafing runs.



Crusader lands at Chance Vought's Grand Prairie, Tex., facility carrying two 2,000-lb. bombs, mounted on pylons under each wing.





## Today's Minuteman will be protected by Tailor-made AAF "Environmental Control" Systems

Deeply buried in isolated launch silos, the Minuteman missiles will strike back instantly, even under direct attack. This is well known. But how can each missile, with its sensitive guidance elements, remain always operational and ready?

Part of the answer is the Minuteman's environmental support system—prime contractor, American Air Filter Company Defense Group.

A system of heating, ventilating, air filtering, refrigeration, and humidity control may seem commonplace. Yet few firms even felt qualified to bid on this Minuteman assignment. The technical problems were staggering. The reliability of hundreds of missiles was at stake. Also the ability of remote control personnel to survive and retaliate.

AAF's capability for such a task had evolved out of four decades of pioneer engineering and large-scale production for military and civilian industry. But even AAF engineers were surprised at the speed with which Minuteman's urgent schedule carried them beyond previous limits of the art of environmental control.

Component after component was redesigned, as AAF moved inevitably away from the idea of equipment serving the weapon—to create a necessarily *integral part* of the weapons system itself.

In completing its part of the system on schedule, AAF's Defense Group utilized its own production plants, plus resources of our Air Filter Division, Temper Air Group (Herman Nelson), Fiber Glass Group (Amer-glas), and other AAF divisions and subsidiaries. This corporate team offers scope, flexibility, and effective systems management capability.

If environmental control is important to your project, send for AAF Bulletin D-164. Write Defense Products Group, American Air Filter Company, Inc., 310 Third Street, Rock Island, Illinois.



**American Air Filter**  
BETTER AIR IS OUR BUSINESS

## EQUIPMENT

### Rubber Spray Used To Build Fuel Tanks

Akron—Technique which uses rubber sprays to manufacture fuel tanks for light aircraft has been developed by Goodyear Tire & Rubber Co.

Light aircraft fuel tanks are manufactured by spraying a liquid urethane on a cardboard form. Between the layers, liquid nylon is painted and a layer of liquid nylon is laid. The whole unit is then vulcanized and the form removed.

In the past, a relatively expensive plaster form was used. Layers of nitrile rubber sheeting and rubberized fabric were utilized. The overlaying parts were then cemented and whole unit was vulcanized in high-pressure steam. After the operation was completed, the form was broken inside the fuel tank and then the plaster pieces were removed through the tank's aperture.



### Portable Oil Pump

Special hand-operated portable pump which filters oil to 10 microns during sump filling was designed for United Air Lines' Caravelle fleet. On-the-spot filtering is required because Rolls-Royce Avon turbojets' oil supply must be replenished, if oil is needed, 30 min. after shutdown. Consumption averages only .9 pint per hr. Full oil sump before each flight is necessary for accurate oil supply indication, Avon having a sight indicator rather than a dip stick. Maintenance pump was built for United Air Lines by Jay Besore & Associates, San Francisco.



## INHERENTLY COMPENSATED

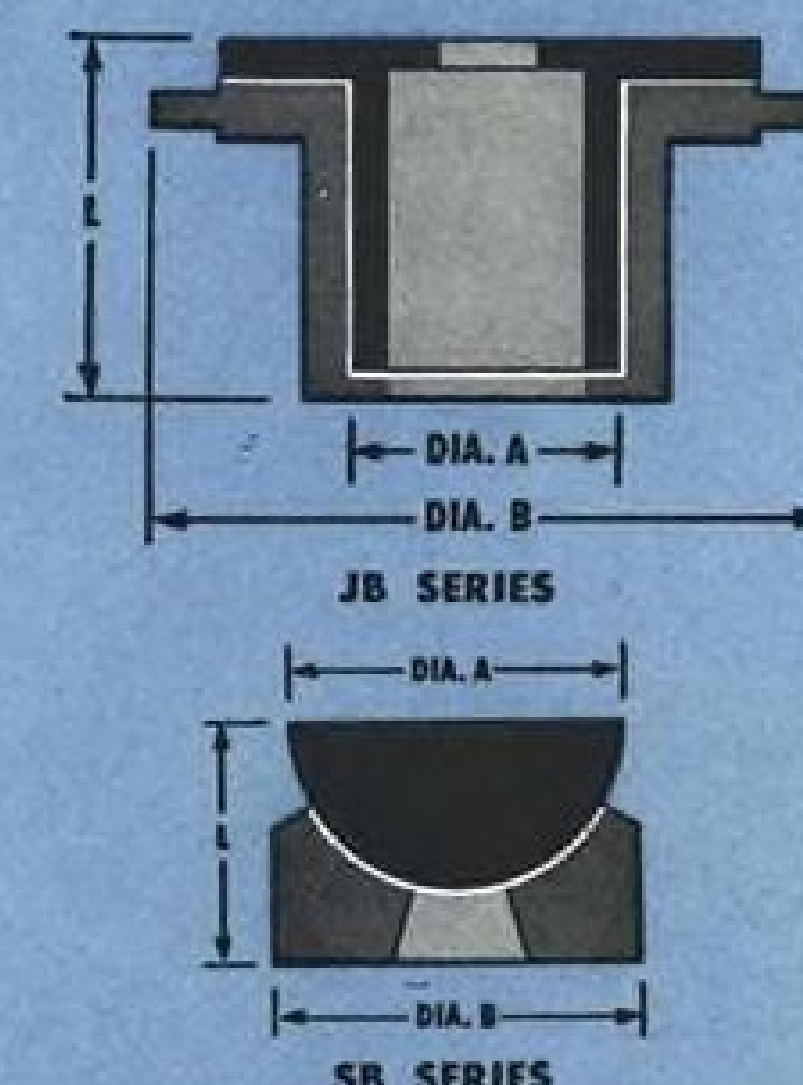
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Air and Oil Bearing Technology developed by Dunn Division of Wayne-George Corporation produced the well-known Dunn Oil and Air-Bearing Test Equipment which has been successfully used by industry over the past four years. This in-house technology has led to the design of inherently compensated pressurized air and oil bearings as standard components available for a wide variety of industrial and scientific applications.

Applications include:  
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inspection and machine tool spindles ... where high load bearing capacity with negligible friction and runout are mandatory.

### STANDARD FLOATED BEARINGS\*

DIMENSIONS (inches)				THRUST CAPACITY	
UNIT MODEL NO.	DIA. A	DIA. B	LENGTH L	(LBS.) OIL AIR	
JB-300	3	8	5	2,000	550
JB-600	6	12	7	4,500	1,200
JB-1200	12	18	8	10,000	2,000
SB-300	3	4	2	400	100
SB-600	6	7	4	1,500	350
SB-1200	12	14	8	6,000	1,400

\*Custom bearings can be provided

For Floated Bearing Technical Data write to Dunn Division  
Dept. 03, 322 Needham Street, Newton 64, Mass.



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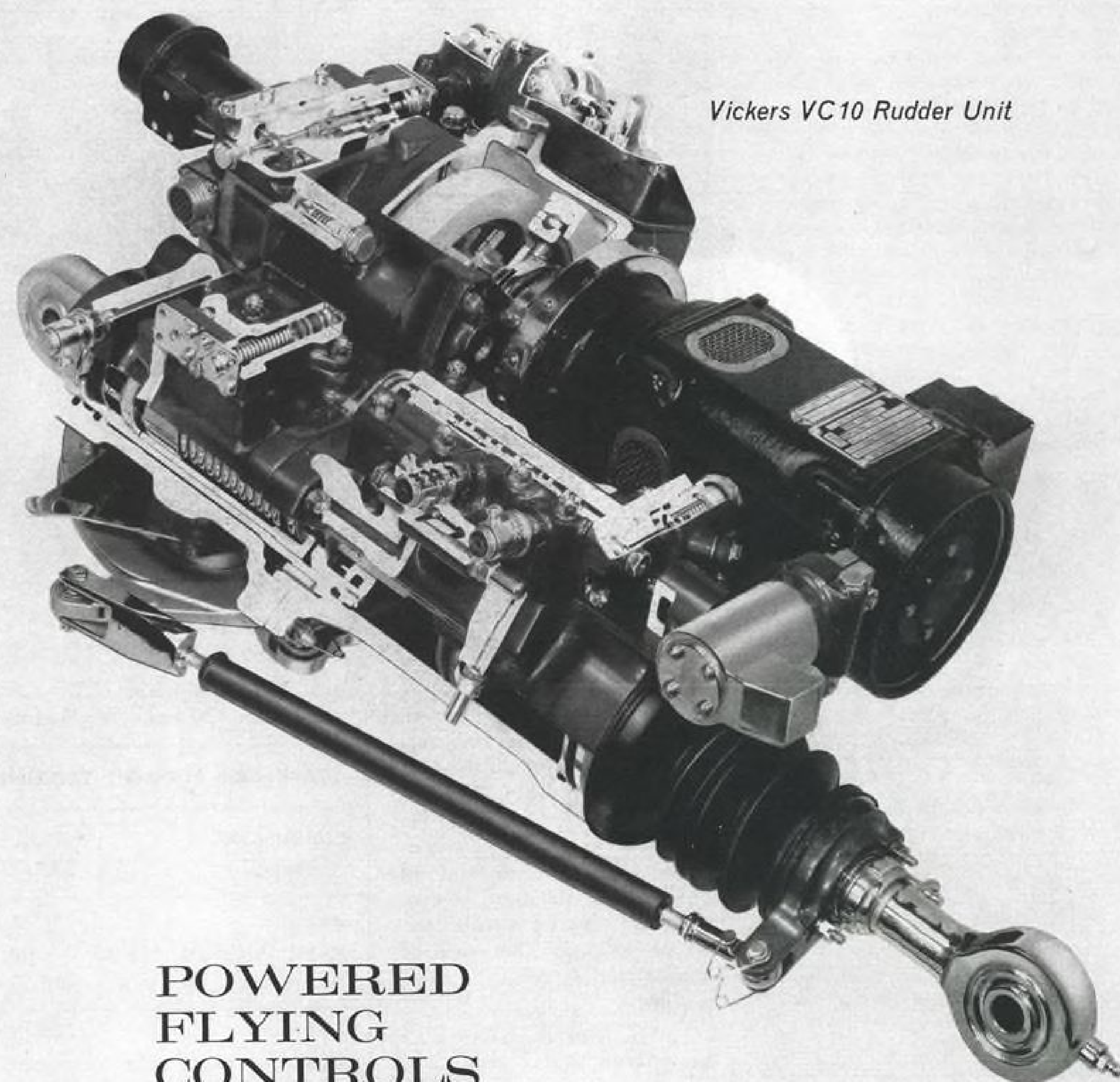
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## Glass Fiber Cockpit Section Used in C-141

New York—Glass fiber cockpit section for fabrication of flight deck assembly is being used by Lockheed-Georgia Co. in development of the C-141 jet freighter. Use of mold instead of part-by-part buildup reduced development time for the section by 400%, Lockheed officials say.

