

Aviation Week & Space Technology

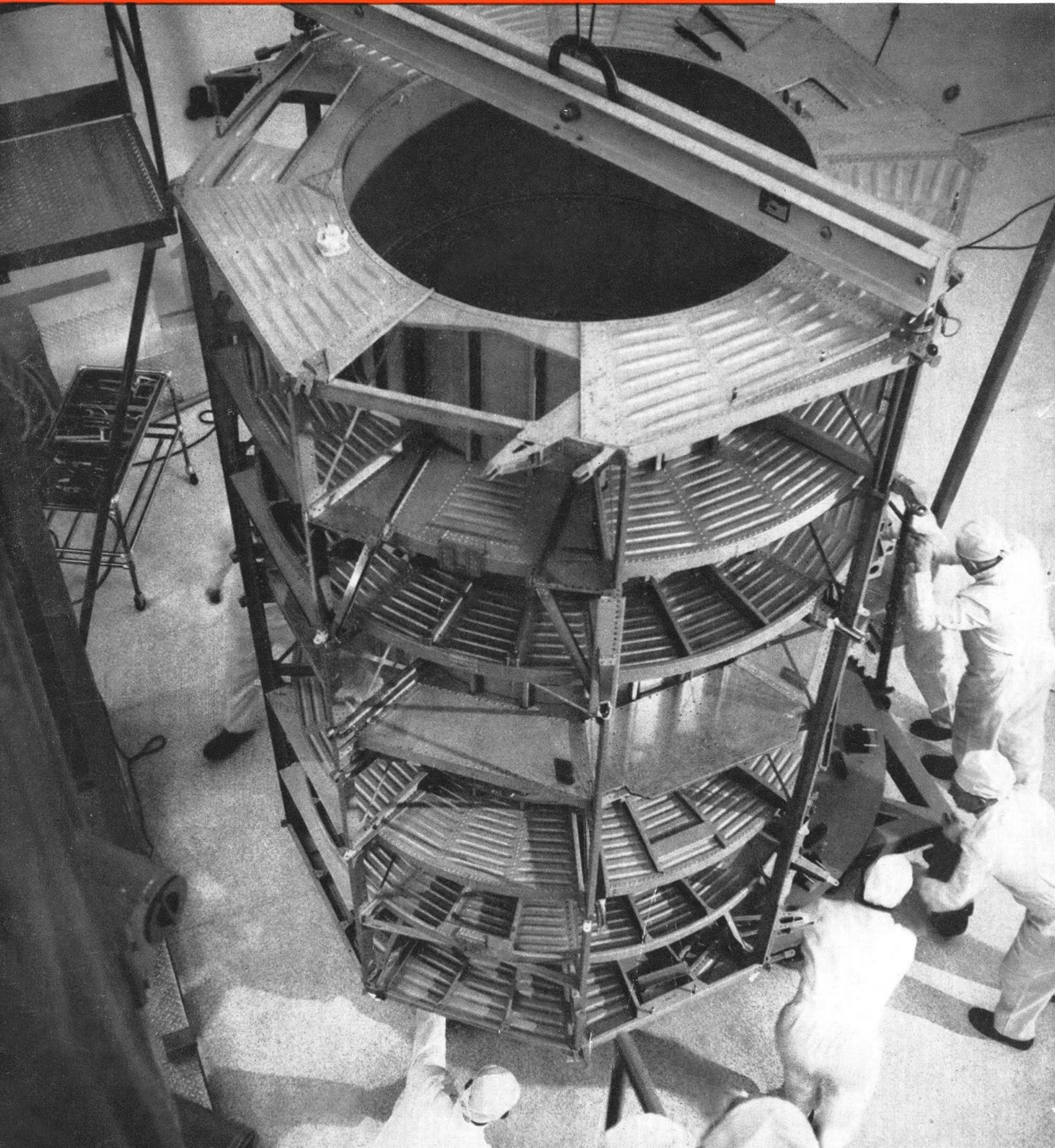
June 18, 1962

**Star-Tracker
Gives Vehicle
Attitude Data**

**Grumman OAO
Test Structure**

75 Cents

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tradition...



Modern designers now specify KAYLOCK® thin wall inserts and obtain the following benefits.

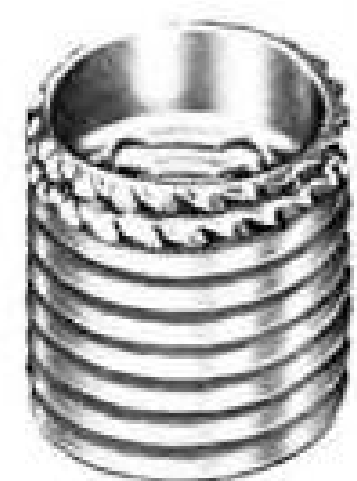
COSTS ARE REDUCED—Standard taps and gages are used in the hole preparation to accept this insert, together with simple KAYLOCK installation tools. There are no tangs to break off or coils to distort.

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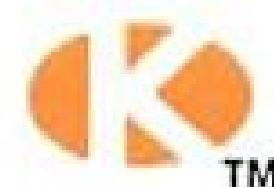
SPACE IS SAVED—The thin wall design permits minimum boss diameters in the parent material, saving space and weight.

HIGH RELIABILITY IS ACHIEVED—Mating bolt retention is assured by the proven KAYLOCK elliptical locking device, qualified to MIL-N-25027. The insert is positively locked in position in the parent material against "in service" rotational displacement.

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first in all-metal self-locking fasteners



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impossible. And, when these wires are embedded in a proven dielectrical covering, they give airplanes sure ice protection under any conditions.

Iceguard is just another example of how Goodyear's technical engineering staff—the largest, most experienced group in its field—keeps coming up with new and better solutions to aerospace and related problems. Want more examples—or help with your problems? Write Goodyear, Aviation Products, Dept. A-1715, Akron 16, Ohio.

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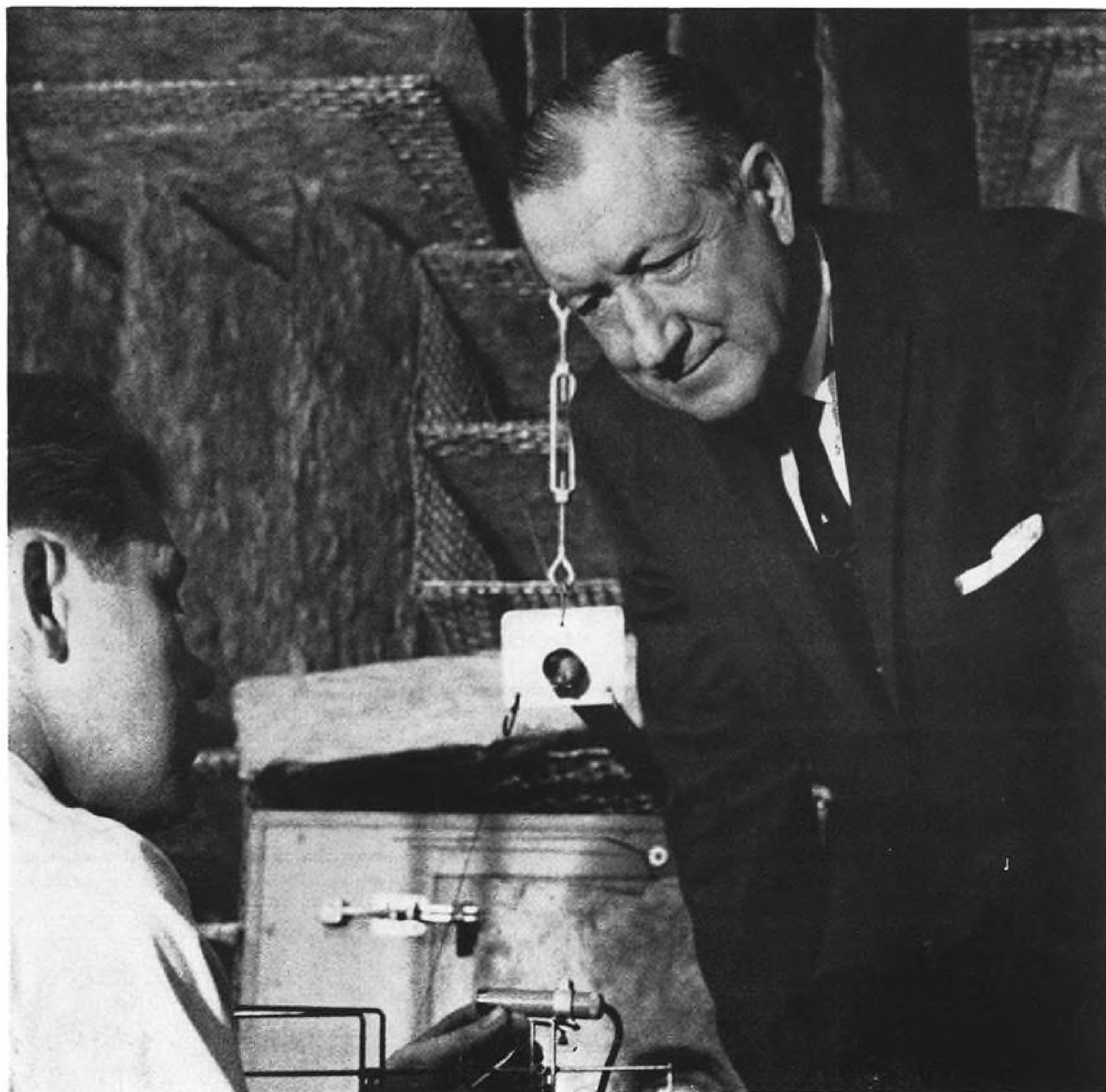
ANOTHER IN A SERIES DEPTH MANAGEMENT IN ACTION

POWERFUL SOUND FROM ANAHEIM

Sound systems to warn U. S. cities of attack . . . communications for Cape Canaveral, Hamilton Air Force Base and for Thor Missile bases . . . stereophonic sound in more than half the theaters in the U. S. — these are just a few examples of products engineered and manufactured by Altec Lansing Corporation, Anaheim, California. This LTV company also produces electro-pneumatic transducers for high intensity sound testing. Other Altec developments include loudspeaking telephone conference systems . . . condenser microphones . . . and transistorized repeater and termination bays used in the Air Force's project Quick Fix. These new products — and modern facilities such as the company's anechoic test chamber where several

tons of glass fiber isolate outside sound environment — are a far cry from the early experiences of Altec Lansing's President Alvis Ward, a member of the team that produced the world's first successful "talking pictures." Throughout his career, Mr. Ward has been a key contributor to the science of sound reproduction and has at the same time guided Altec Lansing to a position of industry leadership. By combining this caliber of management in depth with proved technical competence in aerospace, electronics, communications and consumer products, LTV is furthering U. S. goals for progress, security and national well-being.

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AEROSPACE CALENDAR

- June 25-27—Sixth National Convention on Military Electronics, Institute of Radio Engineers, Shoreham Hotel, Washington.
- June 25-30—Symposium on Electromagnetic Theory & Antennas, Copenhagen, Denmark. Sponsors: Technical University of Denmark; International Scientific Radio Union.
- June 26-28—Aviation Conference, American Society of Mechanical Engineers, University of Maryland, College Park, Md.
- June 26-28—203rd National Meeting, American Meteorological Society, University of Alaska, Fairbanks, Alaska.
- June 26-29—Third International Symposium on Rarefied Gas Dynamics, University of Paris, Paris, France. Sponsors: AFOSR; ONR; NASA. (Open meeting.)
- June 27-28—Ninth Annual Symposium on Computers and Data Processing by the University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park.
- June 27-29—Joint Automatic Control Conference, Institute of Radio Engineers, New York University, New York, N. Y.
- June 28-29—Fourth National Symposium on Radio Frequency Interference, Institute of Radio Engineers, Town House, San Francisco, Calif.
- July 7-11—16th Annual All-Woman Transcontinental Air Race from Oakland, Calif., to Wilmington, Del.
- July 12-13—12th General Assembly, NATO Advisory Group for Aeronautical Research and Development, Paris, France.
- July 17-19—Lunar Missions Meeting, American

(Continued on page 7)

AVIATION WEEK and Space Technology

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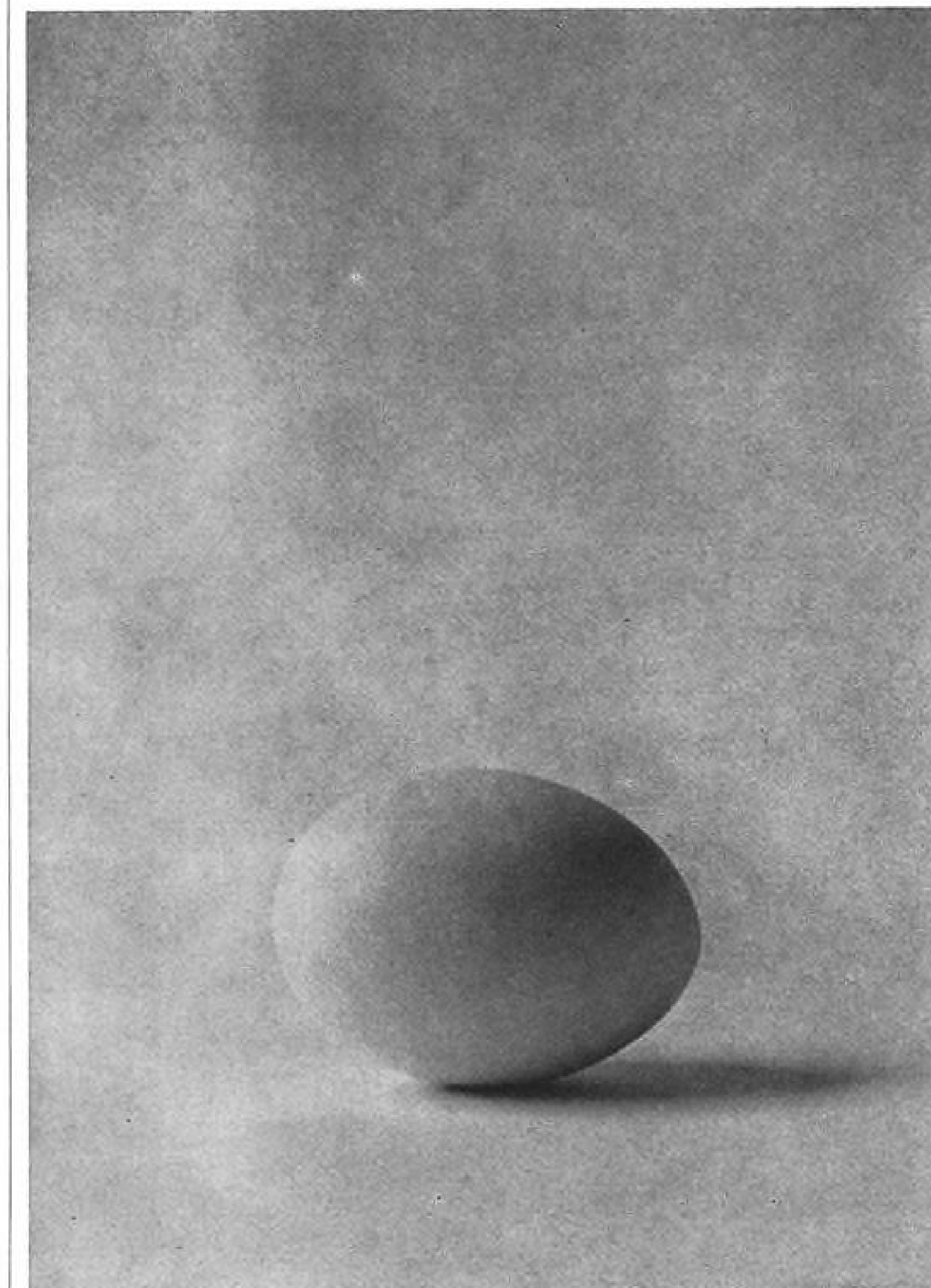
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AEROSPACE CALENDAR