Without the technique, development personnel would have had to await construction of the first production hull before beginning preliminary installation of 1,200 electrical items and 11 mi. of wiring, tubing, control cables and crew facilities.

Technique was devised experimentally for JetStar development, then adopted for the C-141 when it proved to be a practical cost saver and shortcut toward scheduled completion dates.

Glass fiber section is obtained from full-scale plaster molds of the flight deck hull. Time is saved since fiber can be trimmed to exact proportions, whereas metal must be tooled in most instances, according to Lockheed.

Mockup also speeds up formulation of rib sections, which can be cut along their edges and bent to the hull's contour, eliminating need for a variety of detailed fabrication tools.

Carlos Rafael  
Hablará en el 45  
aniversario de la  
Revolución de Octubre  
(Nuestro Columna del día)

# REVOLUCION

PRIMERA EDICION

Publicado a la Presidencia, Prensa y Turismo de la Comandancia en Jefe, República Cubana

Año V No. 2103 La Habana, Lunes 5 de Noviembre de 1962 Director: Carlos Rafael • 30 Centavos

## ¡PRIMERAS FOTOGRAFIAS DEL AVION YANQUI ABATIDO!



Wreckage del avión U-2, interamericano, derribado sobre suelo cubano cuando espía. (Foto de la SECCION CINEMATOGRAFICA DEL MINFAR).

## CONTINUAN HOY LAS CONVERSACIONES DE MIKOYAN

### Cubans Display Wreckage of U-2

Cuban newspaper "Revolucion" prominently displayed photos of wreckage of U-2 high-altitude reconnaissance plane. Cuban reports stated that the aircraft, piloted by USAF Maj. Rudolf Anderson, Jr., was shot down by Cuban anti-aircraft batteries. Unofficial U.S. view was that the reconnaissance plane was hit by Soviet-supplied anti-aircraft rockets (AW Nov. 12, p. 34). Body of the pilot was returned to the United States for burial. Caption in the newspaper reads: "Wreckage of the North American U-2 plane shot down over Cuba while engaged in an espionage mission." U.S. observers have indicated that although Soviet equipment was used to down the U-2, the actual firing was performed by Cuban troops, adding that U.S. sources believed Soviet technicians were under strict orders not to take action against U.S. aircraft. Lockheed-built plane was downed Oct. 27.

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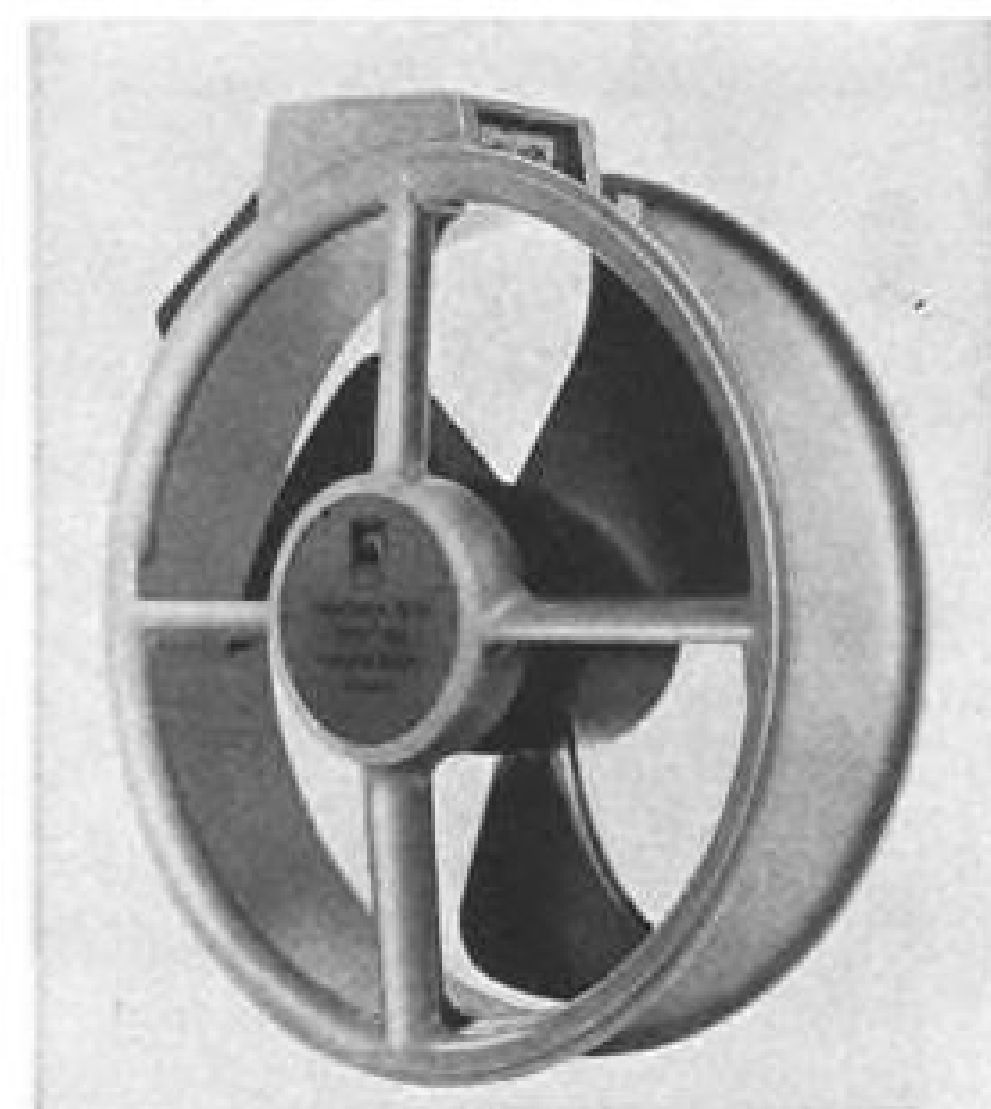
**Aviation Week  
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# NEW AEROSPACE PRODUCTS

## Lightweight Cooling Fan

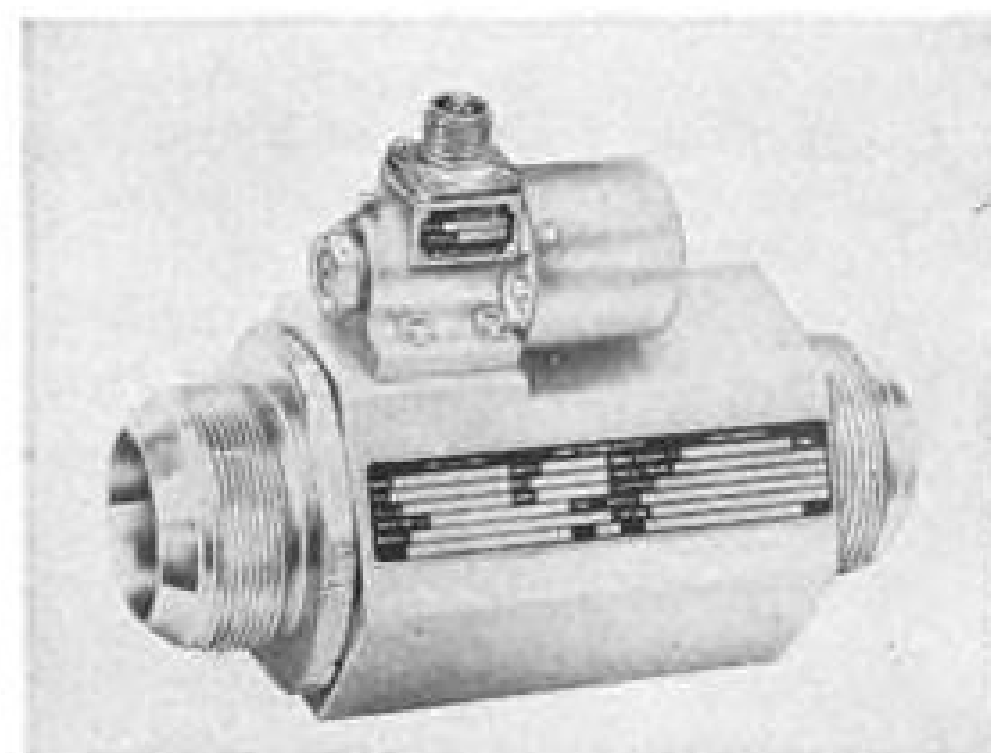
Cooling fan for electronic applications weighs 1.5 lb. and delivers 270 cu. ft. of air per minute at free delivery.



Fan is 7 in. in diameter and 2 7/8 in. thick, making it suitable for mounting in any instrument panel, the manufacturer says.

Fan has prelubricated stainless steel ball bearings, can be used continuously at any temperature from -55C to +65C. Fan operates at 3,380 rpm., single-phase, 115 v., 50-60 cps., consumes 22 watts. Device is made of a high-strength polycarbonate plastic.

Rotron Mfg., Woodstock, N. Y.



## In-Line Shut-Off Valve

Valve (MV-555 series) gives dependable on-off control of air or corrosive propellants with nearly full line capacity, the manufacturer says.

Valve may be piloted from line fluid being used or from a separate pressure source such as a solenoid or by hand. Valve is made of aluminum alloy and available with O-ring or sliding Teflon seals. It can handle pressures as high as 3,000 psig., the manufacturer says. Solenoid models are 100 v.a.c. and 28 v.d.c. Tube sizes available are 1 in., 1 1/4 in., and 2 in. Models are also available for cryogenic service.

Marotta Valve Corp., Boonton, N. J.



## Center of Gravity Locator

System measures unbalance in X-Y axes directly and allows location of an object's center of gravity to within  $\pm 0.001$  in. on these axes.

System consists of a detecting head and a portable indicating instrument powered by four self-contained flashlight batteries. Detecting head has a drilled mounting surface to which a variety of jigs and holding devices can be adapted. Calibration of the system is accomplished by placing a known weight a known distance from the center of the head, creating a precisely known unbalance.

Detector heads are available in 250 lb., 1,000 lb., 2,500 lb., and 10,000 lb. load carrying capacity with unbalance ranges of  $\pm 25$ ,  $\pm 100$ ,  $\pm 250$ , and  $\pm 1,000$  in. lb., respectively.

Bytrex Corp., 50 Hunt St., Newton 58, Mass.

## Pressurization Pump

Airborne pump (Model 4002) provides clean, dry air free from oil and carbon at altitudes as high as 60,000 ft. for pressurizing airborne radar and instruments.

Pump is a d.c. unit operating on 50 watts at 1.8 amp. Pump is guaranteed to have a 1,000 hr. life, the manufacturer says, and a circulation capacity of 975 cu. in. per min.

Aero Devices Co., 8218 Lankershim Blvd., N. Hollywood, Calif.

## Wire Welder

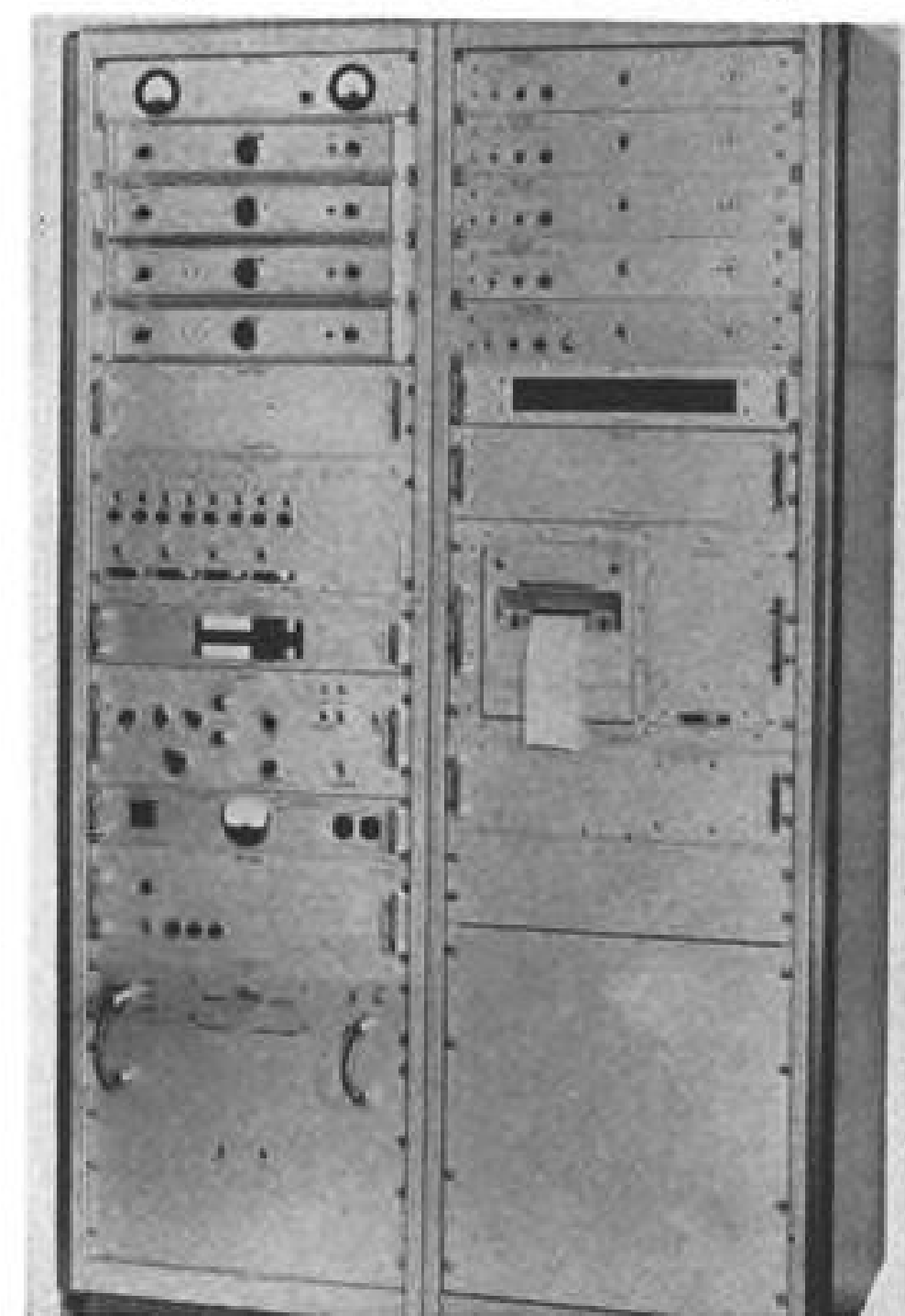
Bench-size portable welder made in Monaco makes solderless, fluxless welds on wires, thermocouples, fittings, etc.

Unit, called "Monarc," weighs 23 lb. Weld is made by a hand-held "stylarc" unit shaped like an oversize pencil; a ground is achieved by holding the work pieces in pliers. From 1/4 to 3 sec. is needed to accomplish the weld, depending on the thickness of the work. Six-position heat switch provides heat range for all types of metals.

U.S. Distributor, Price & Rutzebeck, P. O. Box 30, Hayward, Calif.

## Ballistic Integration System

Solid-state system (Model SY-101) obtains ballistic data from rocket motor static tests and presents it immediately upon completion of tests of fuel and motor performance and efficiency.



System accepts four channels of input data simultaneously from thrust and pressure transducers which it processes electronically to produce a readout combination of the integration of thrust versus time, pressure versus time, and the integration of the time interval. Readout is via printer and lamp bank, with provisions for four-magnetic tape, clock pulse and gate pulse output.

System is 45 in. wide, 23 in. deep and 77 in. high and weighs 850 lb.

B & F Instruments, Inc., 3644 N. Lawrence St., Philadelphia, Pa.

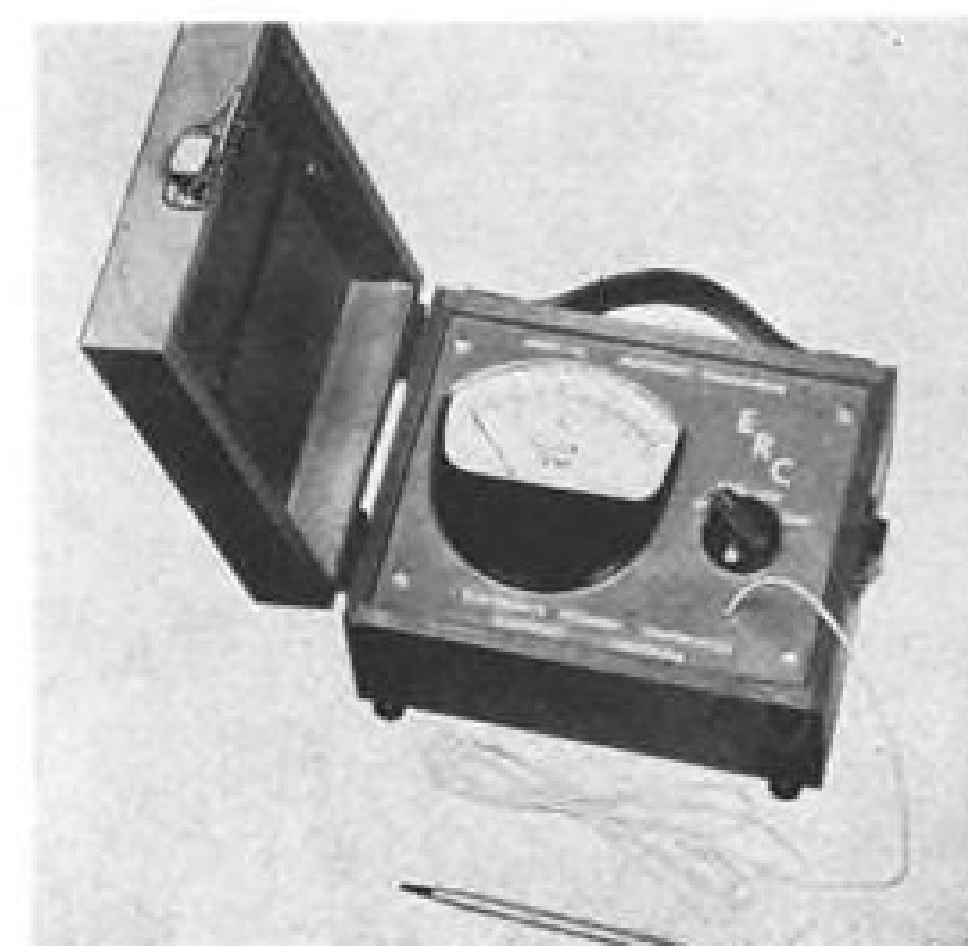
## Cryogenic Quality Meter

Panel meter gives continuous readout of quality (per cent vapor by volume) of cryogenic fluid at a given point in a cryogenic system. Provisions also are incorporated for operating a strip chart recorder, recording oscillograph, or oscilloscope.

Quality meter gives readings over the full vapor range from 0 to 100% with  $\pm 1\%$  accuracy over the full scale. Meter consists of a pipe section which is inserted into the cryogenic system and an electronic rack that can be remotely located.

Applications include missile fuel analysis, transfer line efficiency studies, pump cavitation studies, and sloshing effect studies.

Space Sciences Inc., 2 Mercer Rd., Natick, Mass.



## Electronic Thermometer

Electronic thermometer gives accurate readings of surface temperatures in 3 to 10 sec., the manufacturer says.

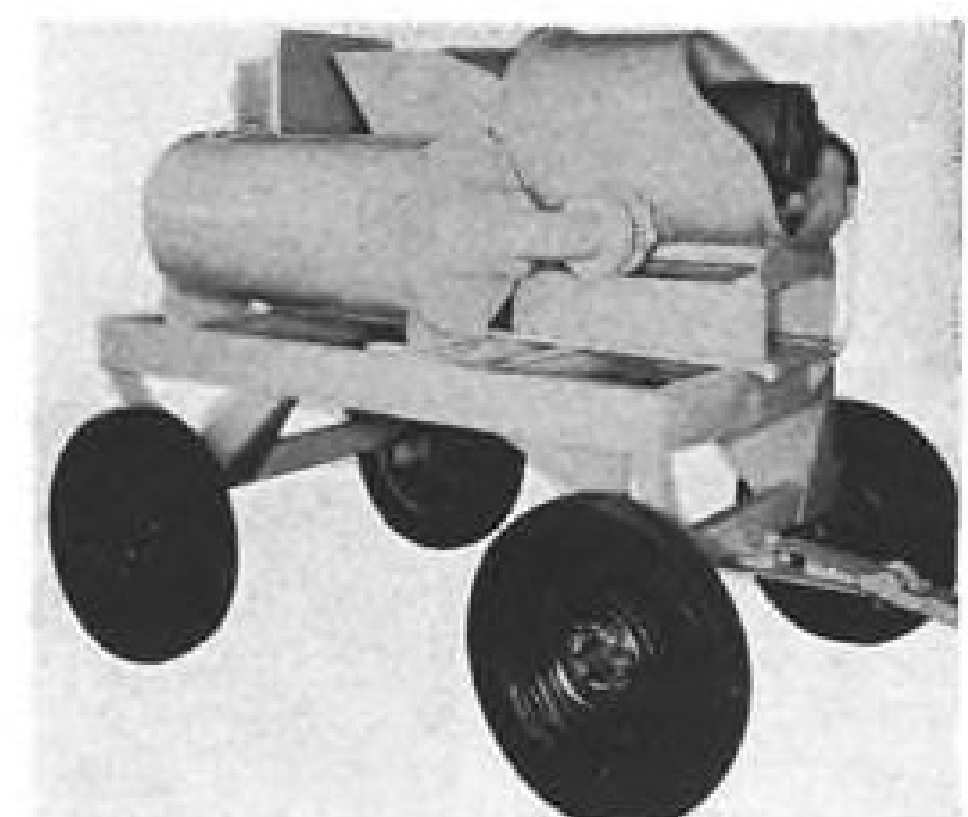
Unit will read temperatures of any component of an electronic circuit as well as point-to-point temperature contours of heat dissipating devices. Thermometer allows designers to plot gradients of heat sinks and make other thermal measurements during development processes, thereby verifying calculations without redesigning the final package, the manufacturer says.