(Continued from page 5)

- can Rocket Society, Pick Carter and Statler Hilton Hotels, Cleveland, Ohio.
- July 24-Aug. 2—National Soaring Championships, El Mirage, Calif. For information: National Soaring Championships, P.O. Box 997, Victorville, Calif.
- Aug. 1-5—Experimental Aircraft Assn. Fly-In, Rockford Airport, Rockford, Ill.
- Aug. 7-9—Low Level Wind Conference, Texas Western College, El Paso, Tex. Sponsors: American Meteorological Society; U. S. Army Signal Missile Support Agency. (Aug. 9 session in Dallas.)
- Aug. 8-10—1962 Standards Laboratory Conference, National Bureau of Standards' Boulder Laboratories, Boulder, Colo.
- Aug. 10-11—IAS National Specialists Meeting, Man-Machine Competition, Olympic Hotel, Seattle, Wash.
- Aug. 13-16—Pacific Energy Conversion Conference, American Institute of Electrical Engineers, Fairmont Hotel, San Francisco.
- Aug. 13-16—Seventh Symposium on Ballistic Missile and Space Technology, U. S. Air Force Academy, Colorado Springs, Colo. Sponsors: USAF; Aerospace Corp.
- Aug. 14-16—Cryogenic Engineering Conference, University of California of Los Angeles, Los Angeles, Calif.
- Aug. 14-17—International Conference on Precision Electromagnetic Measurements, Boulder Laboratories, National Bureau of Standards, Boulder, Colo.
- Aug. 15-17—Nuclear Propulsion Conference, Monterey, Calif. Joint Meeting: Institute of the Aerospace Sciences; American Rocket Society; American Nuclear Society.
- Aug. 15-17—Third International Electronic Circuit Packaging Symposium, University of Colorado, Boulder, Colo.
- Aug. 19-25—Annual Meeting and Conference, Airport Operators Council, Princess Kaiulani Hotel, Honolulu, Hawaii.
- Aug. 20—Technical Symposium, Precision Potentiometer Manufacturers Assn., Statler Hilton Hotel, Los Angeles, Calif.
- Aug. 21-24—Western Electronics Show and Conference, Institute of Radio Engineers, Los Angeles, Calif.
- Aug. 21-24—International Symposium on Far Infrared Spectroscopy, Sheraton Gibson Hotel, Cincinnati, Ohio. Sponsor: Materials Central, Aeronautical Systems Division, Air Force Systems Command.
- Aug. 21-Sept. 17—14th Session, International Civil Aviation Organization Assembly, Rome, Italy.
- Aug. 23-24—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Westward Hotel, Anchorage, Alaska.
- Aug. 23-24—Conference on Thin Films, Colorado Hotel, Glenwood Springs, Colo. Sponsor: Solid State Electronics Laboratory, University of Denver's Research Institute.
- Aug. 27-29—AIME Technical Conference on Advanced Electronic Materials, Benjamin Franklin Hotel, Philadelphia, Pa.
- Aug. 27-Sept. 1—Third International Congress, International Council of the Aeronautical Sciences, New Congress Hall, Stockholm, Sweden.

(Continued on page 9)

HEAT EXCHANGERS IN A HURRY



(Or: A new slant on $q = \int u(t_h - t_c) dA$)

Heat exchanger design problems are reputed to make young men gray and older men bald. It thus gives us joy to report that Budd heat transfer engineers are today retaining whatever cranial adornment they started with. You can profit thereby.

Budd offers complete design, prototype and production services for plate-fin heat exchangers. We produce these compact, lightweight and highly efficient components by both dip-brazing and epoxy bonding... with aluminum, stainless steel, copper and other materials... in myriad configurations for missile cooling, intercoolers, oil coolers, air conditioning systems and other land, sea, air and space applications.

What's new about that? Just this:

To design the best heat exchanger for a given job, a number of complexly interrelated thermal variables... heat transfer rate, thermal conductance, transfer area, hot- and cold-side temperatures, etc... are usually juggled around until the required heat transfer rate is attained.* During this labor, the designer must also find a way to satisfy such vital external requirements as size, weight, strength, reliability and cost.

We now announce, as modestly as possible under the circumstances, that Budd is applying new techniques that enable plate-fin component heat exchangers to be designed and produced *faster than ever before!*

This is not the result of an overnight inspiration. Our Environmental Control Systems Department has long been busy with a fresh and deep-probing investigation of ana-

lytical approaches to heat exchanger design. Their study was pointedly abetted by the experience, the knowledge of practical operating conditions, and the voluminous test data we've accumulated in over 20 years of designing and producing complete heat exchanger systems, as well as component exchangers and other types of environmental control systems.

Our new design method enables us to fix optimum exchanger relationships and values with surprising speed. In several recent cases, we've designed complex new exchangers in a few hours!

How do we do it? The details we guard. But we can say that design reliability as well as speed is assured by a pre-specified feedback checking technique. (In a moment of flamboyance, we tagged the new method "Feedback-Controlled Design." It may stick.) Other enticing information is contained in our heat exchanger bulletin, which we'll naturally send on request. (If you don't already belong to The Budd Electronics Chowder and Marching Society, be sure to ask for your membership credentials too.)

There is, of course, an eminently scientific way to verify our rather substantial claim—let us design and deliver your next exchanger. Why wait? Environmental Control Systems, Budd Electronics, 43-22 Queens St., Long Island City 1, N.Y.

*Simplified formula shown above. Also, in another usage: q =beverage consumption rate, A =total transfer area, u =beverage to blood stream, u =beverage conductance per ft² of A , t_h =torpidity, maximum allowable, t_c =torpidity, initial.

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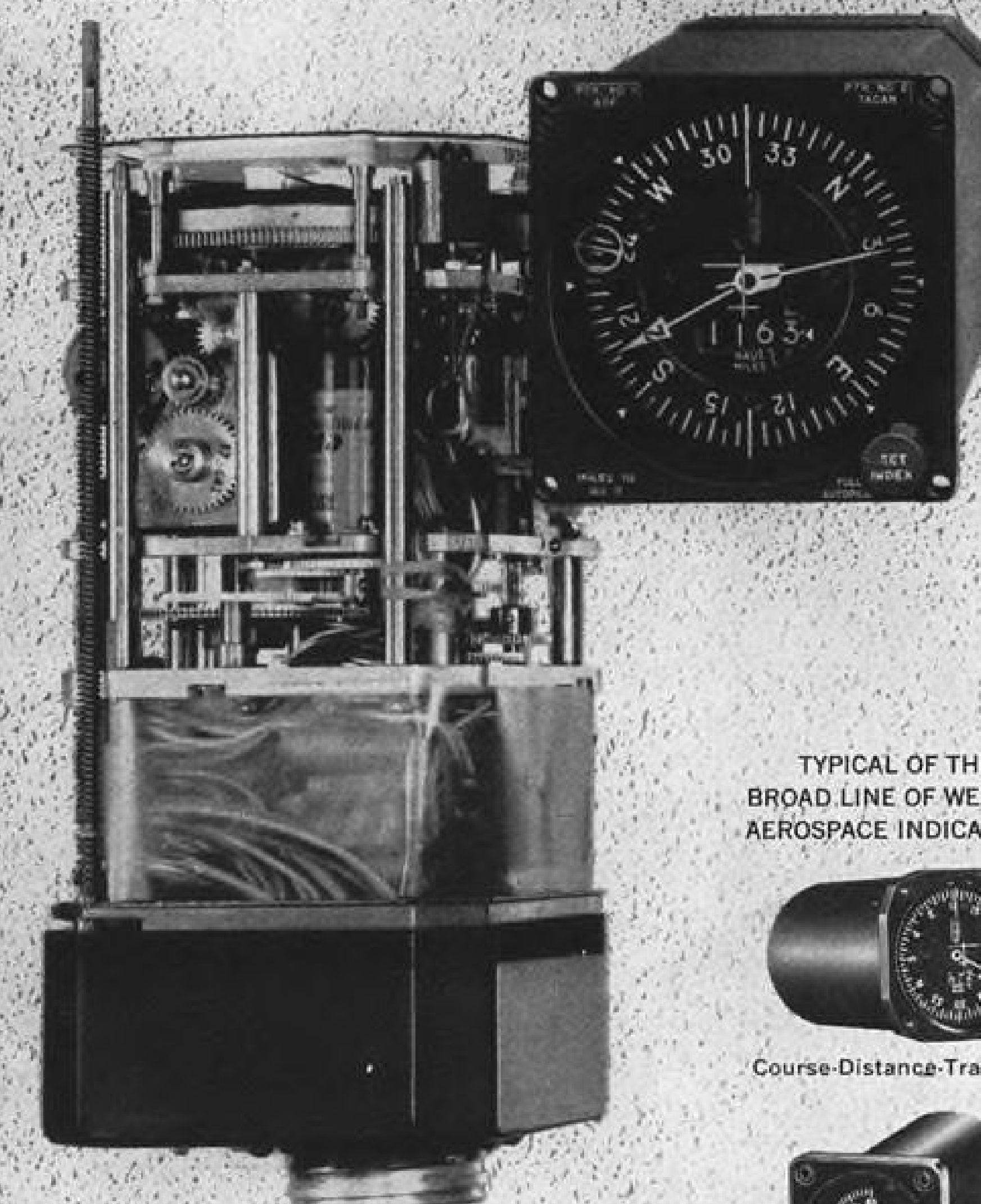
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AEROSPACE CALENDAR

(Continued from page 7)

- Aug. 27-Sept. 1—Second International Congress, International Federation of Information Processing Societies, Munich, Germany.
- Aug. 28-30—Fourth Conference on Maintainability of Electronic Equipment, Electronic Industries Assn. (in cooperation with Department of Defense), University of Colorado, Boulder, Colo.
- Sept. 3-7—National Advanced Technology Management Conference, Institute of Radio Engineers, Seattle, Wash.
- Sept. 3-7—International Symposium on Information Theory, Institute of Radio Engineers, Brussels, Belgium.
- Sept. 3-9—1962 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.
- Sept. 5-7—Symposium on Measurement of Thermal Radiation Properties of Solids, Biltmore Hotel, Dayton, Ohio. Sponsors: Aeronautical Systems Division, USAF; National Bureau of Standards; NASA.
- Sept. 10-14—Fourth National Conference on Applied Meteorology, American Meteorological Society, Hampton, Va.
- Sept. 10-14—Annual General Meeting, International Air Transport Assn., Dublin.
- Sept. 13-14—10th Annual Engineering Management Conference, IRE, Hotel Roosevelt, New Orleans, La.
- Sept. 17-18—Hydrofoil & Air Cushion Vehicles Meeting, Institute of the Aerospace Sciences, Shoreham Hotel, Washington.
- Sept. 18-23—16th National Convention & Aerospace Panorama, Air Force Assn., Las Vegas, Nev.
- Sept. 19-20—Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences, Hotel Commodore, New York.
- Sept. 19-20—Operations & Maintenance Symposium, Airwork Corp., Millville, N. J.
- Sept. 19-22—Second International Agricultural Aviation Congress, National Superior Agronomy School, Grignon, France.
- Sept. 24-28—13th International Astronautical Congress, American Rocket Society, Sofia, Bulgaria.
- Sept. 25-28—Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif.
- Sept. 26-Oct. 2—1962 General Conference, Federation Aeronautique Internationale, Athens, Greece.
- Sept. 28-29—Society of Experimental Test Pilots' Sixth Annual Awards Banquet & Symposium, Beverly-Hilton Hotel, Beverly Hills, Calif.
- Oct. 15-18—International Symposium on Space Phenomena and Measurement, Institute of Radio Engineers, Statler-Hilton Hotel, Detroit, Mich.
- Oct. 29-31—Symposium on Dynamics of Manned Lifting Planetary Entry, Philadelphia, Pa. Attendance limited; for information: Sinclair M. Scala, General Chairman, Room M7023A, General Electric Co., MSVD, Valley Forge Space Technology Center, Box 8555, Philadelphia 1, Pa. Co-sponsor: AFOSR.
- Nov. 13-18—17th Annual Meeting and Space Flight Exposition, American Rocket Society, Pan Pacific Auditorium, Los Angeles, Calif.

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*Test Level H, Advisory Groups of Reliability of Electronic Equipment.



Situation Display



Bearing-Distance-Heading

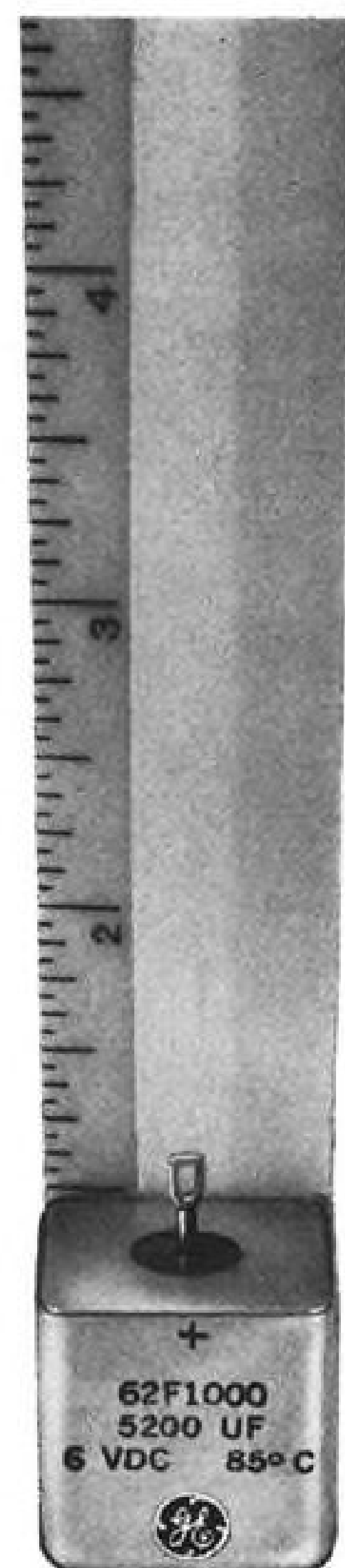


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This is only one of the improved characteristics of Aeroquip's new Hose of Teflon which is made by a new patented process which counter rotates the elongated granules (fibres) of Teflon during extrusion. The new technique improves upon conventional methods of extrusion in which the Teflon fibres

are arranged in a parallel longitudinal direction. In addition to eliminating weepage, Aeroquip Hose of Teflon controls effusion of gases to significantly stricter requirements.

Presently acceptable military and commercial performance levels are exceeded by new Aeroquip Hose of Teflon. Where higher hose performance is required, advanced specifications can now be written and met.

Aeroquip Hose of Teflon is produced in a wide range of sizes. It is designed for use with Aeroquip "super gem" Fittings (MIL-F-27272). These fittings are detachable and reusable for quick, easy field assembly of Hose Lines of Teflon. Mail the coupon below for your new Catalog 106 with full information. Aeroquip Products Are Protected By Patents In U.S.A., Canada And Abroad. Aeroquip Corporation, Jackson, Michigan.