Thermometer is available in 50-100F, 150-250F, 0-100C, and 100-200C ranges. Accuracy is 1 1/2% of scale range. Unit is portable, housed in a wooden case, and powered by a transistor radio battery.

Electronics Research Corp., 108 S. Olive St., Claremont, Calif.

## Purging Unit for LOX Tanks

Mobile purging unit blows heated air through liquid oxygen tanks to cleanse them.

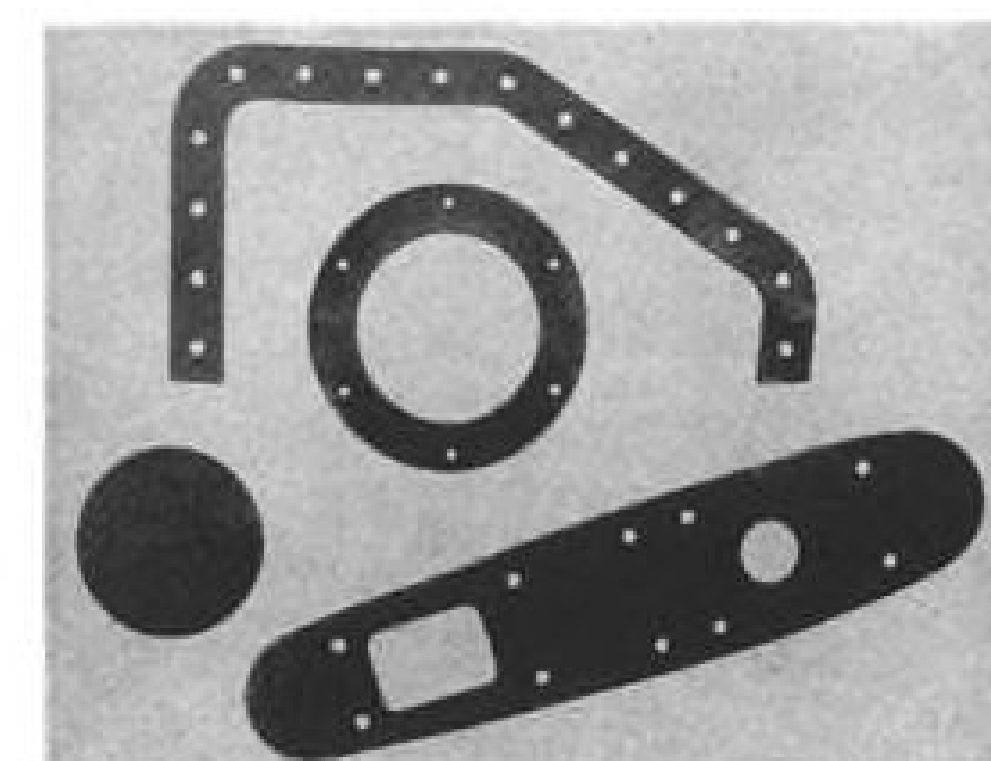


Unit passes atmospheric air through a filter and compresses it to 5 lb. psi. in a centrifugal blower. Discharge air from blower is heated to a 250F minimum and then fed into the liquid oxygen tanks by a short length of hose. Tanks discharge into the atmosphere. Unit illustrated is rated at 10 hp., but special sizes are available.

Spencer Turbine Co., 486 New Park Ave., Hartford, Conn.

## Sponge Gasket Material

Closed-cell sponge gasket and seal material called Viton Sponge is said to give satisfactory performance in corrosive, hydrocarbon and high temperature environments unsuitable for synthetic rubber compound gaskets and seals, the manufacturer says.



Material resists deterioration of jet fuel, gasoline, hydrocarbon solvents, hydraulic fluids, perchlorethylene, lubricating oils and greases, and other chemical and corrosive substances at temperatures of 400F and above, according to the manufacturer.

Material is reported to be well suited to aircraft and missile applications as well as other fields.

The Connecticut Hard Rubber Co., 407 East Street, New Haven 9, Conn.



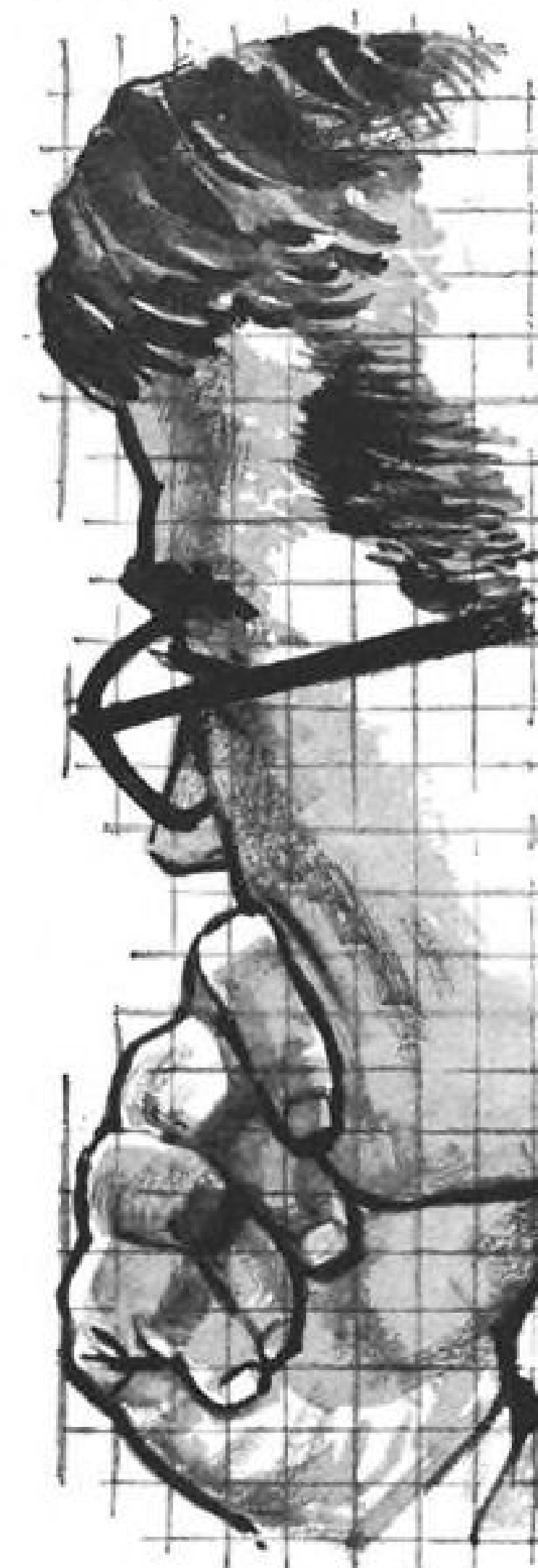
## Portable Microfilm Reader

Lightweight, compact reader for engineers needing reference to engineering drawings on microfilm occupies one sq. ft. desk space and weighs 31 lb., the manufacturer reports.

Called Portable Aperture Card Reader, Model MKR, the device projects a 10 1/2 in. by 12 in. image on a green-tinted screen. Reader has fixed 15 to 1 magnification, single control scanning lever which permits quick positioning of microfilmed image and a focus control knob located at hand level. The aperture card is inserted between two glass flats, to prevent scratching and heat buckling.

Recordak, 770 Broadway, New York 3, N. Y.

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### FUEL CONTROL

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de Havilland design and manufacture complete air conditioning systems which are fully tested in the most up-to-date environmental test chamber before delivery. Components can be supplied to meet individual requirements.



### POWER SUPPLY

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## BUSINESS FLYING



CZECHOSLOVAKIA'S L-40 META SOKOL business plane is fitted with a supercharged 140-hp. engine and features a reverse tricycle landing gear. Price of the airplane, delivered in the United Kingdom, is \$12,880 duty paid. Note Czech An-2 in background.

### Aviation Week Pilot Report:

## Meta Sokol Shows Ruggedness, Stability

By Herbert J. Coleman

Brno—Czechoslovakia's four-place Meta Sokol single-engine executive aircraft is a rugged, easily flown plane implicitly designed for operations in rough conditions where maintenance could be a logistics problem.

Aircraft, which has been flown since 1956, has been fairly successful as a Czech export item, although government officials decline to give precise production figures. It is being phased out of state production late this year, probably due to emphasis now being put on the twin-engine Morava 200D (AW Oct. 29, p. 92).

Despite this official position, the Meta Sokol compares favorably with any of its Western counterparts, including price. Airplane's price, delivered in the United Kingdom, is \$12,880 duty paid, according to distributor Peter S. Clifford, Oxford Airport.

In line with Czech government policy, the airplane has been demonstrated in Omnipol sales tours in emerging African republics and in Cuba and South America. Unique reverse tricycle landing gear was especially developed for the rough landing conditions found in relatively undeveloped areas.

Another sales factor in the Czech sales campaign has been to maintain a high degree of visibility, exemplified in the low-cut windshield and large side windows in the sliding canopy. High slab tail also was added for more maneuverability and critical speeds.

Airplane flown by this AVIATION

WEEK pilot at Brno Sports Club field, a rough grass strip about 10 mi. from the industrial city of Brno, was an Omnipol demonstrator with Czech registration OK-NMD. Pilot for the flight was Miloslav Kochir, of Omnipol, the state's export organization.

Value of the reverse tricycle gear is immediately apparent; airplane sits level on the ramp and taxi visibility is greatly improved. System also allows the pilot to taxi quite fast, even in ruts caused by heavy rainfall at Brno.

Interior of the Meta Sokol is well appointed and there is considerable leg room in both pilots' positions and in the rear seat. Luggage is stored behind the rear seat.

Weather for the first flight was poor, with ground fog patches and ceiling of about 200 ft. Flight was abandoned after about 10 min. of looking for a hole in the overcast. Weather conditions later improved to a 6/10ths ceil-

ing of 3,000 ft. Wind was 15 kt. from 270 deg. and ground temperature of 53F.

Starting the M-332 140-hp. engine is simple and consisted simply of turning on master and ignition switch, adding a few strokes on the primer pump, and pushing the starter button. Supercharger is left on for taxi and takeoff; engine is warmed up at the usual 800-1,000 rpm.

Unusual feature of the Meta Sokol is a button on the control wheel, resembling a radio button, which controls the rpm. of the two-blade Avia V-410 metal propeller. For takeoff, button is depressed as throttle is opened, until prop is rotating at 2,700 rpm.

Takeoff is made at this power rating, with 20 deg. of flap extended. The airplane has a tendency to yaw to starboard on takeoff, but this is easily controlled by rudder action. Roll was short, even in the rough-ground conditions, and climbout was made at 85-90 mph., using 35 in. Hg. and 2,700 rpm., with supercharger on. Gear retracts into fairings under the wing and is operated by large hand lever between the pilots. Supercharger was cut off at 2,000 ft. when power was reduced for cruising at about 130 mph., normal speed for the airplane.

Meta Sokol is responsive to harsh handling and has a tendency to hold its position when it is once established. Little trimming is needed, even in sharp banks up to 30-40 deg. The Meta Sokol is restricted for aerobatics; the airframe is stressed to 3.50 with flaps re-

### Rolls Engines for Morava

Omnipol, the Czechoslovakian state export organization, has shown considerable interest in fitting the Morava 200D executive twin with Rolls-Royce Continental engines to replace the present 260-hp. M-337 engines (AW Oct. 29, p. 92). Primary reason is to increase Morava export sales to the West; dealers have met customer resistance because of the question of M-377 spares and parts availability.



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tracted (positive acceleration). Never exceed speed ( $V_{ne}$ ) is 162 kt. Recommended normal operating speed is between 125-130 kt.

Even in gusty weather, such as was experienced during this flight, Meta Sokol control forces are small and little elevator deflection is needed to keep firm control.

Minor lateral oscillations tend to damp themselves.

However, in stall conditions the warning is fairly slight. In a gear-down, full-flap stall, with power back to idling, the warning is a tail buffet that is heard, rather than felt, and left wing drops off sharply at about 47 kt. Recovery is fast by opposite rudder deflection and by dropping the nose to regain flying speed.

In a power-on clean stall, at 2,000 rpm., the Meta Sokol stalls out at 55 kt. with much the same reaction.

#### Stability Shown

Airplane has excellent climb characteristics, retaining about 800 fpm. until approaching 8,000 ft. Supercharger usually is used for this maneuver. In a circular letdown, with power cut back, the Meta Sokol can be set in position, say a 15 deg. bank to the left, and it will continue the maneuver under hands-off conditions, as a demonstration of its inherent stability.

At a maximum continuous power run, using 29 in. Hg. and 2,500 rpm., the Meta Sokol reached about 143 mph. indicated airspeed. Run was quite short, due to turbulent conditions below the overcast.

#### Three-Point Touchdown

For landing, the gear and all-metal split flaps are extended at about 75 kt., on downwind leg. Because of surface gusts, landing was made at about 70 kt., 10 kt. faster than usual and the Meta Sokol was flown on final in a fairly flat glide. Touchdown was three-point, to keep the impact off the small third wheel located about midway on the belly. Even considering the gusts, which were then up to about 20 kt., landing roll was short and there was no problem in directional control. The airplane can be turned on its own axis, another strong point in favor of its use in underdeveloped areas.

Airplane flown, OK-NMD, was limited to operations in temperatures ranging from -20C to +30C. Beyond this limit, the engine is modified to include an oil cooler, usually performed before the airplane is transported to Africa or South America.

Engine is an air-cooled, in-line four cylinder powerplant fitted with a disengagable centrifugal supercharger and a low pressure fuel injection system,

situated forward of the inlet ports. Fuel is carried in two leading edge tanks, both vented, and in two tip tanks which now are standard equipment on the airplane.

Wings are of cantilever construction with a 6.5% dihedral at the outer sections; all-metal tailplane is situated on the thrust line. Wing area is 156 sq. ft. and chord is 6 ft. 8 in. at root, tapering to 3 ft. 3 in. at wingtips. Aspect ratio is 6.9 and the gross weight is 2,100 lb.

Meta Sokol is built in four units—forward fuselage, rear fuselage, windshield and canopy assembly and tail section. Forward fuselage is all-metal monocoque construction and is built together with the wing sections. Rear fuselage is a cone made without using extra stringers and with one frame at midlength.

Omnipol says maximum endurance of the airplane is about 7 hr. Range is about 700 mi.

#### Trener Master

In a short flight in the Z-326 Trener Master sport and aerobatic training plane, Kochir demonstrated airplane's remarkable ability for sustained inverted flight. The Trener Master is used extensively in Soviet bloc countries as the initial trainer for cadets; in Czechoslovakia, for instance, Cuban pilot trainees are checked out on the Trener

### PROBLEMATICAL RECREATIONS 145



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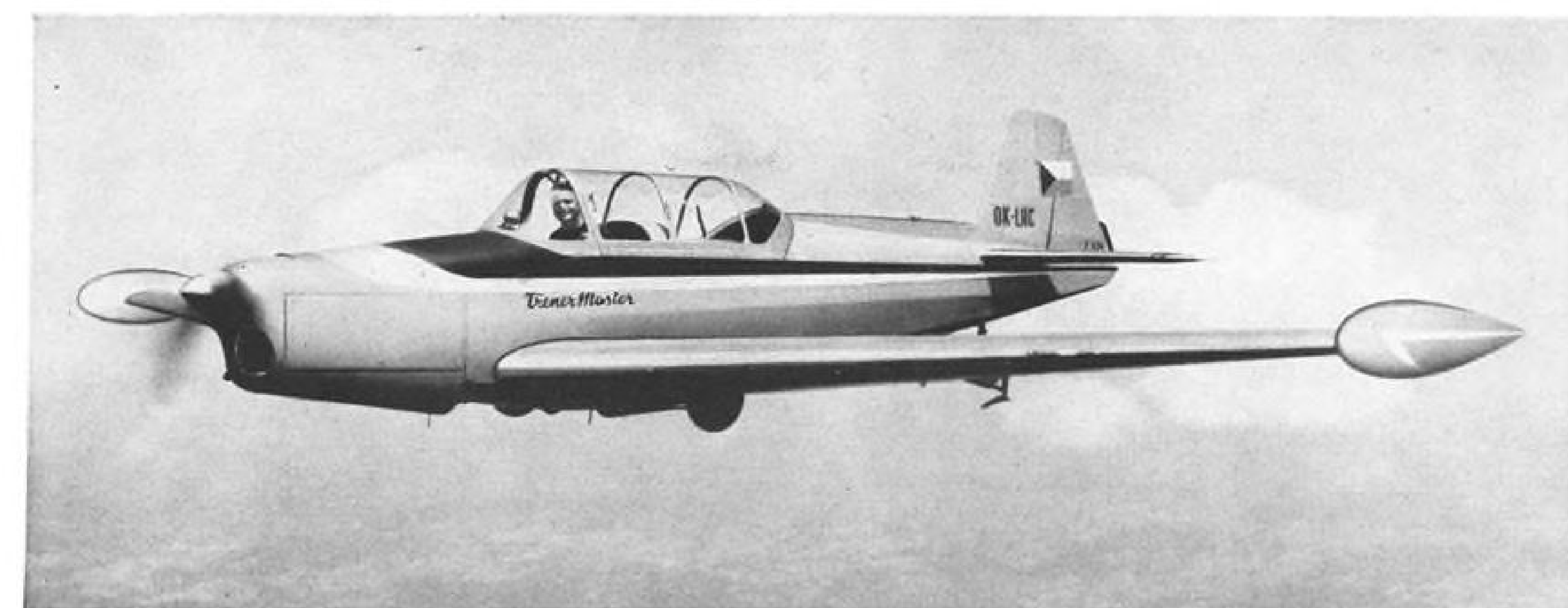


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**LATEST VERSION** of the Czechoslovakian Trener Master, fully aerobatic trainer and sport plane, is the Z-326, which has retractable landing gear. Wing has been stretched one foot over previous models of the aircraft. Gear protrudes below wing slightly to take up impact shock in event of a gear-up landing. Trener Master is certified aerobatic with tip tanks installed but empty.

Master before moving to more sophisticated aircraft such as MiG-series fighters.

Kochir said the airplane can be equipped with skis for mountain work and has proved quite popular in Communist countries as a glider tug. It is built by the Moravan Aircraft Factory at Otrokovice and has changed very little since its first flight in 1957. Principal change was addition of retractable landing gear and a fuselage beefup calculated to extend the range of the Trener Master's aerobatic capabilities. Wingtips also have been redesigned to take tip tanks if customer desires, and wing on the Z-model has been extended one foot.

Takeoff from Brno sports field was short, less than 1,000 ft. and Trener Master was airborne at about 50 mph. Climb to 2,000 ft was accomplished at about 70 mph. and airspeed built up to 125 mph., the normal operating range.

There appears to be no limit to aerobatic uses of the Trener Master. On this flight, maneuvers included tight loops, a falling leaf, and chandelles. Inverted flight lasting 1½ min. was also made, with no engine cutout experienced. Carburetor has been fitted with a check valve and booster to keep fuel flowing during flights in this position.

Landing roll also was quite short and

Trener Master showed good braking and ground handling characteristics. Final approach is flown at between 40-45 mph.

Trener Master is powered by a Walter Minor 6-3 six-cylinder inverted in-line engine which develops 160 hp. at 2,500 rpm. Fuel tanks, placed in the wing roots, carry 10 Imp. gal. each (12 U.S. gal.). Tip tanks hold a total 8 Imp. gal. (10.8 U.S. gal.) and airplane is cleared for aerobatics with tanks in-

stalled, but the tanks must be empty.

Basic fuselage is of welded frame construction, covered with metal skin; there is some use of wooden stringers for reinforcement. Wing is a semi-monocoque trapezoid utilizing one main and one auxiliary spar. Main spar resists flexing moments, while torsion moments are transmitted to a torsion box formed by the main spar and leading edge stiffeners. Tailplane is all-metal with fixed rudder trim tab.