PATENTED EXTRUSION PROCESS
Improved characteristics are achieved by counter rotation of elongated granules of Teflon during extrusion of the tube.



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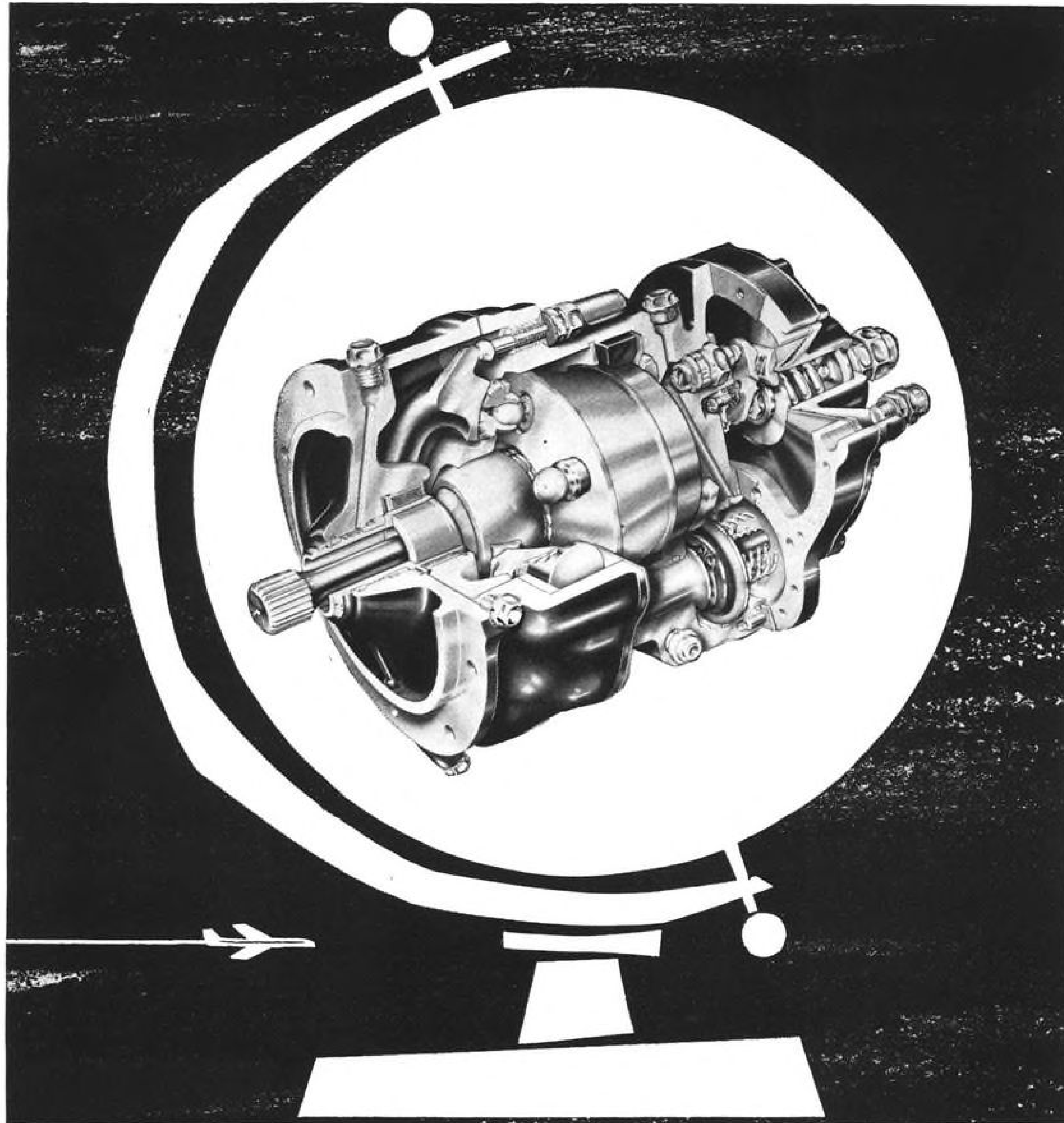
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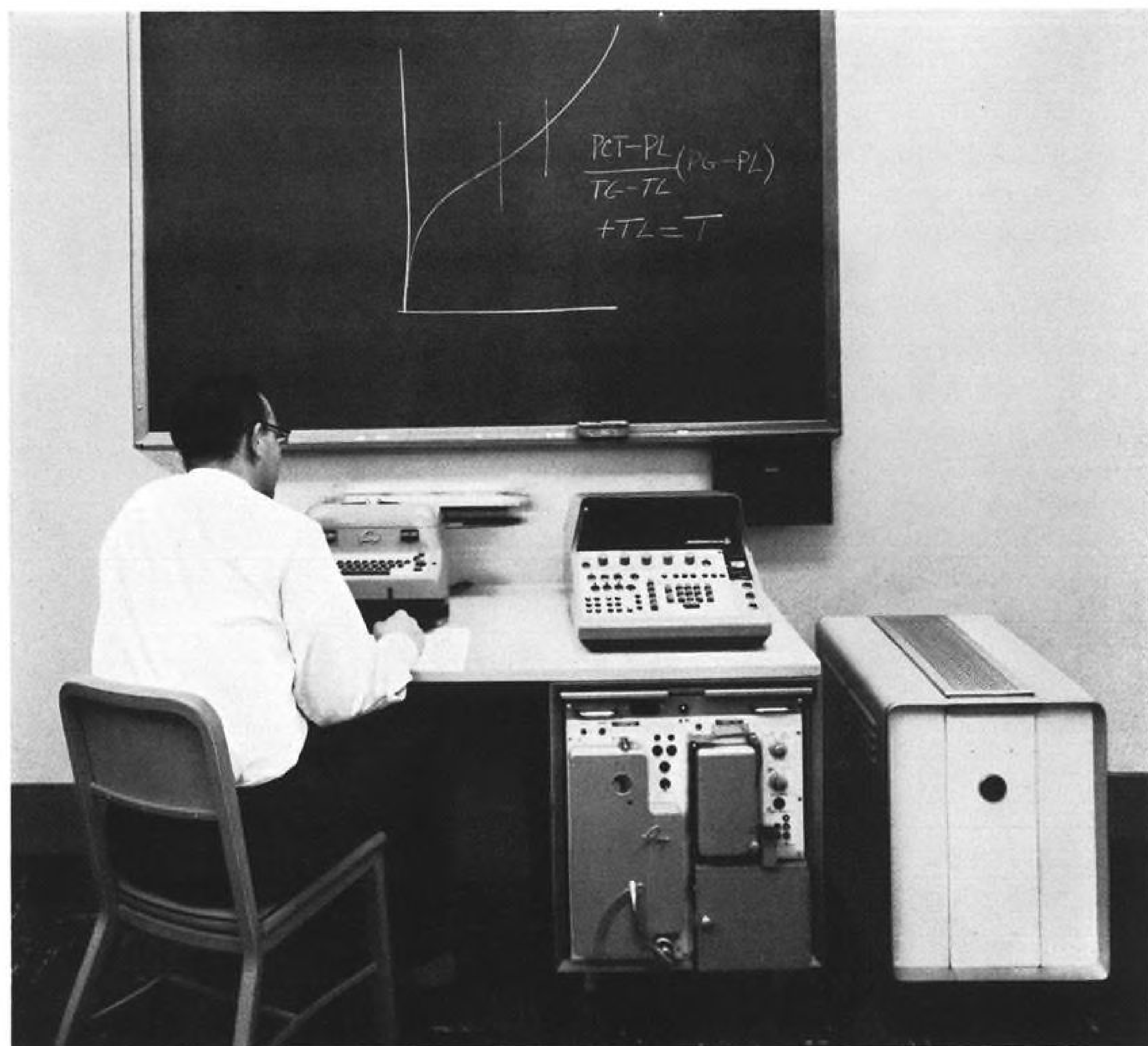
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This computer speaks English.

Some computers act as though they're trying to hide the facts. Not Recomp.®

Recomp II has a built-in direct numerical display of any memory word. When it wants to show you a number like 1000., it shows just that: 1000. And it can carry it out to 12 digits. To show you 1000., other computers may display something like this:

● ● ○ ○ ○ ○ ○ ● ○ ● ● ●

or like this:




Recomp II automatically checks every program, bit by bit, against the original tape. And built-in echo checking of typewriter or punch output assures accuracy.

Recomp II abounds in other built-ins (floating-point,

square root command, and conversion from decimal to binary, to name a few). It has two high speed memory loops (each containing 16 instructions). It has a large word length (40 bits). And a large memory (8160 instructions).

Recomp II is ideal for medium-scale needs; Recomp III is perfect for small-scale needs. You can lease a Recomp III for \$1,495 (complete with no accessories required), or a Recomp II (with a complete line of peripheral equipment) for up to \$4,500 a month.

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Autonetics is a Division of North American Aviation.

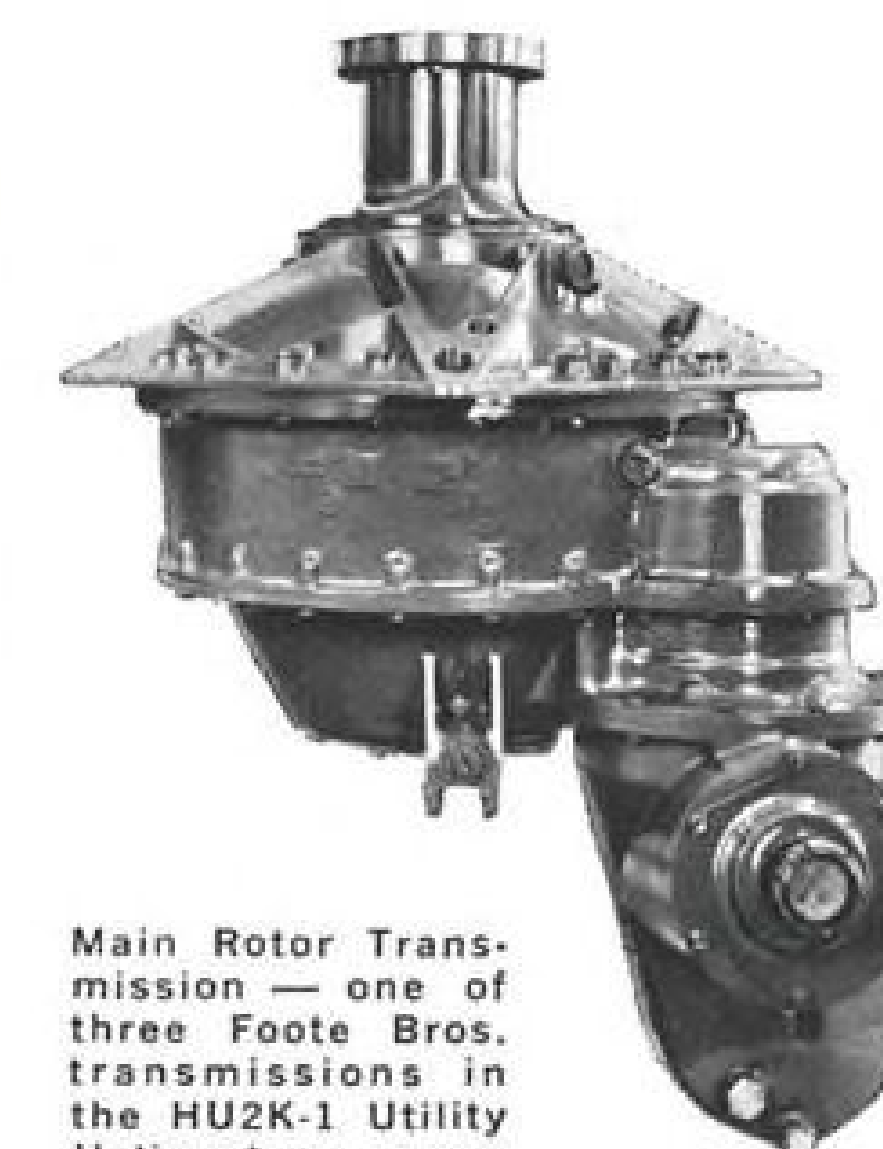
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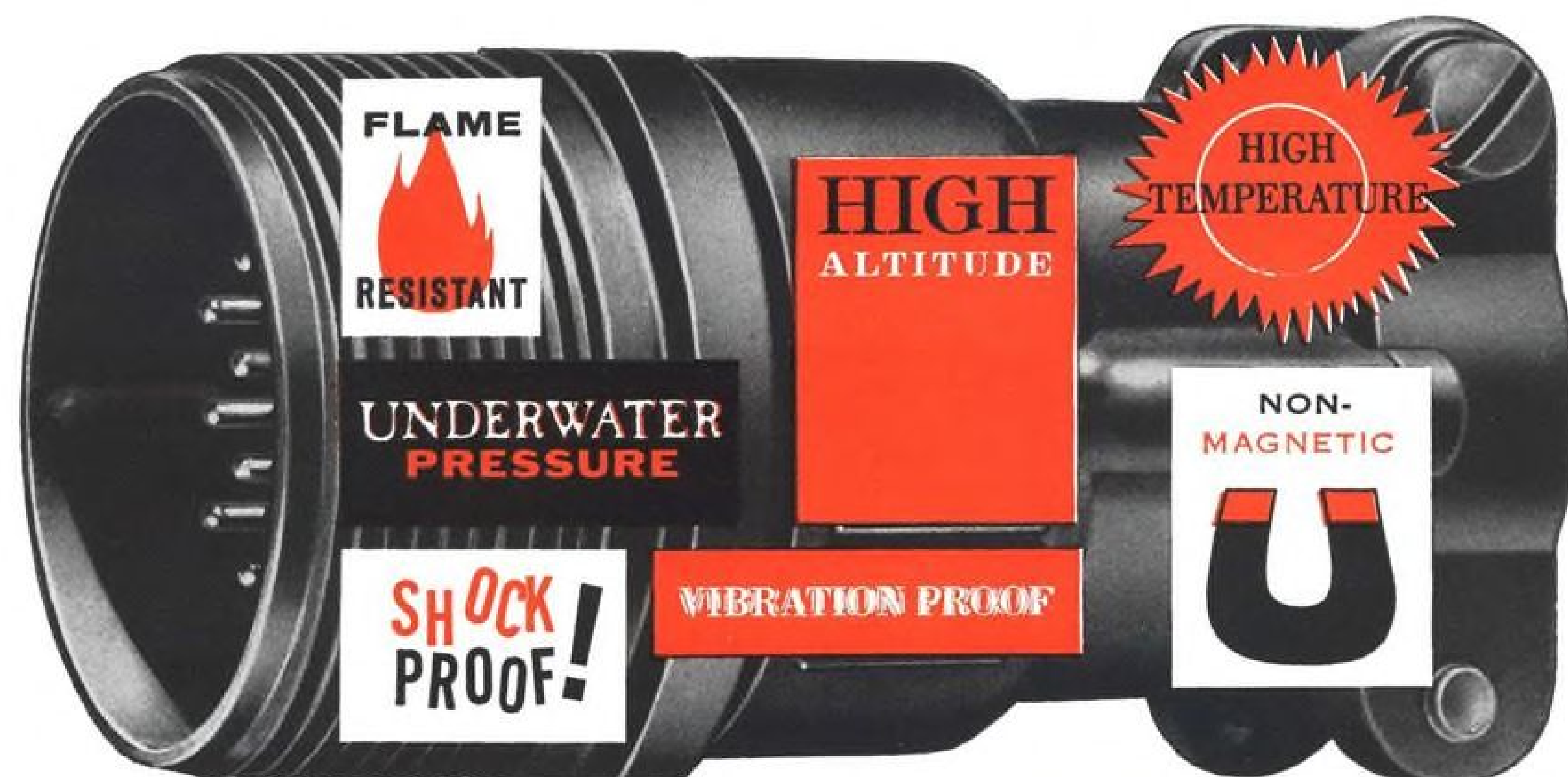
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COVER: Aluminum and titanium structural test model of Grumman Aircraft Engineering Corp.'s Orbiting Astronomical Observatory (OAO) is being constructed in the company's Bethpage, N. Y. clean room. Spacecraft is 9.5 ft. high and has a 6.5-ft.-dia. plane-to-plane. Weight is 3,300 lb., including 1,000 lb. of equipment. Major equipment is located in two mid-bays to keep moment of inertia low. Overflow equipment is located in end bays. The craft will be launched by an Atlas-Agena B vehicle. Note similarity to aircraft in construction techniques. For other details, see p. 71.