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For further information write:

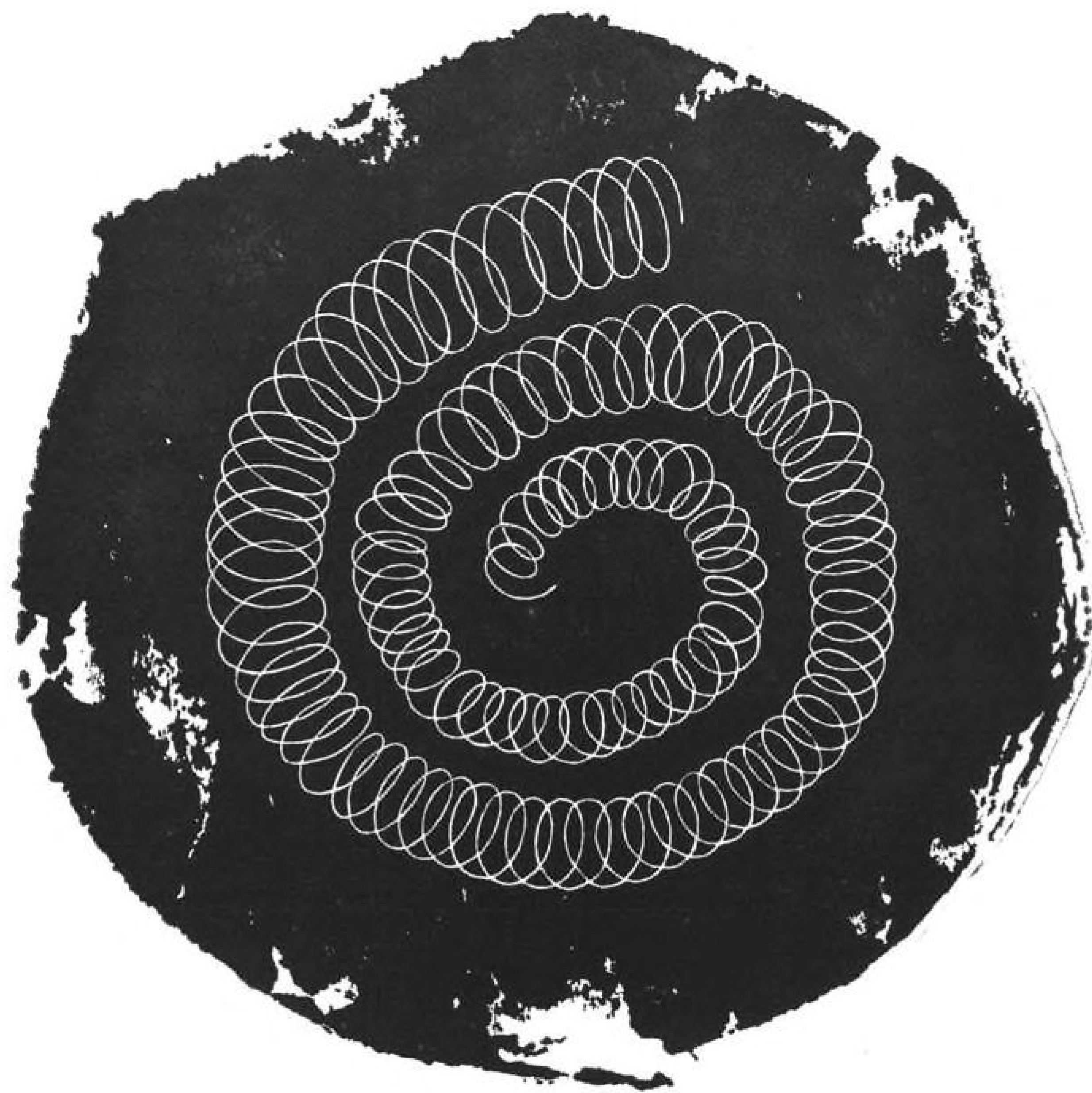
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### Meta Sokol L-40

Length .....	24 ft. 9 in.
Height .....	8 ft. 3 in.
Wingspan .....	33 ft. 0 in.
Wing area .....	156 sq. ft.
Gross weight .....	2,100 lb.
Empty weight .....	1,780 lb.
Payload .....	833 lb.





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## WHO'S WHERE

(Continued from page 23)

### Changes

Stephen E. Einig, director of marketing, Defense Products Division, Fairchild Camera and Instrument Corp., Syosset, N. Y., succeeding John S. Auld (AW Nov. 5, p. 142).

Frank Genco, sales manager, Air Cruisers Division, The Garrett Corp., Belmar, N. J.

Francis B. Malloy, production control supervisor, Swedlow, Inc., Los Angeles, Calif.

Ray E. Williams, production manager-air data systems, Guidance and Control Systems Division of Litton Systems, Inc., Woodland Hills, Calif.

William H. Boone, general sales manager, On Mark Engineering Co., Van Nuys.

Michael M. Grove, assistant sales manager, Robertshaw-Fulton's Bridgeport Thermostat Division, Milford, Conn. Milo J. Bowen succeeds Mr. Grove as product manager for the division.

George Alexander, manager of United Technology Corp.'s newly established technical liaison office, Houston, Tex.

James R. Riedmeyer, assistant general manager, Tamar Electronics Microwave Division, Anaheim, Calif.

Dr. Malcolm R. Currie, Dr. George F. Smith and Harley Iams have been named a three-man directorate to manage Hughes Research Laboratories, Malibu, Calif. Dr. Lester C. Van Atta, former director of the laboratories, now chief scientific consultant

reporting to the vice president and general manager of Hughes Aircraft Co.

Dr. Bernard A. Lippmann, director of physics, Defense Research Corp., Santa Barbara, Calif.

Bob P. Helgeson, chief of the recently activated (Las Vegas) Nevada Extension (SNPO-N) of the Space Nuclear Propulsion Office. SNPO is a joint office of the Atomic Energy Commission and NASA.

Donald H. Adler, head, Magnetics Devices Division, Cannon Electric Co., Los Angeles, Calif.

Wallace E. Bjornson, site director for installation of Strategic Air Command's new command control system at March AFB, Riverside, Calif., for International Electric Corp. (IEC). IEC, a subsidiary of International Telephone and Telegraph Corp., is system manager for Project 465L, the new SAC system.

Dr. Robert B. Goldman has been appointed to the corporate Engineering and Research Staff of Philco Corp., Philadelphia, Pa., responsible for coordinating military and industrial technical programs.

J. L. Thorne, manager of Westland Aircraft Ltd.'s, London (England) office, succeeding Lt. Col. J. W. Richardson, retired.

Charles M. Echeverria, Jr., senior project engineer and program manager on the CH-53A helicopter project, Sikorsky Aircraft, a division of United Aircraft Corp., Stratford, Conn. Also: Roderick L. Smith, assistant senior project engineer; Neil C. Heslin, CH-53A program project engineer.

Dr. James G. Gaume, head, Life Sciences Program, Northrop Space Laboratories, Hawthorne, Calif.

Rubin K. Feldman, department manager of the newly established Thermodynamics and Chemistry Department, Electronics and Avionics Division of Emerson Electric Manufacturing Co., St. Louis, Mo.

Thomas N. Keeton, advertising manager, Northrop Corp., Beverly Hills, Calif.

Jack D. Little, deputy manager, Information Sciences Department, Planning Research Corp., Los Angeles, Calif.

John Winter, technical director, Sundstrand Aviation-Denver, Denver, Colo.

A. M. Okun, corporate director of reliability, General Instrument Corp., Newark.

Franz C. McVay, senior engineer, Applied Technology, Inc., Palo Alto, Calif. Also: Mike T. Smith, manager of the company's newly established Washington (D. C.) office.

Alfred Holtum, chief, Antenna Design Group, Andrew Corp., Chicago, Ill.

C. R. Kazebee, manager-research and development-improved Minuteman (WS-133B) Program, Autonetics, a division of North American Aviation, Inc., Anaheim, Calif.

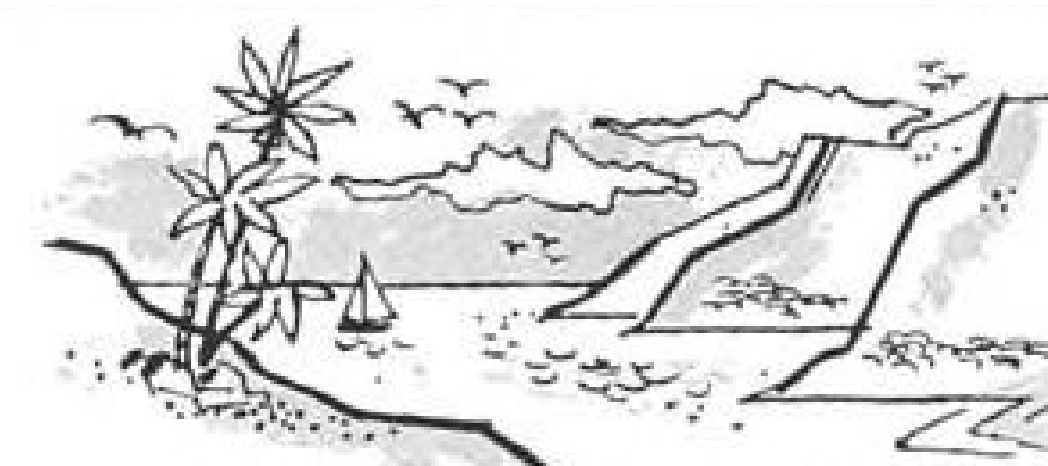
Clyde F. Coombs, quality assurance manager, Berkeley Division, Beckman Instruments, Inc., Richmond, Calif.

Col. Harry K. Evans (USAF, ret.), senior customer relations representative, Republic Aviation Corp., Farmingdale, N. Y.

Thomas Schweinzer, chief engineer-research and development, Erik A. Lindgren & Associates, Inc., Chicago, Ill.

Dr. L. E. Godycki, manager-materials research, Trimpot Division of Bourns, Inc., Riverside, Calif.

T. Kenneth Riggs, staff consultant, General Kinetics, Inc., Arlington, Va.



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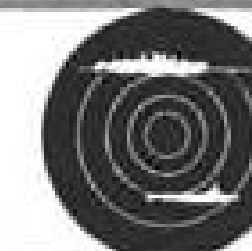
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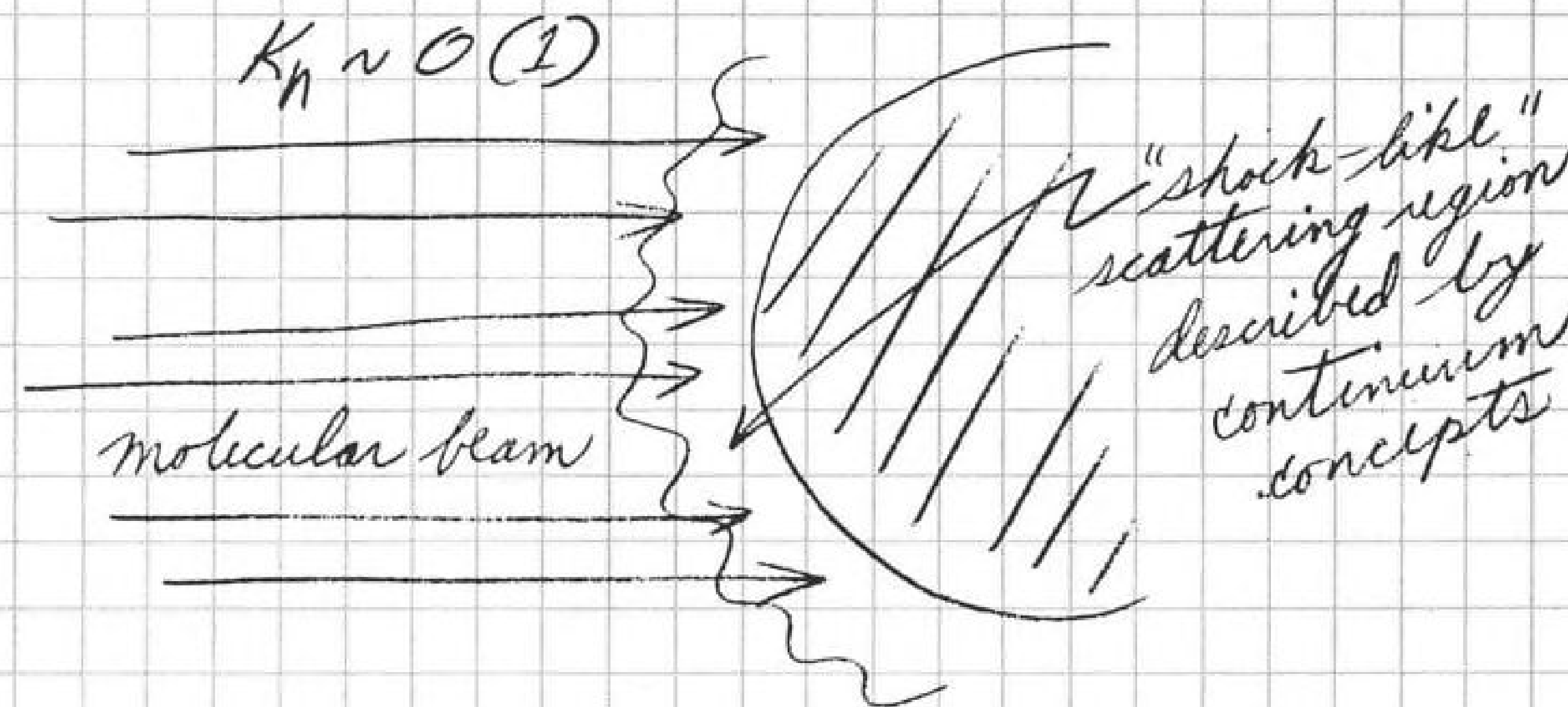


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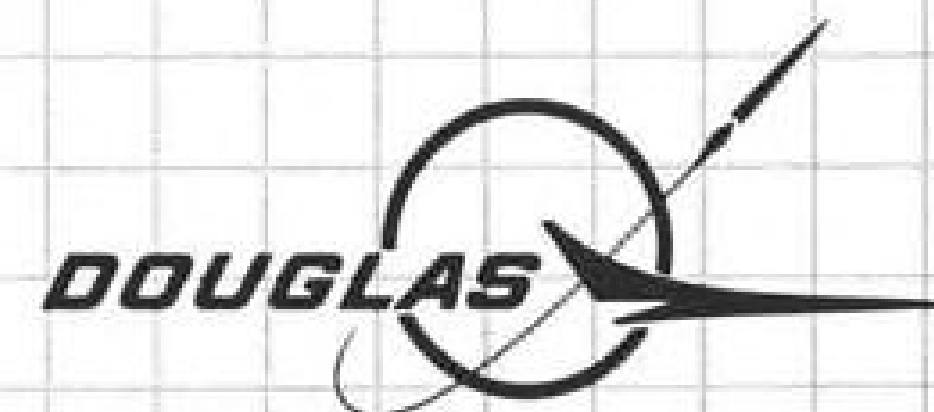
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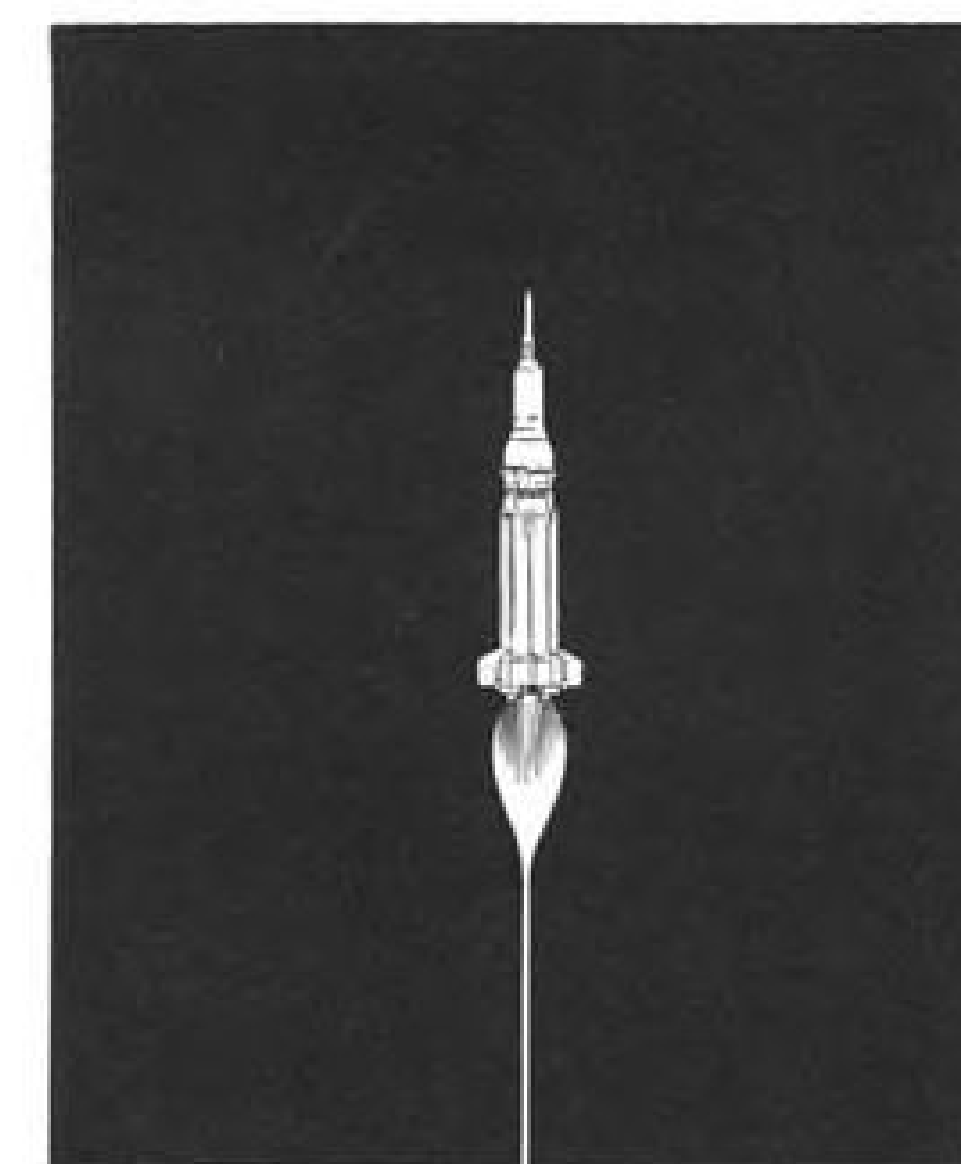
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Men at all degree levels in Mechanical and Aeronautical Engineering are sought for these exacting assignments. The role of our engineers in this group is to evaluate advanced propulsion systems concepts such as turbojets, turbofans and ramjets as they apply to advanced subsonic, supersonic, hypersonic and V/STOL aircraft. We are also seeking Marine Engineers for work on marine vehicle applications.

The nature of these programs provides ample opportunity for individual expression and progress.

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For this interesting work area, we require men holding a B.S. or M.S. degree in Aeronautical or Mechanical Engineering. The work involves advancing the state-of-the-art in component design technology. This program combines an experimental effort, coordinated with analytical studies, which will produce the technology required for the design of advanced powerplants. Aerodynamic, thermodynamic or combustion experience, coupled with a common sense approach, is a desirable combination for this responsibility. The right men will be in a position to gain a broad view of overall program developments and to participate in new application studies.

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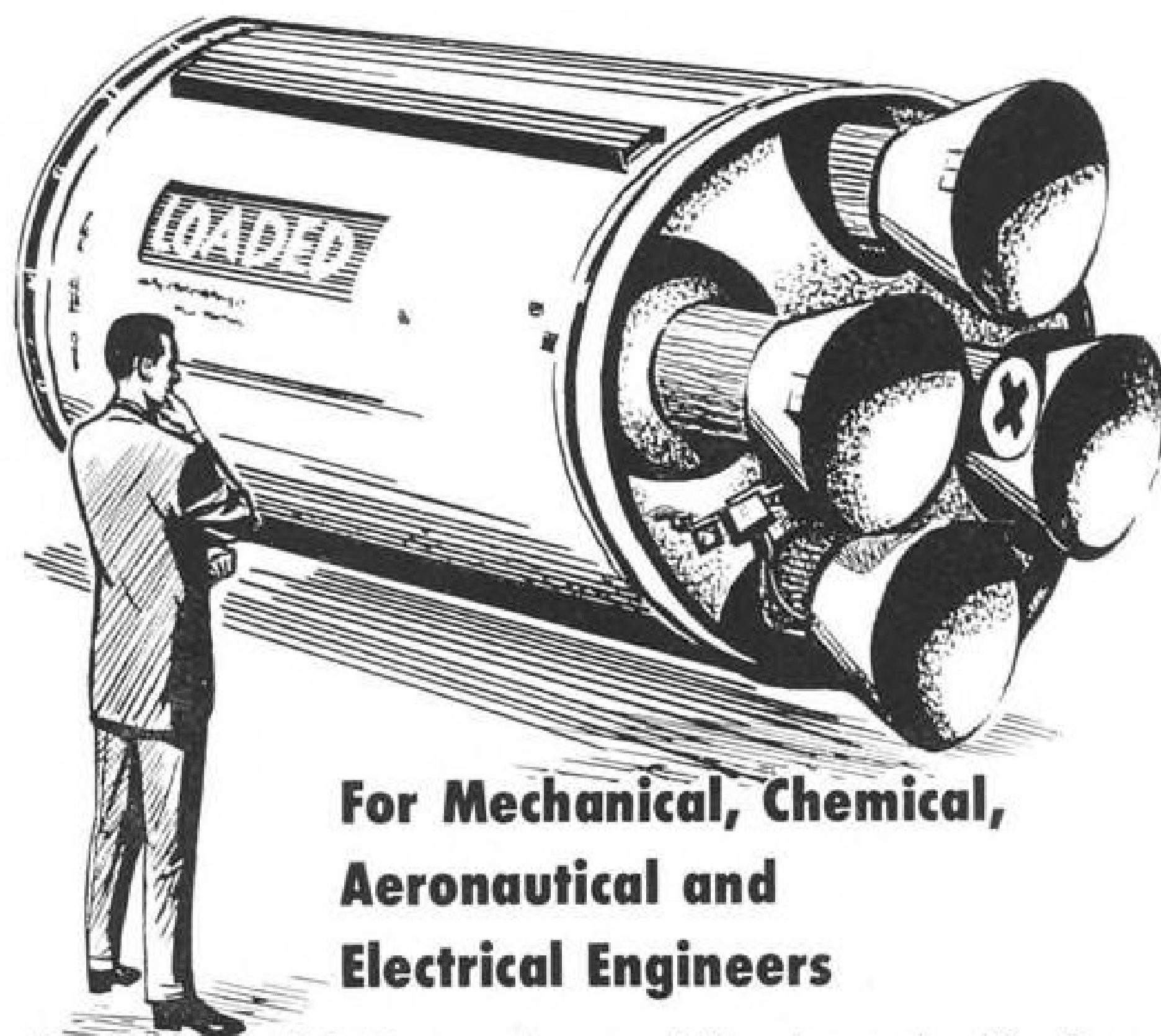
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## LETTERS

### Reversing Parkinson

I believe AVIATION WEEK readers who noted your Nov. 5 article (p. 26) on India's airlift needs and who are familiar with Parkinson's law will be interested to know that our goal is not just to give the C-82 and C-119 Fairchild a quick shot of adrenalin by adding jets. We are out to reverse Parkinson's law in all of its aeronautical aspects and recreate these aircraft into two of the world's best and most unsophisticated military or industrial aerial trucks by stripping their still unexcelled cargo airframes of unnecessary gadgets in favor of simple, positive systems. I expect these to include an inexpensive detachable blown flap system, drooped ailerons and enough other simplified variants on the present state of the art to produce aircraft that will clearly outshine the Russians in the areas of simplicity, ruggedness and STOL performance—and to outearn the latest short and medium range cargo aircraft at a ton-mile cost that will make a hardened American airline controller smile. Thanks for your coverage of our present jet C-119 program to give India the airlift capability she needs right now quickly and cheaply. Please place us at the Municipal Airport, Long Beach, Calif., where we have been operating for the past six months in new facilities rather than at our old Gardena address as recorded in your (first) article.