PICTURE CREDITS

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EDITORIAL

New Horizons for Aircraft

With the dawn of the space age and the accompanying rise of the intercontinental ballistic missile as an operational weapon, there has been a tendency in some military, industrial and technical circles to abandon development of the aircraft as a useful vehicle. In the natural and necessary rush to master new space technology many organizations, both industrial and governmental, have come dangerously close to forsaking the aeronautical technology that is still an important foundation for spearheads into space as well as a fruitful source of new applications to man's age-old problem of transportation.

For a while it looked to many observers of the aerospace industry as if the B-70 program might represent the last dying gasps of aircraft as military weapons and the supersonic transport program might be their last useful application in the civil field. We never subscribed to this viewpoint. For the past several years we joined editorially those voices who warned against abandoning all research and development effort in the aeronautical field.

Thus it is heartening now to see many signs of the pendulum swinging back to a more realistic balance on the future of new types of aircraft along a wide range of performance capabilities.

An aircraft is simply a transportation vehicle whether it carries weapons, people or cargo. The advantages its applications offer come in the compression of time and the resulting increase in mobility, although more sophisticated studies of the over-all transport problem now indicate that reduced cost is becoming an important competitive factor favoring air transport over other methods.

Although the ICBM has become the prime delivery method for nuclear warheads, and space surveillance systems may take over some of the aircraft's traditional long-range reconnaissance mission, a wide variety of new military aircraft applications is developing, from the variable geometry TFX tactical fighter concept and VTOL strike and transport aircraft down the technical spectrum to ultra-simplified guerrilla warfare aircraft. While strategic delivery capability will remain the prime measure of military power, it is obvious that the lack of an effective limited war capability, ranging from suppression of guerrilla infiltration to Korean-type non-nuclear conflicts, would severely handicap the exercise of national will in the international scene.

In the current effort to increase U. S. capability in this area, heavy reliance must of necessity be placed on aircraft and helicopters already in the inventory, many of them from mothballed stockpiles. But as the urgency of this requirement increases, and opposing forces' responses to it increase, as indeed they both will, it will be necessary to develop a whole family of new aircraft applying all of the new technology now available to solve these limited war problems. These requirements will not only affect the airframe and engine manufacturers but will also develop

a new market for all of the auxiliary equipment, including avionics, that must be adapted to these new tasks. Aircraft and helicopters are still the only transportation methods that can deliver heavy firepower, troops and supplies with the mobility required for non-nuclear war. The flying crane concept, as typified by the Sikorsky S-64 and the Mil Harke, should also fit into the picture.

In the transport field it is now obvious that aeronautical development has a great deal to contribute in addition to the supersonic transport. The supersonic transport program is certainly a spearhead of advance for the whole aeronautical state of the art, but it is by no means the whole story for development of better air transport.

The jet executive-type transports of Lockheed, Aero Commander, Lear, and de Havilland, to name a few, are already on the technical scene, and their widespread availability will certainly mean a major change in the character of the business flying fleet. The short-haul jet transport field has become a highly competitive battle between the Boeing 727, de Havilland Trident, British Aircraft Corp.'s BAC 111 and advanced Caravelles.

The clamor is growing for a modern grass roots-type feederline aircraft capable of filling the gap in the air transport network between the bush and small cities and the traffic hubs of the short-haul carriers. Closely related to this requirement is the development of modern aircraft specifically designed to open up economically countries that are now hobbled to primitive transportation systems lacking even adequate road networks. The use of air vehicles for this mission has already been demonstrated in the mining and oil explorations around the world, but there has never been the political link to apply this technology to the foreign aid program. Instead, vast sums have been poured into far less productive forms of transport for these backward areas.

It has also become clear that the Soviet Union is fully aware of the political opportunities offered in these areas through initial technical penetration with civil aviation. Neither the U.S. government nor the aerospace industry has been particularly perceptive in responding to this threat, although this country possesses superior resources.

The requirement for development of a new generation of air vehicles across the entire technical spectrum now is emerging. It will require not only some strong industry stimulation but also a more perceptive approach by national policy makers if this great national resource of aeronautical capability is to be usefully applied in the space age. Both technicians and policy makers will have to apply a high degree of originality as well as ingenuity to make this new generation of aircraft serve the military, economic and social environment of the future in which they must operate successfully.

—Robert Hotz

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WHO'S WHERE

In the Front Office

Gen. Lucius D. Clay (USA, ret.) elected to the Board of Trustees of Aerospace Corp., Los Angeles, Calif.

William B. Rieke, president, Lockheed Aircraft International, Inc., Los Angeles, Calif., succeeding J. Kenneth Hull, retiring.

Dudley Swim, California businessman, elected a director of National Airlines, Inc. Richard N. Golbach, vice president-marketing and a director, Statham Instruments, Inc., Los Angeles, Calif.

Maj. Gen. C. Stanton Babcock (USA, ret.), assistant to the president of Stanford Research Institute, Menlo Park, Calif.

Bill Strunk, a vice president, Astro-Systems, Inc., South El Monte, Calif., a subsidiary of Astro-Science Corp. Paul R. Abbey, vice president and director of marketing, American Concertone, Inc., Culver City, Calif., a division of Astro-Science.

The Sierracin Corp., Burbank, Calif., has been reorganized into three divisions and the following appointments announced: Vice President George L. Wiser, general manager of the newly formed Sierracote Division; Vice President C. J. Gilbert, general manager of the Sierraglo Division, formerly Sierracin Electronics. Vice President S. F. Arn continues as general manager of the Spraymat Division. Also: Gordon E. Watkins, corporate director of technical sales.

Dr. Richard B. Morrison, director, Launch Vehicle and Propulsion Programs, Office of Space Sciences, National Aeronautics and Space Administration, Washington, D.C., and Dr. John F. Clark, associate director and chief scientist. Dr. John E. Naugle replaces Dr. Clark as director of Geophysics and Astronomy Programs. Dr. Morrison succeeds Col. Donald H. Heaton, USAF, now reassigned to the Air Force Systems Command. Also: William H. Evans, director, NASA's Pacific Launch Operations Office, Point Arguello, Calif.

Joe L. Browning, technical director, U.S. Naval Propellant Plant, Indian Head, Md.

Honors and Elections

Joseph A. Walker, chief research pilot for the National Aeronautics and Space Administration's Flight Research Center, has received an honorary Doctor of Aeronautical Sciences degree from Washington and Jefferson College, Washington, Pa.

Dr. E. T. Ferraro, vice president-logistics for General Precision Aerospace, has received the Greer Award for 1962 in recognition of his contributions to the Department of Defense activities in the area of maintenance and product support.

B. S. Shenstone, a director and chief engineer of British European Airways, has taken office as the president of the Royal Aeronautical Society for 1962-63, succeeding Air Marshal Sir Owen Jones.

Carl A. Benscoter, vice president-operations of Mohawk Airlines, has been elected president of the Air Transport Assn.'s Airlines Operations Conference, and J. E. Frankum, vice president-general transportation manager of Trans World Airlines, vice president of the conference.

(Continued on page 106)

INDUSTRY OBSERVER

► Defense Secretary McNamara has authorized initial planning for a national command and control system, designed to provide the President and Joint Chiefs of Staff with survivable communications for control of U. S. global forces. Responsibility for the new program has been given to the Defense Communications Agency, working under the Joint Chiefs of Staff.

► Tentative USAF plans for production of the United Technology Corp. 120-in. segmented solid propellant rocket motor (AW May 14, p. 33) call for procurement at a rate of approximately eight units per month and may require UTC to pour propellant at a rate as high as four million pounds per month. Total market is expected to reach about \$1.5 billion by 1970.

► Industry proposals are being readied for competition to equip the third and fourth ships in the Mobile Atlantic Range Stations (MARS) series (AW June 11, p. 101). Proposals were requested earlier this month by Air Force Missile Test Center at Patrick AFB, Fla.

► Scheduled launch date for Bell System's Telstar communications satellite has slipped from late this month to mid-July because of delay in satellite availability. However, Defense Department officials who recently visited Bell Telephone Laboratories to see Telstar, in connection with study and subsequent reorientation of the Advent satellite program (see p. 32), came away highly impressed with the quality of the BTL effort.

► Tactical Air Command is searching Air Force bases and sending letters to qualified reserve officers to obtain pilots for a buildup of fighter squadrons. Release of Air National Guard forces from active duty will require TAC to build up forces to complement the Strategic Army Corps (STRAC) under the combined Army-Air Force strike command. Reserve officer pilots are being recalled to active duty for STRAC/TAC assignments to fill cockpit vacancies for the first time since 1957.

► USAF headquarters has begun selective release of study contracts for long-range weapon systems requirements that are part of the Systems Command study program. The program was halted a year ago on the ground that too much engineering time and talent was devoted to these studies in industry (AW May 14, p. 26), but six such programs were released in May.

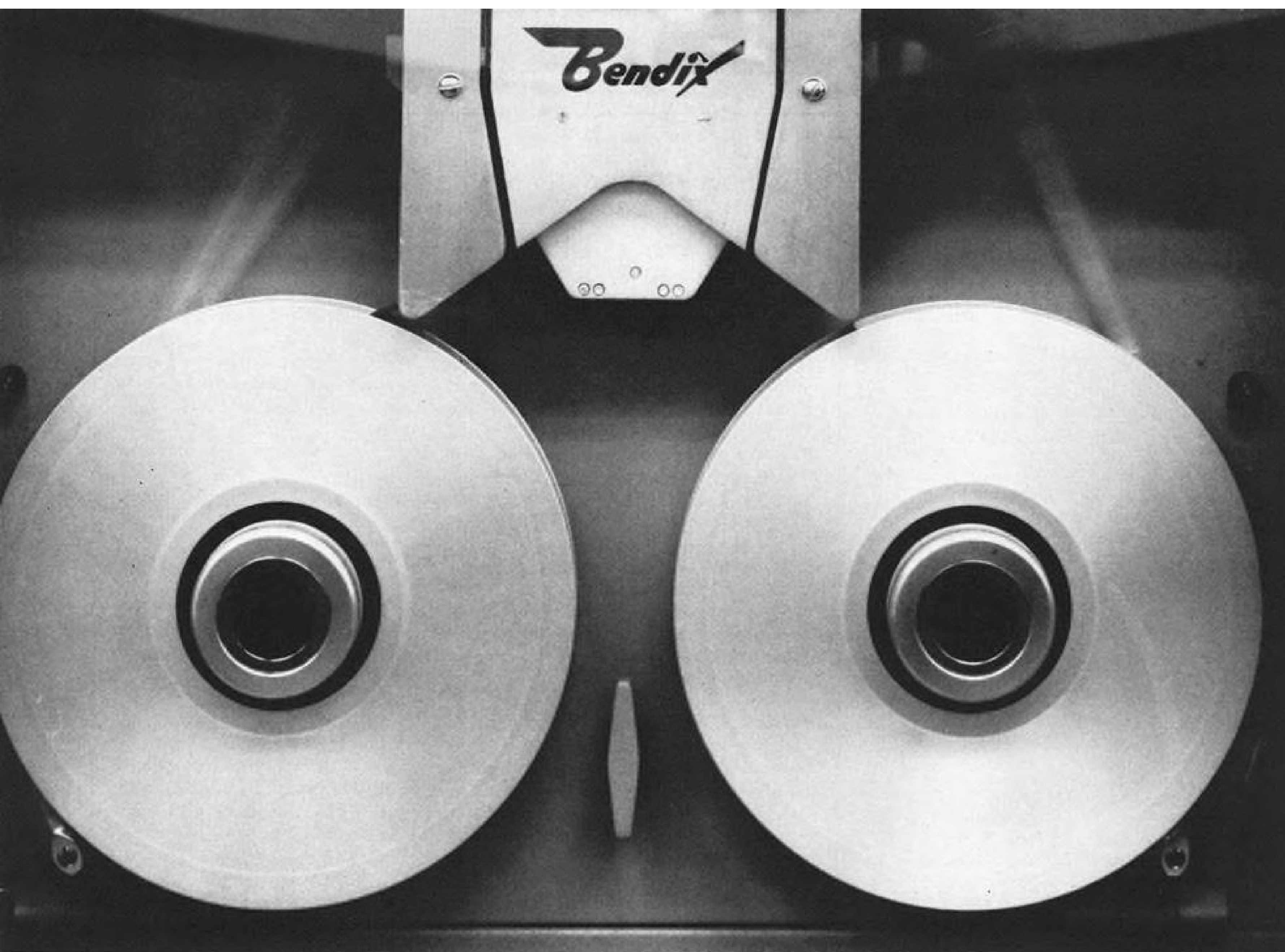
► U. S. wants ground stations for electromagnetic field probes in the joint U. S.-Soviet Union research program (AW June 11, p. 39) to be located in Bolivia or Brazil, according to Rep. James G. Fulton (R.-Pa.), second-ranking Republican on the House Science and Astronautics Committee. Fulton said the Soviet Union favors locating the stations in India.

► Sensors which will be used in USAF Systems Command Space Systems Division-Atomic Energy Commission Vela Hotel satellite program for detection of nuclear blasts in space are expected to be sufficiently sensitive to detect, from a 50,000-mi. circular earth orbit, nuclear explosions as far away as the vicinity of Mars.

► Tetrahedron-shaped satellites, programed to be carried piggy-back on Midas early warning or Samos surveillance satellite boost vehicles, are being developed by Space Technology Laboratories for measuring damage to solar cells in the Van Allen radiation belt. Program will involve development of one prototype satellite for ground evaluation and six for orbital operations.

► Army is moving ahead with its new battlefield missile system, tentatively called Missile B. Army Ordnance Missile Command, Redstone Arsenal, Huntsville, Ala., has invited industry to submit capability statements.

► Aim of Navy's Transit satellite navigational system when it becomes operational next year is to have four or more of the vehicles in polar orbits providing continuous coverage in polar areas. There will be "holidays," or areas temporarily not covered by the satellites in the lower latitudes. These may be covered by satellites in 24-hr. synchronous equatorial orbits.



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Washington Roundup

AMR Custody Dispute

National Aeronautics and Space Administration has won a behind-the-scenes battle with the Air Force for custody of the space agency's holdings at the Atlantic Missile Range, with an assist from Chairman George Miller of the House space committee.

Air Force campaign went so far as to press for an executive order to give the service control over the 72,644-acre area NASA is acquiring at Cape Canaveral (AW Feb. 12, p. 31). But this effort was derailed when Rep. Miller's committee added language to NASA's budget authorization bill specifying that the space agency would have custody over any land it acquires.

Deputy Defense Secretary Roswell Gilpatric met with Rep. Miller and NASA Administrator James Webb at a private luncheon in the Capitol and tried to persuade them to remove the restriction. But Rep. Miller stood firm. He feels the Air Force does not need custody of the land to manage the range efficiently.

Air Force also wanted to buy 14,800 acres for Titan 3 facilities at the Cape north of NASA's new tract. But NASA won White House approval to make the acquisition. Webb last week asked the Senate space committee (see p. 27) to authorize \$32 million for this additional acreage, including the cost of relocating the Haulover Canal and bridge, part of the inter-coastal waterway.

Nuclear Test Spying

U.S. is not trying to jam sensors on the Russian ships standing outside the nuclear testing area in the Pacific. Defense leaders hope the Soviet government will reciprocate when U. S. ships try to observe the expected new round of Russian tests in the Arctic. Also, it is difficult to jam the type of electronic equipment the Russians are using. Soviets are especially interested in the electromagnetic signatures of the nuclear blasts.

Cuban air force now includes 60 Russian-built MiG-type jet fighters, including 20 supersonic twin-jet MiG-19s. Cuba has also received from Russia 24 Mil-4 helicopters, 20 An-2 utility planes and 8 Il-14 twin-engine transports.

Another medical report is expected soon on USAF Maj. Donald Slayton, the astronaut disqualified from Mercury flights because of heart flutter. Dr. Paul Dudley White, heart specialist, has entered the case. One of NASA Administrator Webb's big worries is the decision that would be posed if Slayton's heart begins fluttering just before lift-off.

House Airlift Probe

House Armed Services special subcommittee will review U. S. tactical and strategic airlift capability in a series of hearings starting late next month or early August.

Chairman Mendel Rivers, in reviewing airlift capability, also will take testimony on a bill to give the President authority to take over any transportation system during a national emergency and a measure to redesignate the Military Air Transport Service as the Military Airlift Command and place it under the Joint Chiefs of Staff. MATS reorganization was recommended by the subcommittee after its extensive 1960 hearings.

President Kennedy will make the first live intercontinental telecast via communication satellite when the Bell System's Telstar goes into orbit—hopefully this summer. Edward R. Murrow, U. S. Information Agency director, is drafting the 10-min. telecast in concert with a committee formed by domestic TV networks. Telecast may include plug for communication satellite stock to be sold to the public (see p. 32).

Supplemental Airlines

Break is anticipated in the impasse between the House and Senate conferees on widely different bills giving permanent operating authority to supplemental airlines. House until now has refused to broaden the limited individual ticketing authority in its bill to conform more closely with the more liberal Senate measure. But House conferees finally are talking seriously about basing this authority on a fixed percentage of past business.

Dr. Harold Brown, director of Defense Research and Engineering, estimates one F-111A (TFX) will cost about \$3 million while an RS-70 would cost about \$100 million if a wing of 45 aircraft were built. He gave these estimates during a closed meeting of the Senate Appropriations Defense Subcommittee.

Capitol corridor comment after Sen. John McClellan's hearing on pyramiding defense profits: "An elephant is a mouse developed under a cost-plus-fixed-fee contract."

—Washington Staff

U. S. Is Formulating New Space Policy

Welsh drafting document as part of top-level review;
Administration concerned over issue of military role.

By George C. Wilson

Washington—Kennedy Administration is drafting a new policy statement on the broad objectives of its space program as part of a top-level review of such controversial questions as the military's role in space.

National Aeronautics and Space Council already has written several drafts of the policy statement and has sent them to pertinent federal agencies for comment. No draft has yet been submitted to President Kennedy.

Dr. Edward C. Welsh, executive secretary of the space council, indicated to AVIATION WEEK that a final draft might be ready for the President's consideration before next month. Welsh said the job was undertaken because it was felt there was "a need for a policy statement" beyond the one President Kennedy submitted to Congress May 25, 1961, recommending an expanded program designed to land an American on the moon and give the U. S. leadership in space (AW May 29, 1961, p. 25).

Drafting of the policy statement, besides representing an attempt to push

public thinking about space beyond the manned lunar landing program, signifies a new "where-do-we-go-from-here" phase in the national space program. These are other aspects of this phase:

- **NASA-DOD review.** National Aeronautics and Space Administration and Defense Department leaders will review their respective programs over the next 90 days. NASA Administrator James E. Webb told AVIATION WEEK the review was needed because civilian and military programs had advanced considerably since the last review, and it was desirable to "get into more detail"

on space programs controlled by each.

- **Congressional concern.** Congress is displaying more interest in the military role in the national space program. Several members of the House Science and Astronautics Committee feel the military role should be enlarged and have asked Chairman George P. Miller (D.-Calif.) to hold hearings on the civilian-military relationship in the national space program. The House Special Government Information Subcommittee will touch on this relationship if it goes ahead with hearings on the Defense Department's decision to cloak military space activities in secrecy (AW June 11, p. 25).

- **Air Force campaign.** Air Force is pressing ahead on several fronts to enlarge its space role, despite Defense Department claims no major expansion is contemplated. The Air Force, for example, encouraged Welsh to draft the new space policy statement in hopes the military space needs would gain wider recognition. The State Department is reviewing the policy document to prevent the U. S. space program from projecting a military image.

In short, the Kennedy Administration is being forced to give an unprecedented amount of private and public attention to the civilian-military relationship in the space program. President Kennedy himself, for example, was disturbed about a New York Times story which said the Defense Department had decided to enlarge its military space activities. That story was based on an earlier AVIATION WEEK report on the manned Saint program (AW June 4, p. 34). The President's angry reaction to the report was interpreted as a setback to those hoping to enlarge the military's space program.

Defense officials denied there was any change of emphasis in military space programs, but did not foreclose a future expansion. Deputy Defense Secretary Roswell L. Gilpatric told the Senate Aeronautical and Space Sciences Committee last week that "there has been no new significant decision for new military programs" since the Defense Department presented its budget to Congress in January. Gilpatric said that "there has been no pressure that I am aware of from the White House or from the space council for us to project the military further into space programs."

But he added: "We are very conscious of the need, however, for taking out, if you will, certain technological insurance, be it cost support or a share of the national objective of the peaceful use for outer space. . . . We have had some sad experiences, obviously,

in reaching agreements with the Soviets on nuclear test bans and other such objectives for the benefit of mankind. And we want to be prepared, and we don't want to be caught by surprise if any hostile use of space should occur. So we are making studies. We are interested in pursuing technologies, acquiring capabilities such as in this rendezvous area, and there we do have somewhat different [needs]."

Specifically, Gilpatric said NASA's Gemini program did not have direct application to the military because maneuverability was keyed to the target rather than the vehicle itself and therefore would not be able to deal with hostile objects in space. Also, he said, the military needs all-weather capability, controlled re-entry "and other attributes which may not altogether be satisfied" by the Gemini program.

Even so, Gilpatric said, "we are going to use fully the experience that is achieved by NASA in Gemini. In the meantime, there has been no major decision within the Administration and certainly [none] within Defense Department to embark on enlarged space programs for the military alone. We are pursuing the programs that have been submitted to the Congress. If we have further needs in the future we will, of course, propose them in the usual way." Gilpatric said Defense would not submit a supplemental budget request to Congress for Fiscal 1963 to obtain more money for military space programs.

NASA Administrator Webb told the Senate committee that "the true situation" regarding the civilian-military relationship is that the "President's policy has been, in accordance with the law, to develop the space program as a civilian peaceful effort to the fullest extent possible, but always pressing with the kind of technology that would permit us to move rapidly in the military field if we were required to do so. It is a little bit like 'keep your powder dry' with respect to the military side."

"There are obviously developing, as we get a national launch vehicle program under way that gives us great rocket power, new uses—both military and civilian," he said. "None of us can foresee the end of these. I think the policy question is: at what point do you pick up the new capability this national launch vehicle program gives you and apply it for specific purposes?"

He said NASA conducts research of especial interest to the military. "If we did not do that," he said, "the military should move rapidly itself." Webb answered "I think so" when asked by Sen. Howard W. Cannon (D.-Nev.): "Isn't it implicit in our stated policy in the use of space for peaceful purposes that we be able to counteract any aggressive move in space by a hostile user?"

Webb Says Earth Rendezvous Is Favored

Washington—Earth orbital rather than lunar orbital rendezvous appears to be the best way to proceed to the moon, National Aeronautics and Space Administration Administrator James E. Webb said last week (AW June 4, p. 25).

He told the Senate Aeronautical and Space Sciences Committee that the experience gained maneuvering around the earth "would have very great assurance for those of us who might be concerned as to whether some other nation would develop a capability that we could not match. It seems to me that the whole national posture of developing the medium of space would be improved if we have an active program around the earth, and even if it looked technically possible to land a few months sooner on the moon or a year sooner with the lunar rendezvous, I would suspect all considerations would weigh in favor" of the earth orbital rendezvous.

"The important thing to bear in mind," Webb said, "is that we have this experimental flight program with the Gemini on a booster already available. Just as we use the X-15 and fly time after time to gain the experience we need, we will be doing that with Gemini."

Webb, however, did not altogether preclude a lunar rendezvous. "We are still welcoming all the good ideas people have," he said.

NASA hopes to make a firm decision on the method of transfer to the moon before the end of this month, and lunar orbit rendezvous had been gaining momentum in recent weeks as the result of exhaustive studies sponsored by the agency. Lunar orbit mode involves a two-man lunar lander, called a bug, which would eject from the main Apollo spacecraft after it went into orbit around the moon.

Decision will not greatly affect the design of the command and service modules, being built by North American Aviation Space and Information Systems Division. However, decision on the spacecraft propulsion module depends on which method is chosen. Earth-orbit rendezvous Apollo configuration will have a propulsion module, and the lunar orbit system will not.

There is considerable support in Congress for an enlarged military space role. Key lawmakers in both the Senate and House told AVIATION WEEK a primary reason why NASA's budgets have been approved overwhelmingly thus far is the conviction that much of the civilian research will have direct application to the military.

Chairman Richard B. Russell (D.-Ga.) of the Senate Armed Services Committee, for example, during this year's hearings on the Defense budget, questioned whether NASA could take care of military space needs. "We made a mistake in creating the space agency and in giving all the power to it that we did," Sen. Russell said. "I question this analogy between the Atomic Energy Commission and the space agency. There is no analogy there."

Rep. Miller is among those who favor the present civilian-military relationship in the space program. He told AVIATION WEEK he saw little need for a new space policy statement since one is already in the law establishing NASA. "I don't know what anybody could do without amending the space act. And no one has advised me of any reason why the present space policy should be changed," he said.

But several senior members of the House space committee, including Reps. Olin E. Teague (D.-Tex.) and Emilio Q. Daddario (D.-Conn.), fear the military space role may be too small. They are, respectively, the chairman and ranking Democrat on the House Manned

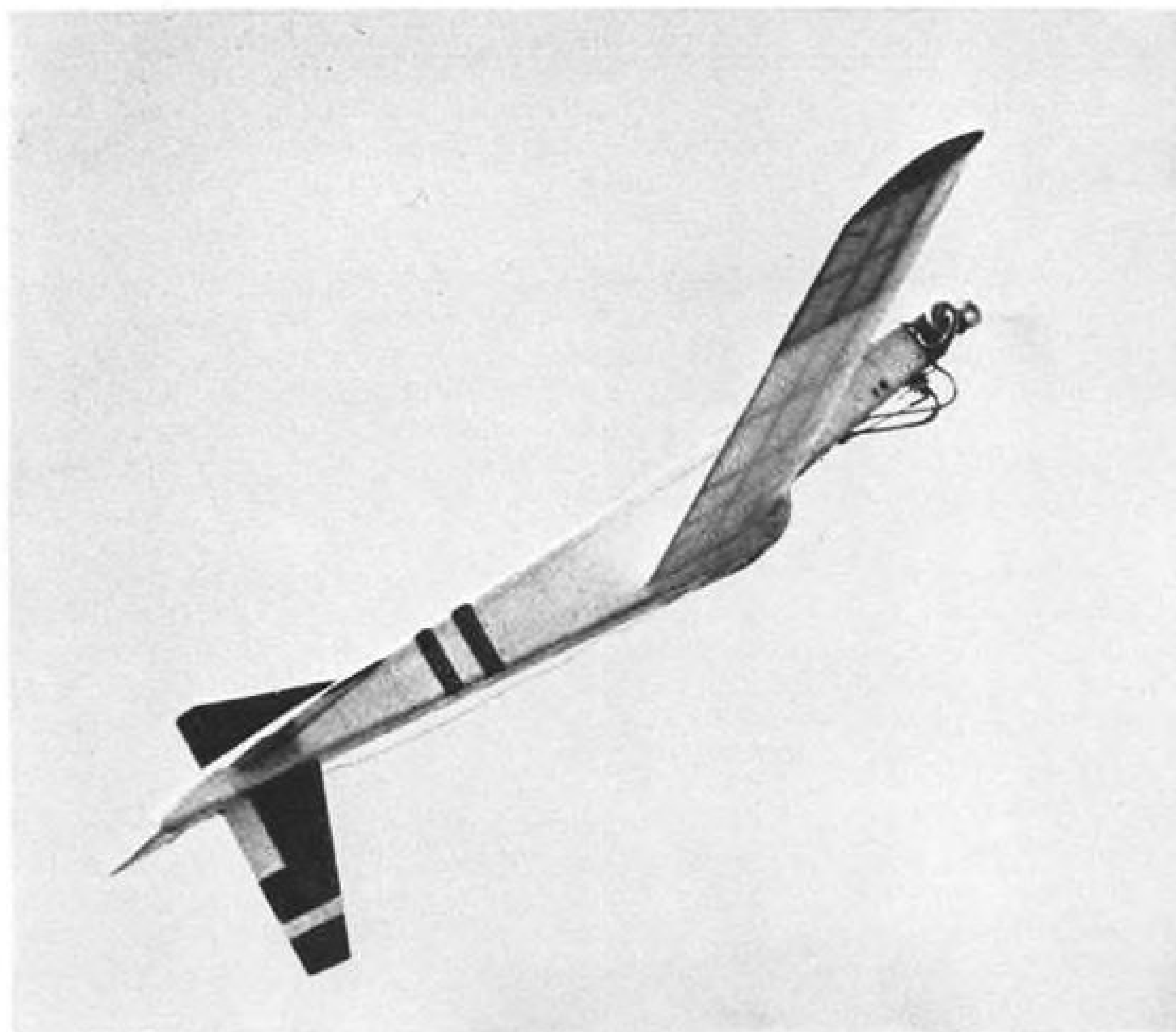
Space Flight Subcommittee which reviewed the NASA budget.

Dr. William O. Baker, vice president of research for Bell Telephone Laboratories, told the subcommittee the technological knowledge gained from NASA's program "will not be adequate for achieving the position in national security that we must have. . . . We have not seen a national policy that defines . . . the affirmative role of military in space."

Although some members of the House space committee have been urging hearings to discuss in depth the civilian-military roles in space, Rep. Miller said he sees no need for doing that at present. He said NASA and DOD "seem to have things pretty well in hand." One idea is to have joint House space committee and House Armed Services Committee hearings.

Air Force is pursuing its studies of military space weaponry and may award a contract soon to explore the bombs-in-orbit concepts. Such a study is being considered by the Defensive Systems Branch, Advanced Systems Plans and Analysis Office of USAF's Space Systems Division. Air Force studies of vehicle designs, missions and sensors for a manned satellite inspector have been delayed, partly because of the public controversy over the military's space role (AW June 4, p. 34).

These studies are accompanied by an intensive Air Force campaign to persuade members of Congress that the military should be given a larger space role.