F. H. STEWARD  
President  
Steward-Davis, Inc.

### Instrument Crusade

After reading the "Slow Reaction" letter by Maj. Redeen in your Oct. 8 issue (p. 128), I feel compelled to comment on certain of his observations and conclusions in an effort to set the record straight.

Maj. Redeen stated that the TWA 720B #1 engine disintegration accident represented "cause for much serious concern." I couldn't agree with him more. It is a pity, however, that the responsible regulatory agencies of the airline industry take action only after a catastrophic accident occurs or a near accident, as in this case. In 1959 FEIA urged the mandatory installation of vibration indicators and pointed out instances where shrapnel from disintegrating jet engine turbine wheels had punctured the airframe. Our proposal fell on deaf ears.

Now, however, as an outcome of this accident, the CAB recommends installation of such equipment.

Maj. Redeen goes on to say that it is incomprehensible that someone of the crew did not notice the impending failure of #1 engine. He stated that the various engine parameters must have been indicating a malfunction "... with increasing emphasis subsequent to failure." Additionally, he states that "... the flight engineer, even with severely limited experience (63 hr. on 707 equipment), should certainly have been able to monitor the relatively simple to read, and limited number of, clocks re-

quired to trouble shoot a catastrophic turbine failure."

Having acquired 7,000 hr. in the air and approximately 1,500 hr. in 707s as a flight engineer, from my experience I can honestly say that it is quite possible that whatever indications of impending failure might have been indicated they could easily have gone unnoticed by the crew and especially by the flight engineer.

Evidently Maj. Redeen has never been exposed to the shocking instrumentation design and layout incorporated in our present day jet airliners.

For his benefit, I would like to review the situation which exists. The majority of engine instruments are located between the pilot and copilot on the forward instrument panel. The flight engineer at his station is located some five feet from the F/F, EGT, N1 and N2, and EPR "clocks" that Maj. Redeen says "... must have been trying to reach somebody's consciousness prior to turbine disintegration ...". To add insult to injury, the "clocks" are two inch peanut type displays. Under such circumstances, I defy anyone to effectively and conscientiously monitor and correlate these bits of information. The balance of the engine parameters—oil pressure, temperature, and quantity—are located on the extreme right side of the flight engineer's panel. Therefore, to correlate the total information displayed for any one engine the engineer must rotate his vision through approximately a 120-deg. arc. He can't scan one display panel without completely ignoring the other. Thank God, a few in the industry have finally come to their senses as displayed in the cockpit layout of the Lockheed C-141. It isn't the ultimate in design, but it's head and shoulders above the rest.

Since 1955 the FEIA has continuously opposed the present day cockpit instrumentation layout as being unacceptable, impractical, and unsafe. We have a multitude of documented incidents to support our arguments, which have been presented to the FAA, CAB, airlines, and manufacturers, but again our pleadings have fallen on deaf ears.

Maj. Redeen is of the opinion that the reaction time of the crew was too slow in this emergency, and stated "... that things have to be accomplished quickly in an even more professional manner than back on the props ...".

Once again I tend to agree with his observations, but we are not going to reduce the number of accidents by adhering to the hideous cockpit design philosophies and concepts that have been followed in our jet equipment.

The good major stated he did not intend to be rabid on this subject; I do, and will continue to be, for there is a sickness in this industry that is becoming entirely too prevalent.

The attitude of most, which includes the FAA, is one of "show me the bodies and I will act, until then don't bother me, I have too much work to do."

GLENN B. IVERSON  
Vice President-Engineering, FEIA  
Washington, D. C.

### Candid Camera Caper

I write this letter very reluctantly, as I feel that further mention of this insidious subject only adds fuel to the fire. However, inasmuch as AVIATION WEEK has reported to its readers the actions of the House Government Operations Subcommittee in its probe into candid camera antics of certain individual flight engineers (AW Sept. 24, p. 47, Oct. 8, pp. 42, 43), then I feel it only fitting and proper that other flight engineers present the other side of the coin. The other side of the coin will not be received with all the fanfare and sensational press coverage that stories of stewardesses sitting on pilots' laps, etc., do, since it lacks the bizarre qualifications that the news media of today seem to feel the public wants.

This letter is addressed to the readers of AVIATION WEEK who do not have a working knowledge of what transpires behind the closed cockpit door.

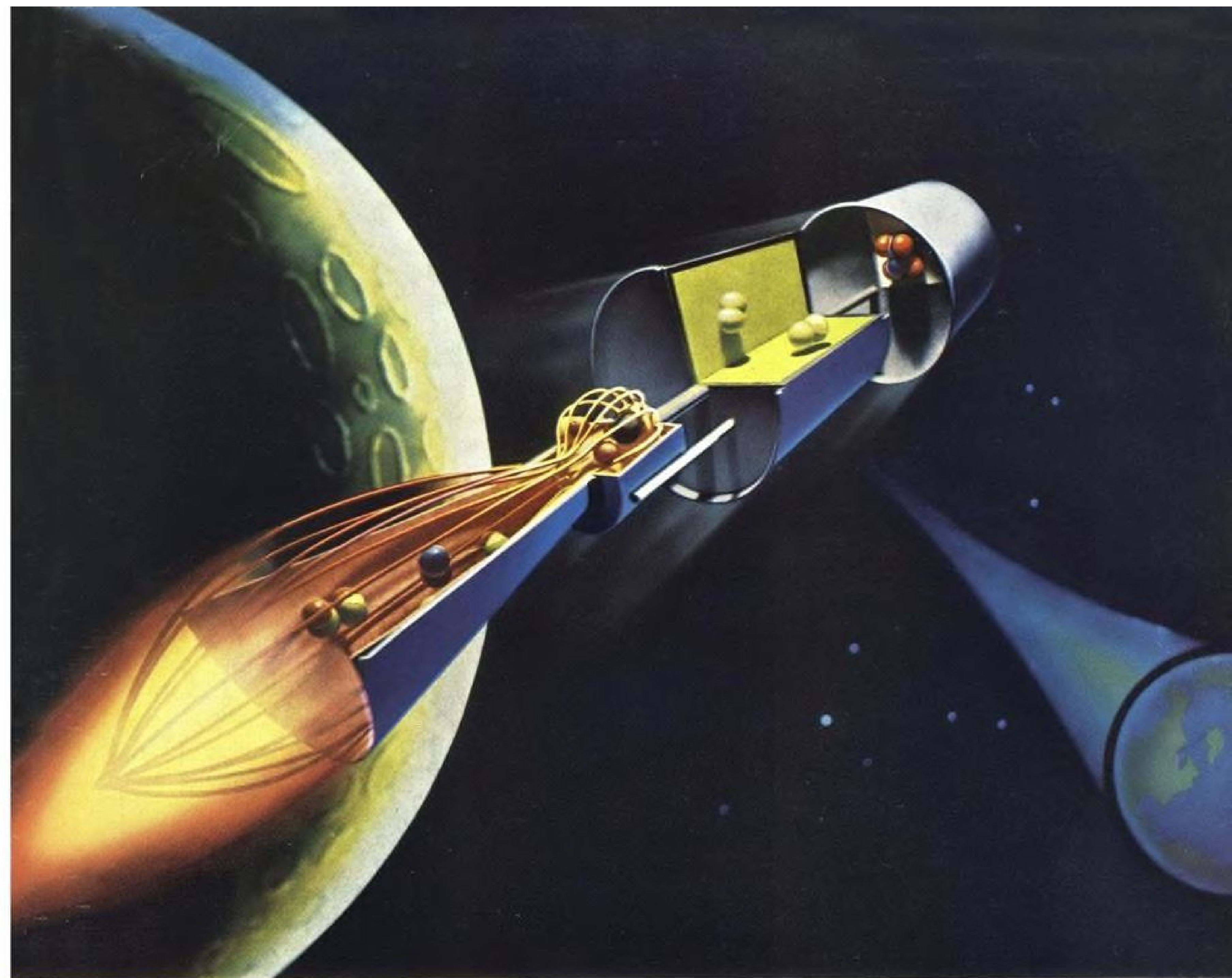
If your faith in the people who transport you around in commercial aircraft has been shaken by the disclosure that Playboy magazine has found its way into the cockpit, or that stewardesses have occupied the copilot's seat for a few ecstatic moments while she was led to believe that 'little old her' was actually flying, then you are being misled by the very publications you read. You are being led to believe that a serious threat to safety exists, when, in actuality, there is none. Certainly, not in that area.

It would not be fitting to discuss the merits of a regulation that prohibits crew members from reading while in the active pursuit of their duties, or one that states that only authorized persons shall be at the controls of an aircraft. These are self-evident. However, there are conditions that exist that do, in fact, violate the strict letter of the law while at the same time adhering strictly to the spirit of the law. To believe otherwise is rather naive. That pictures were taken of these picaresques and then purported to be evidence of dereliction of duty on the part of pilots to the extent that safety was jeopardized is nonsense.

I am forced to write a letter supporting the commercial pilots' professional integrity because they have earned it. It is easier for me, a professional flight engineer, to do this than it is for the professional pilot. If this attack were upon the Air Line Pilots Assn., in one form or another, I would support it. The fraud that ALPA has apparently succeeded in foisting on commercial aviation deserves rebuttal and resistance in any form that might prove effective. However, this sordid attempt to discredit pilots with a relatively meaningless fact that in turn is twisted and amplified far out of proportion to its relative merit as regards safety, is too much to stand by and mutely condone.

As an interested and qualified observer of the actions of pilots of commercial airliners today, I stand behind them 100% when any attempt is made to undermine the confidence and respect due them for their responsible and highly professional performance in the carrying out of their duties.

ALAN WIDDICOMBE, Flight Engineer  
Pan American World Airways  
Frankfurt AM Main, Germany



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