Reconnaissance Drone Tests Slated

Small drone developed by Republic Aviation Corp. for possible use as Marine Corps battlefield reconnaissance vehicle (AW Apr. 30, p. 34) will be checked for ability to avoid radar detection in tests next month at Twenty-Nine Palms, Calif. Long rudder on bottom side of fuselage permits unobstructed deployment of landing chute and provides stability for avoiding steep turns. Wire running from rudder along fuselage bottom to wing is radio guidance antenna. Wire loops under nose protect throttle actuator from damage in takeoff and landing. Aerial camera apparently is housed in bulge just below wing roots.

Finances Loom as Major Problem After IAS-ARS Consolidation

Financial difficulties are likely to face the Institute of the Aerospace Sciences and the American Rocket Society for the first few years after their planned merger (AW Jan. 29, p. 26), according to the booklet "Principles of Consolidation" just released for study by the members.

In an accompanying letter to members, IAS President L. Eugene Root said, "The experience of both societies over the past two years indicates great effort and management ingenuity will be required to avoid a sizable year-end deficit this year and next, as well as further into the future, particularly with relative increases in services to members."

Root said dues in the new American Institute of Aeronautics and Astronautics (AIAA) to be formed by the merger, will be higher in some membership grades than for the same grades in the present societies. Average dues are \$25 per year. The cost of services supplied by the two technical societies is about \$65 per year. The difference must be made up from advertising in society publications, donations and bequests from non-members, corporate member dues, government contracts, etc.

The principles of consolidation were approved by the IAS Council and the ARS Board. If the two governing bodies interpret member response to be generally favorable to the principles, a detailed plan of consolidation and an AIAA constitution will be submitted to a formal vote. Consolidation could be effective informally by October and could probably be legally complete by February, 1963.

Consolidation plans include a two-year transition period during which special nomination and election procedures will maintain an equal voice for each of the two former societies. This period is thought to be sufficient to allow a feeling of AIAA unity to develop. It will also provide a way to introduce staggered terms of office for directors and a multiple choice ballot for their election.

Between the time IAS and ARS members formally vote to go ahead with the consolidation and the time when the consolidation becomes legally effective, a de facto executive committee with equal representation of the two societies will provide administration. It will function until the AIAA officers are installed. On the legal date of consolidation, resignations of ARS and IAS national officers will become effective.

The consolidation steering committee

anticipates that there will be a number of non-recurring costs during the transition period including the direct expenses of accomplishing the consolidation, absorption of any 1962 operating deficit of the ARS or IAS, and write-off of excess liabilities of the ARS. The IAS Council has voted to allocate up to \$350,000 for the purpose of meeting these costs if consolidation is completed. Largely through grants and gifts, IAS has accumulated assets with a book value of \$2.6 million. Its net worth is about \$1.7 million. ARS has a slight excess of liabilities over assets.

Each society spends about \$1.25 million per year on services to members and operating costs. In each case, about a third of that figure is accountable to the cost of publications.

According to the principles of consolidation, AIAA eventually would plan to publish four technical periodicals and a new quarterly intended for the general public which would "maintain the desired public image of the new society" and "contain objective and authoritative articles on the social, economic, military and political implications of advances in aeronautics and astronautics."

The Russian supplement, now produced by the ARS, and the International Aerospace Abstracts, now produced by the IAS would be continued.

Of the four regular technical journals:

- **Journal A** will print papers on aerodynamics, gas dynamics, magnetohydrodynamics, hypersonics, space physics, meteorology, structures and materials, and aeroelasticity.
- **Journal B** will print papers on propulsion, combustion, liquid and solid rockets, electric and nuclear propulsion systems, flight mechanics, control and guidance, instrumentation and communications.
- **Journal C** is to be issued monthly to cover engineering subjects. A news letter to inform members of important events may appear as part of Journal C.
- **Journal D** will contain short summaries of scientific papers and research notes and will be published monthly.

Each member would receive Journal C and his choice of Journal A or Journal B at no cost beyond his membership dues. The other publications would circulate on the basis of paid subscriptions. The number of free journals sent to members may have to be reduced to cut society costs. Journal C would be intended to earn maximum advertising revenues but advertising would be limited in Journals A and B.

The process of consolidation at the national level will be accomplished by merging ARS into IAS and revising the IAS charter, constitution, by-laws and name to constitute the AIAA. Lawyers for the two existing societies recommend this procedure as the best way, legally and equitably, to conduct the consolidation.

At the local level, consolidation of IAS and ARS sections will be done under rules providing much local autonomy but within guidelines drawn by national and regional groups. Consolidation of sections is supposed to be completed as early as possible and the final deadline is to be Jan. 1, 1964.

About 35 local section consolidations are expected and about 20 sections have no section of the other society near enough to make consolidation necessary. These will become sections of the AIAA and will continue to operate with a minimum of change.

There are now 39 IAS and 56 ARS sections.

When all the necessary consolidations are completed, there should be a total of about 55 AIAA sections.

Senate Move Unlikely On Procurement Bill

Washington—Procurement legislation tightening Pentagon procedures in contract negotiations, which passed the House 362 to 0, appears to have little chance of Senate action this session.

Defense Department has opposed provisions of the bill, approved by House Armed Services Committee last year, on the grounds that the objectives can and are being accomplished by administrative regulations and practices. A majority on Senate Armed Services Committee support this view.

Defense has also objected that writing regulations into law establishes undesirable inflexibility in procurement.

The House-passed measure would:

- **Require contractors** to certify that cost figures in negotiated contracts are correct.
- **Direct "full disclosure"** of information by the contractor during negotiations.
- **Require an after-the-fact review** of incentive type contracts before final settlement to assure that the incentive bonus was merited by the contractor.
- **Require advance payments** to contractors on negotiated contracts to be supported by written findings.
- **Give General Accounting Office** authority to block payments in cases where it is discovered that the contractor has clearly given erroneous information on costs.

The House passed a similar measure on a voice vote in 1960, but it was not acted on by the Senate.

Latest Proposals for F-111A Fail To Meet Requirements of Navy

Washington—Navy insistence that the size and weight of the F-111A (formerly TFX) bi-service tactical fighter make it adaptable to aircraft carrier operations has resulted in performance specifications not being met in proposals submitted by the Boeing Co. and General Dynamics Corp.

A recent re-evaluation of the proposals at the Aeronautical Systems Division at Wright-Patterson AFB attempted to reconcile a 6,500-lb. weight difference in Navy and Air Force requirements (AW June 11, p. 25).

Director of Defense Research and Engineering Harold Brown has been placed in the position of acting as the final arbitrator in settling the matter. His own engineering team must also recommend the final choice of contractor. When and if the choice is made depends not only on technical decisions, but also on possible cost-effectiveness studies.

This was the situation last week as teams of 400 to 500 engineers at both the Boeing plant in Wichita, Kan., and the General Dynamics plant in Ft. Worth, Tex., awaited results of their labors, which began last September when six contenders entered the TFX competition. Last Jan. 30, their work intensified when Boeing and General Dynamics were chosen as finalists and told to rework their proposals.

Plant officials report morale of team members is beginning to suffer. They also were becoming apprehensive about overhead expenses caused by keeping the teams together, which far exceed what the firms were paid for re-doing the proposals.

Air Force officers have expressed bitterness over what has happened to the original requirements since the Defense Department ordered that the TFX project combine the requirements of the Navy and Army in February, 1961. Army low-speed close-support requirements were later split off as the VAX project, making the F-111A a bi-service effort.

The tactical attack mission profile desired by the Air Force would have the aircraft proceed toward its target at subsonic speeds and low altitude for 800 mi., then dash 200 mi. to the target at supersonic speeds at low altitude, attack, and then retreat at supersonic speeds at high altitudes. This is popularly known as the "lo-lo-hi" profile.

To achieve such performance with variable geometry wings, the Air Force envisioned an aircraft weighing 85,000 to 90,000 lb.

Air Force compromised, dropping its requirement to considerably less than 65,000 lb., while the Navy is holding to 55,000 lb. The weight cuts have primarily affected dash distance at supersonic speeds, loiter time at extreme ranges and ferry ranges. Navy requirements for range and loiter time are less than those of the Air Force. Navy has no long-range ferry requirement because the aircraft would be carrier-based.

The proposals also contain deficiencies in other areas, according to Defense officials. These cover all four types of missions—interdiction, air superiority, reconnaissance and close support. In addition to size and weight factors, aerodynamics plays a part, with difficulties being presented in high-altitude, high-speed maneuvering, low-altitude, low-speed maneuvering and landing characteristics. A Navy requirement that the aircraft could be launched with no wind speed over the carrier

Senate Votes Full RS-70 Funds; Passes \$48.4-Billion Defense Bill

By Katherine Johnsen

Washington—Senate last week overwhelmingly sustained Air Force's \$491-million program for the RS-70 reconnaissance-strike aircraft on two roll-call votes, and then passed a \$48.4-billion defense budget for Fiscal 1963 by an 88 to 0 vote.

An amendment by Sen. William Proxmire (D-Wis.), which would have reduced the RS-70 appropriation to the \$171 million recommended by Defense Secretary Robert S. McNamara and the President, was defeated 74 to 13.

A more rigid amendment placing a ceiling of \$171 million on RS-70 expenditures for Fiscal 1963, offered by Sen. Everett Dirksen (R-Ill.), was defeated 72 to 15.

A House-Senate conference committee will decide between the \$224 million approved by the House (AW Apr. 16, p. 26) and Senate's \$491 million.

Sen. Willis Robertson (D-Va.), chairman of the defense appropriations subcommittee reported during floor debate that he had been informed by McNamara that Defense is giving "very serious consideration" to the use of additional RS-70 funds voted by Congress. Total defense budget approved by the Senate was \$600 million more than the \$47.8 billion passed by the

Bell HU-1E Progress

Ft. Worth, Tex.—Production configuration of the Bell HU-1E, Marine Corps support helicopter version of Army's HU-1B Iroquois, has been determined and the go-ahead has been given on fabrication of detail parts and assemblies. Primary changes included revision of electrical system to a.c. and addition of a rotor brake.

HU-1E avionics changes will include ARC-52 ultra-high-frequency transceiver, ARC-94 high-frequency AM/SSB (single-sideband) transceiver, APX-6B identification equipment, and ARN-52 Tacan navigation.

flight deck adds to the weight and complexity of the aircraft's wing aerodynamic design.

Air Force maintains that the Navy can accommodate much heavier aircraft on its carriers, pointing out that the Douglas A3D, now in service, weighs 70,000 lb. It also sees little need for the zero wind over the deck requirement, which would permit carrier launching while the ship is traveling downwind.

House. The Administration recommended \$47.9 billion.

Other items at issue between the House and Senate conferees include:

- **Research grants.** House limited indirect costs of research grants to 15% of direct costs; Senate eliminated this restriction.
- **Aircraft spare parts.** The Senate restored a \$130 million reduction made by the House in the Navy and Air Force requests for spares.
- **Lockheed C-141.** The House reduced the \$107 million earmarked for the program to \$97 million, with the objective of forcing Lockheed to partially finance the component development costs of the aircraft, which may later be produced for commercial use.
- **Raytheon Sparrow 3.** The Senate restored a \$5-million reduction made by the House in anticipation of a reduction in the unit cost of the missile.

The Senate approved a 1% across-the-board reduction in all procurement accounts to spur improvements in procurement processes.

The Senate also approved the \$157 million for Dyna-Soar and the \$35.1 million for the North American T3J trainer voted by the House. The Administration requested only \$115 million for Dyna-Soar and \$18.1 million for the T3J.



TITAN LIQUID PROPELLANT ENGINE was mounted near a large solid propellant engine for environmental tests during a recent firing of the solid motor by Aerojet-General Corp. at Sacramento, Calif. Solid engine developed 700,000 lb. thrust, but ruptured several seconds after photograph was taken. Titan engine nozzles were destroyed by the rupture which occurred when solid engine chamber pressure dropped after 45 sec. of scheduled 120-sec. firing. Total engine run was 71 sec. Titan engine environment tests are designed to show effect on the motor during future space flights with solid boosters.

Nozzle Failure Halts Solid Rocket Test

Sacramento, Calif.—Nozzle failure at the aft edge of the largest one-piece graphite throat insert yet tested ended static firing of a 700,000 lb. thrust Aerojet-General solid-propellant rocket about half-way through a scheduled 120-sec. run.

Analysis of data is not yet complete and the precise reason for the nozzle insulation failure has not been determined. While chamber pressures and temperatures were not significantly higher than in earlier tests of large

segmented solid rockets, the total heat flux was much higher than had ever been imposed on the nozzle of such a rocket because of the high gas flow rate.

Other objectives of the test included:

- **Comparative evaluation** of two different liquid injection thrust vector control (TVC) fluids at pressures ranging 500 psi. to 750 psi. and comparison of two TVC valve designs. The two fluids were sodium perchlorate and nitrogen tetroxide. Engineers are not certain that valid data was obtained on the functioning of one of the valves before the failure occurred, but the complete range of planned thrust deflection was achieved with both of the fluids.

- **Measurement** of some of the effects of heat and vibration from the solid rocket upon a Titan 2 liquid propellant engine mounted directly above the horizontally emplaced 100-in.-dia. test motor. USAF Space Systems Division wanted the data for application to the 624A Standardized Space Launching System. The Titan engine and many of the sensors installed in it were destroyed in the fire after the nozzle failure but data was recorded before this occurred. Earlier plans (AW June 11, p. 25) to pump fluids through the Titan engine during the test were dropped.

- **Test of the feasibility** of scaling up the igniter used on shorter Aerojet

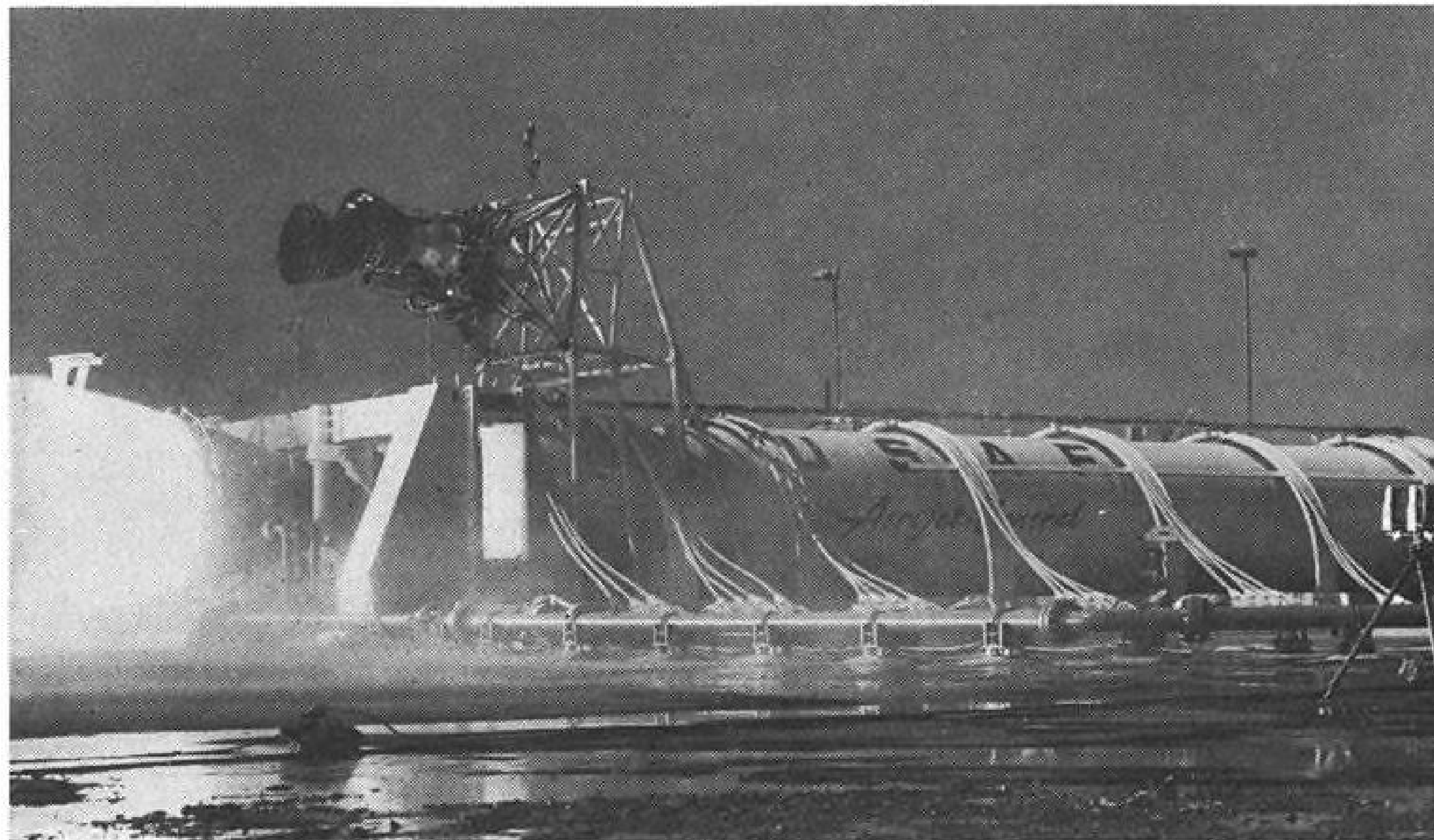
segmented rockets of this diameter for use on the long 700,000 lb. thrust motor.

Ignition was successful and thrust varied according to a schedule beginning with an early build-up to the 700,000 lb. maximum and then tailing off along a programmed regressive thrust curve. Planned average thrust for the test had been 620,000 lb. At 45 sec. after ignition, a hole was burned in the top side of the nozzle expansion cone at the aft edge of the graphite insert in the nozzle throat. Shortly afterward, the insert was expelled from the nozzle. From an observation site 7,200 ft. away, pieces of burning material could be seen flying through the air and a bright fan-shaped flame appeared above the aft end of the motor.

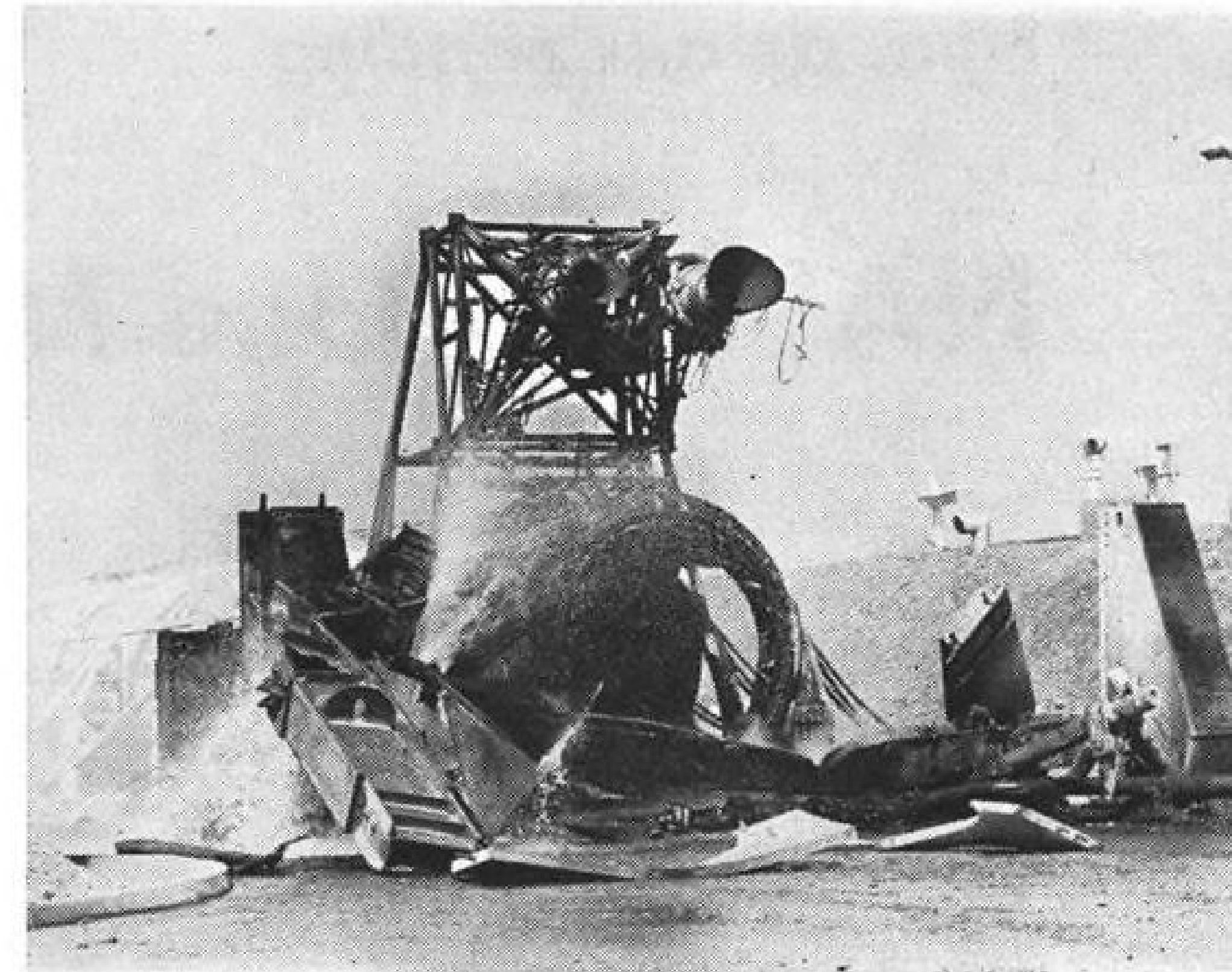
Nozzle Deterioration

Progressive deterioration of the nozzle and finally the break-up of the aft closure of the motor case occurred within about 20 sec. of the initial burn-through. There was no detonation but pieces of the nozzle were found 1,600 ft. from the test stand. The test conductor considered the test terminated 71 sec. after ignition.

The segmented test motor contained 159 tons of conventional polyurethane propellant and was made up of five cylindrical center segments, a nose cap and aft closure.



Aerojet-General Photograph



Missiles and Rockets Photograph

“Highly successful test . . . work on big solids is continuing.”

AEROJET-GENERAL CORP. released the following press announcement on the June 9 firing of its segmented solid rocket: “A new American thrust level of 700,000 lbs. for solid-propellant rockets was set here today under a U.S. Air Force program. The highly successful test was marred when the intense heat called for caused a burn-through in the rocket casing, allowing gas to escape. The rocket did not explode, nor did its parts seatter. Instead, the escaping gas continued to burn through the aft-section until the 159 tons of propellant was consumed. Richard

D. Geckler, Aerojet-General Corp. vice president and manager of the firm’s Solid Rocket Plant, said ‘The overall success of the firing confirms our confidence in large solid rockets.’ Air Force representatives who viewed the test expressed their satisfaction with the data obtained, relating to: a) Record thrust of over 700,000 lbs.; b) Successful ignition of the largest mass of propellant ever put together, and c) Significant information on steering large motors. Work on big solids by the company is continuing.”

MMRBM Awards

Decision is imminent in selection of associate contractors in USAF Ballistic Systems Division’s mobile medium-range ballistic missile (MMRBM) program.

Probability is that two contractors will be chosen in each category to perform three-month program definition studies. This would lead to selection of single associate contractor for development work in each phase under a cost-plus-incentive fee or fixed-price-plus-incentive fee contract.

Aerospace Corp. assisted BSD in technical evaluation of competitive proposals in the various associate categories, which included transporter-launcher, re-entry system, propulsion, command control, integration, assembly and checkout.

Final details pending . . .

NASA To Use More Incentive Contracts

Bendix wins first major NASA incentive award as space agency gains experience in estimating costs of engines

by Hal Taylor

NASA PROCUREMENT officials plan to move heavily into the area of incentive contracting.

The projects most likely to be affected are follow-on contracts for some of the agency's rocket engines and such satellite and spacecraft programs as *Nimbus*, *Aeros*, and the *Advanced Relay* and *Syncom* communication satellite systems.

Ernest R. Brackett, director of space agency contracting, told MISSILES AND ROCKETS, "while final details haven't been completed, we hope to award more incentive-type contracts."

Cost data on these would be based on the space agency's experience with the *Relay* and *Tiros* satellite programs.

"We're still studying them and no final decision has been made," Brackett said.

The decision is expected in September. Webb has set up a special Procurement Study committee and its report is scheduled for that month.

Besides the question of how NASA can award more incentive contracts, it is also working on a review of NASA's methods of contractor selection, the procedures used to determine what

tary's level for fees in excess of 7% for production contracts and 10% for research and development contracts.

Brackett said that what fees NASA may pay under incentives will be determined by the study committee.

The award of the *Mercury* tracking network service contract winds up a procurement action which began last December. At that time, seven electronics firms submitted proposals. In February, NASA trimmed the list to only two firms, Bendix and RCA. Bendix was always considered the leading contender because it has operated the

260-in. Motor Work Statement Completed

Los Angeles—Work statement on the requirements for the 260-in.-dia. solid-propellant rocket motor program essentially was completed last week by a source selection board functioning under Air Force Systems Command's Space Systems Division. Only details in the transportation and launch-readying modes remain to be finished.

Action on the 260-in. motor was taken after Department of Defense decision that there was no immediate requirement for a development program for the 156-in.-dia. motor. State-of-the-art extension for this size solid-propellant configuration basically would be an extension of that required for the 120-in. motor, which United Technology Corp. has been selected to develop. Spacecraft and propulsion groups in the National Aeronautics and Space Administration apparently concur in this conclusion and the net effect is that for the time being the 156-in. motor development is shelved.

Propulsion industry companies had expected the request for quotation (RFQ) for the 260-in. motor program—which probably would be initiated with a feasibility study—would be issued before the end of this month so that USAF could apply any Fiscal 1962 funds it might have had available for this purpose. However, considering the chain of command approvals after requests by Space Systems Division to issue the RFQ, it is likely that no action on the program will be taken until after July 1.

Development of the 260-in. motor, which is expected to develop about 3 million lb. thrust, will demand radically new approaches from the propulsion industry because of the tremendous jump from present technology, particularly in manufacturing techniques. Configuration will be monolithic—cast in one piece as distinguished from the segmented configuration for the 120-in. and 156-in. sizes—and will involve many unknowns, including:

- Ability to cast a single grain almost 22 ft. in diameter, and having a length which will exceed that of the 120-in.-dia. motor (65 to 75 ft.).
- Controlling the mechanism of curing in a monolithic grain of this size. Curing action might even begin before the entire grain has been cast, propulsion technicians feel.
- Nozzle problems relating to material suitability and single or split construction for structural considerations and ease of transportation.
- Transportation methods for a loaded motor of this size. Motor will have to be fabricated near the launch site, then supported in a structure while barged to a storage facility near the launch site, and moved to the pad on rails or by canal barge.

Many similar techniques considered in the Air Force Project Phoenix booster study (AW, Mar. 27, 1961, p. 50) may be reviewed for application to the 260-in. rocket motor.

After feasibility of the 260-in. rocket motor is established, likelihood is that it will be tagged for NASA use unless specific Air Force space projects or defensive weapons systems require one or more of these rockets as a booster, which is not now considered likely.

tractor was to be paid for each phase only if the program were successful.

Requirements in the requests for proposal included the following:

- Normal case cylindrical portion length, 312 in.
- Reference (over-all) case length, 402 in.
- Diameter of forward opening, 44 in. ± 24 in.
- Diameter of aft opening (nozzle end) 60 in. ± 10 in.
- Maximum case weight, 27,000 lb.
- Minimum propellant weight, 350,000 lb.
- Minimum motor mass fraction, 0.90.
- Desired mass fraction, 0.92.
- Minimum delivered specific impulse, 237.
- Web burning time, 100 sec. ± 10 sec., at sea level and 80F.
- Ignition delay, 150 to 500 millisecc.
- Average thrust during web time, 900,000 lb. $\pm 100,000$ lb.
- Average pressure during web time, 800 psia. ± 100 psia.
- Minimum pressure cycle during tests, 0 to 1,050 psi. ± 50 psi. and -0 psi.

Advanced Technology Need Cited by Brown

Washington—Advanced technology and exploratory development must be "pushed and pushed hard" even when there is no formally stated military requirement, to meet subsequent needs of new weapon systems, Director of Defense Research and Engineering Harold Brown said here last week. Dr. Brown, addressing the Armed Forces Communications and Electronics Assn. convention, said this "reduces the motive for stating as military requirements things for which no reasonable military case can be currently made in order to make sure that the technology is developed."

In the absence of reasonably well-proven technology and components, Dr. Brown said, "major weapon systems developments will be deferred. This should avoid some of the expensive mistakes that have occurred in the past in trying to develop systems first and the technology on which they rest later."

He criticized the military services for their failure to be more selective in proposing expanded research and development programs, citing the Navy's Polaris program as an exception. "It simply does not make sense to . . . propose a 40% increase in the military R&D budget, but that is precisely what we are presented with in many cases by the echelons below us," Brown said. "A group which presents, without even an order of priority, a proposed increase for the next year of its research and development efforts of 40% is abdicating its responsibility. . . ."

Foes Hope to Amend Present Comsat Bill

Washington — Government-ownership advocates plan to offer a long series of amendments to legislation establishing a privately-owned corporation to develop and operate a communications satellite system—if, as expected, the Senate rejects their first proposal for a government corporation.

The Senate this week or early next week will start consideration of the measure proposing the private corporation, which would be financed 50% by the general public and 50% by communications common carriers (AW Apr. 2, p. 20). It is sponsored by the Administration, passed the House 354 to 9, and was voted out of Senate Commerce Committee 15 to 2.

Some of the planned amendments were proposed last week in the Commerce Committee minority report, signed by Sen. Ralph Yarborough (D.-Tex.) and Sen. E. L. Bartlett (D.-Alaska).

They included:

- **Maximum price** of \$25 a share on the corporation's stock, instead of \$100, to achieve wider public distribution.
- **A limitation of 10%** on the amount of the common carrier stock that could be owned by any single carrier. The present measure provides for an equitable distribution of this stock among the carriers, but places no specific limitation on the amount that may be owned. It also limits ownership of the stock offered for public sale to 10% by any individual or affiliated group. The minority said that fairness requires that the same limitation be applied to the carrier stock.
- **Requirement** that ground stations be owned by the communications satellite corporation. The bill now leaves it to Federal Communications Commission discretion whether they are to be owned by communication common carriers, by a combination of carriers, or by the satellite corporation. The minority said that if ownership is left to the carriers, "they will, in effect, have control of satellite communications. If the ground stations and satellites are owned by the corporation, it may be possible to improve the competitive structure of both domestic and international communications."
- **"Strong language"** guaranteeing small business a role in the satellite system "in view of the fact that the communications carriers who will be major investors in the corporation are also in the manufacturing business, and since the non-carrier stock can be held by large corporations engaged in manufacturing and supply . . ."
- **A prohibition against** officers and directors of the satellite corporation having "any direct or indirect financial

connection with any communications carrier or equipment manufacturer, or supplier of the satellite corporation." The present legislation only bans officers from receiving salary from any other source during their period of employment by the satellite corporation. Urging government ownership, Yarborough and Bartlett declared in their dissenting report:

"Not only does the . . . bill create a private monopoly, it would go even further and bestow on that single private

monopoly the benefits of billions of dollars of the taxpayers' money. This legislation, if enacted, likely would constitute the biggest giveaway in the history of the United States.

"All the elements necessary for the very existence of an operational satellite communications system have been financed by all the taxpayers of the U. S. It is our belief that all these same taxpayers should receive the benefits of the system when it becomes operational."

USAF to Develop Two Satellites In Advent Program Reorientation

By Philip J. Klass

Washington—Air Force has been given responsibility for development of a new lightweight, synchronous-orbit communication satellite and a new medium-altitude, random-orbit communication satellite following Defense Department's decision to reorient its Project Advent program (AW May 28, p. 25, June 11, p. 31).

The Army, which had management responsibility for the Advent project since September, 1960, with development of launch vehicle and spacecraft delegated to the Air Force, now retains responsibility only for development and operation of the ground and shipboard terminals. Portions of the ground environment used for launch and control of the satellites may be assigned to the Air Force, the Defense Department said. Army also will be responsible for developing ground terminals for the new medium-altitude satellites.

Separate Funding

The Defense Communications Agency, which operates a joint-service non-tactical communications network that would use the communication satellites, is given responsibility for satellite system integration and interface problems. Each of the three agencies involved in the new program will be funded separately for its portion of the project, tentatively identified as Advent 2.

The decision to reorient the Advent program results from several factors, including delays in development of the Centaur vehicle, which was to put the 1,300 lb. satellite in an equatorial orbit at 22,300 mi., and problems involved in the division of Army and Air Force responsibilities. Satellite weight also had grown to the point that the Atlas-Centaur capability was marginal for a 22,300-mi. orbit.

Defense is anxious to expand its global communications capabilities by means of satellites, hopefully by 1964-65. A recent study indicated that advances in stabilization techniques and lightweight traveling wave tubes might permit the design of a lighter weight version of the original Advent weighing about 500 lb., with little sacrifice in performance. Such a satellite could be launched by an Atlas-Agena B vehicle.

Recognizing the present unknowns involved in placing a satellite in synchronous equatorial orbit and keeping it there, Defense decided also to develop a medium-altitude communication satellite which might be operational several years sooner, at altitudes of about 5,000 mi.

SSD Function

Air Force's Space Systems Division, Los Angeles, will handle USAF's new mission in the re-oriented program, and will call for industry proposals on the two types of satellites soon, perhaps within 60 days. First proposals requested may call for a program definition phase in line with current Defense policies.

Defense hopes for cutting the weight of a synchronous satellite stem from new lightweight traveling wave tubes, not available for use in the original Advent at the time the design was frozen. These tubes provide extremely broadband performance and require far less electric power than conventional tubes, slashing the weight of spacecraft power supply. Such tubes, specifically designed for long life in the space environment, have been developed by Bell Telephone Laboratories, Radio Corp. of America, Watkins-Johnson and others. First trials will come in the Telstar and Relay satellites, under development by American Telephone & Telegraph and RCA, scheduled for launch by the National Aeronautics and Space Administration

during the summer and fall of this year.

New techniques for stabilizing a satellite antenna radiation pattern instead of the entire vehicle, to orient the radiation toward the earth, also offer possibilities for major savings in weight and complexity. One such technique, developed by Hughes Aircraft, will be used on its lightweight Syncom communication satellite under construction for NASA (AW June 11, p. 88).

Hughes and RCA, with experience on the NASA satellite programs, are both expected to bid for the new military satellite contracts.

There is speculation that AT&T might enter a version of its own Telstar in the competition.

General Electric, whose missile and space vehicle department was building the original Advent spacecraft, including stabilization and power supply, also is expected to be a contender, along with Bendix, which held the prime contract for Advent spaceborne and ground-based communications equipment.

Proposals Submitted

In the wake of the Defense Department study on Advent, Hughes, Lockheed, Space Technology Laboratories and General Electric reportedly have recently submitted unsolicited proposals to the Space Systems Division for a lighter-weight synchronous communication satellite, while Philco and RCA have proposed medium-altitude satellite designs.

Both GE and Bendix are expected to complete and deliver the first non-flyable Advent prototype and possibly the first flight model to the Air Force for test and evaluation, but further work has been halted. As a result, General Electric has laid off approximately 1,100 employees, including engineers, at its missile and space vehicle department—approximately 10% of the current employment.

B-52H Ends Category 2 Tests at Edwards AFB

Category 2 tests of the Boeing B-52H were completed at Edwards AFB, Calif., June 15. Four of the turbofan B-52Hs were used in the joint Air Force Flight Test Center/Strategic Air Command tests involving 1,800 flight hr. during the past year.

One of the 488-000 lb.-bombers flew 1,500 hr. in evaluations of the complete weapon system. Another aircraft was used for performance, stability and control tests both with and without external stores of Skybolt and Hound Dog missiles. A third B-52H was used in adverse weather tests while the fourth was used for avionics systems tests at Boeing Wichita.

Lear-Siegler to Combine Divisions

Los Angeles—Lear-Siegler, Inc., the corporate identity emerging from the recently approved acquisition of Lear by Siegler Corp., will strongly emphasize aerospace and military systems capabilities of the combined organizations.

A large number of personnel and organizational changes from former corporate setups are expected to be announced in coming weeks as the combined organization attempts to create an image of a major aerospace organization.

Among anticipated changes will be the formation of the following divisions or groups:

- **Astro-Structures Division**, El Segundo, Calif., formerly the Siegler Hufford Division, which makes rocket engine cases for Minuteman ICBM first and second stages.

- **Electronic Instrumentation Division**, Anaheim, Calif., formerly the Siegler Hallamore Electronics Division, which produces telemetry, closed-circuit television systems for the Centaur and Echo programs and ground support equipment for the Atlas ICBM.

- **Power Equipment Division**, Cleveland, Ohio, will combine what formerly was Siegler's Jack & Heintz Division, manufacturer of aircraft-missile electric power generation and control equipment, and Lear's Electro-Mechanical and Lear-Romec divisions. The latter two groups will be moved to Cleveland from Grand Rapids, Mich., and Elyria, Ohio, respectively. The division will be headed by K. Robert Hahn, formerly executive vice president of Lear, who was named head of Jack & Heintz earlier this month.

- **Instrument Division**, Grand Rapids, Mich., consisting primarily of Lear's Instrument Division and Trion Instruments (AW Apr. 16, p. 34).

- **Defense Systems Group**, Santa Monica, Calif., bringing Siegler's Space Systems Technology Group, Inglewood, Calif., into a new space systems center. Dan Burns, former vice president-marketing of Siegler, will head the group. Its prime function will be to seek out military systems requirements.

- **Communications and Controls Division**, New York, including what was Siegler's Magnetic Amplifiers Division and elements of its Olympic Radio & Television division.

Other divisions of the new company will be Olympic Radio & Television, the former Siegler Division; Bogen Division, formerly Siegler's Bogen-Presto Division; Astronics Division; Service Division, International Division, and Electronic GmbH, all based on former Lear divisions.

A Lear-Siegler Research Laboratories Group has been set up in Santa Monica

to be headed by J. T. Thomas, former Siegler corporate director of research. Lear's Solid-State Physics Laboratory at Santa Monica will report to Thomas.

John G. Brooks, former president of Siegler, will be chairman of the board of Lear-Siegler. Al Handschumacher, Lear's president, will be president of the new organization.

Lear-Siegler is expected to have sales of about \$200 million during the 1962 calendar year. Corporate offices will be located at Santa Monica.

Use of the Lear name first in the new corporate identity is an effort to capitalize on that company's wide acceptance in the aerospace industry and is a recognition that the Siegler name has not been identified as closely as possible with the activities of its individual companies or divisions.



XC-142 Propeller

United Aircraft Corp.'s Hamilton Standard Division, Windsor Locks, Conn., will produce attitude control propeller for the XC-142 tri-service VTOL transport (AW June 11, p. 69). Hamilton Standard has been selected by Hiller Aircraft Corp., one of three major contractors for the aircraft, to develop and manufacture attitude control propeller, located on tail, and the transport's four tilt-wing engine propellers (AW Dec. 11, 1961, p. 67). Propellers will consist of glass fiber blades fitted over steel spars.

Army Weighs STOL Transport Proposals

By Larry Booda

Washington—Five proposals embodying configurations that vary from modifications of existing aircraft to completely new designs have been submitted to the Army in its short-takeoff-and-landing (STOL) tactical transport competition (AW Apr. 30, p. 27).

The proposals include conventional slotted fixed-wing, tilt-wing and all-wing designs. Evaluation of the entries is expected to last at least until Sept. 1.

Originally, the Army had intended to develop a follow-on version of the de Havilland Caribou AC-1 twin-engine STOL aircraft, which it is buying in quantity and is now in operational service. In an attempt to capture this follow-on business, General Electric teamed with de Havilland and arranged to install its T64-4 turboprop engines in an AC-1. This aircraft has been flying for almost a year.

Complaints from contractors and Congress caused the Army to open the competition to other companies. Specifications were mailed to a list of prospective bidders early this year and proposals were received by the Army's Transportation Corps June 6. Proposals were limited to U.S. and Canadian companies. This also applied to engines, although foreign-designed engines produced in the U.S. or Canada were allowed.

The five competitors are: Fairchild Stratos Corp.; a combine of Chance Vought Corp., Ryan Aeronautical Co. and Hiller Aircraft Corp.; de Havilland Aircraft of Canada, Ltd.; McDonnell Aircraft Corp. and Albert E. Blomquist and Associates.

This is the first time in the 20 years since it gained its own aviation that the Army has initiated major procurement action on other than an off-the-shelf aircraft. It had been limited in aircraft buying by various Department of Defense directives and statements of roles and missions.

Last year procurement regulations were relaxed enough to allow purchase of newly developed aircraft components. They have now been relaxed further to include completely new aircraft. To a certain extent this authority depended upon the Army training engineers and other specialized personnel to perform evaluations and then supervise development and production. In the past, the Army had depended on the Air Force or the Navy for procurement.

In this competition, a weight limitation of 5,000 lb. imposed on the Army aircraft is being ignored. A regulation still in effect requires specific exemptions in writing to this rule by the Sec-

retary of Defense. When new roles and missions are written, the limitations will probably be dropped.

The Fairchild entry is built around a modified F-27 transport. The basic F-27, which is in service with feeder airlines and private operators, varies in gross weight from 39,400 lb. to 42,000 lb., according to the model. It is powered by two Rolls-Royce Mk. 528-7E Dart engines.

Fairchild proposes a configuration that would raise the current empennage straight up about 7 ft. 6 in. By clearing the aft end of the fuselage, room is created for clam shell doors. The empennage would be altered to include a movable horizontal stabilizer.

The F-27 fuselage does not meet the size and cross-section requirements of the tactical transport specifications, so a larger diameter fuselage has been designed providing space needed for easy transport of vehicles and cargo.

To meet STOL requirements of about 54 kt. stalling speed with gear and flaps down, a double slotted flap has been included. Fokker, which designed the F-27 originally, has already done a considerable amount of development work on this wing. The work was abandoned last year because no military market could be found.

Fairchild has made provision for use of Canadian-manufactured Dart engines or the General Electric T64.

The Vought-Ryan-Hiller proposal is essentially the tilt-wing vertical-takeoff-and-landing (VTOL) vehicle which is being developed under a tri-service con-

tract. The STOL tactical transport version would not include the vertical take-off capability, but would use a modified setting of the wing for takeoff and landing with short forward run.

As proposed, the tilt-wing design has four T64 engines located along the forward edge of the wing in typical transport fashion. An 8,000 lb. payload would be carried at a cruising speed of 215 kt. With growth versions of the T64 engine, the payload would increase to 12,000 lb.

Design gross weight is 37,424 lb.; length is 58 ft. 1 in.; height is 26 ft. 1 in.; wing span is 67 ft. 6 in.

The tilt-wing VTOL of Vought-Ryan-Hiller has not yet flown. First flight date is more than a year away.

McDonnell has teamed with the French manufacturer Breguet. The entry would be the blown-wing turboprop STOL Breguet 941.

McDonnell has signed an agreement which gives it North American rights for both military and commercial markets. Four other French manufacturers have signed cooperation agreements with North American manufacturers covering the engines, reduction gear, propellers and landing gear.

For the Turmo 2D engines, Turbomeca has arranged a licensing agreement with Continental Motors Corp. For the propellers, Ratier has teamed with Hamilton Standard. Hispano-Suiza has paired with Cleveland Pneumatic Industries, Inc., for the reduction gear and Messier will work with Jarry Hydraulics of Montreal for the landing gear.

McDonnell has changed the Breguet 941 to incorporate American instruments and navigation gear for the competition. However, the aircraft remains essentially the same as the 941 prototype which has flown 170 hr.

The 941 has payload capability from 6,000 lb. to 10,000 lb. Cruising speed is 250 kt. and the range is 500 naut. mi. Takeoff over a 50 ft. obstacle can be made in 1,000 ft.

McDonnell backed its proposal with provisions for alternate engines, specifying the General Electric T58 and the Continental 261-5.

Albert E. Blomquist and Associates of Ringoes, N.J., a management and operations study firm specializing in aeronautical production and facilities, has backed a design created by Vincent J. Burnelli. Burnelli, an aeronautical engineer whose work dates to before World War I, designed an all wing STOL aircraft.

De Havilland has submitted a proposal based on Caribou with the T64 engines and strengthened structure.

MA-8 Duration

Washington—Duration of the next Mercury orbital mission—Mercury Atlas-8—will not be decided for several weeks until after analysis of Lt. Cdr. Scott Carpenter's three-orbit flight is complete and his mission is reviewed, along with that of Lt. Col. John H. Glenn, Jr.

James E. Webb, administrator of the National Aeronautics and Space Administration, told the Senate Aeronautical and Space Sciences Committee last week at NASA's authorization hearings that the odds currently favor a three-orbit flight, although a six-orbit mission has not been ruled out.

Expansion of the Mercury mission to six orbits before the one-day Mercury flights begin next year has been under consideration for several weeks (AW June 4, p. 26). However, Walter C. Williams, associate director of the Manned Spacecraft Center and Project Mercury operations director, emphasized that a decision cannot be made on the next mission until evaluation of Carpenter's flight.

Williams said there are good arguments for flying another three-orbit mission, for flying more than three orbits, and for a one-day mission for Mercury Atlas-8, the next flight.

AF Shifts Generals; Davis to Head BSD

Washington—Maj. Gen. W. Austin Davis, commander of the Air Force Aeronautical Systems Division at Wright-Patterson AFB, Ohio, will leave that position to take command of the Ballistic Systems Division at Inglewood, Calif., on July 1.

He replaces Maj. Gen. Thomas P. Gerrity, who will become deputy chief of staff for systems and logistics. (AW June 4, p. 37).

Gen. Davis will be relieved by Maj. Gen. Robert G. Ruegg, who at present is director of procurement and production for the Air Force Logistics Command.

Maj. Gen. Don O. Ostrander, vice commander of BSD, will become director of the Office of Aerospace Research here on Oct. 1.

Other Air Force general officer shifts announced last week included:

- **Brig. Gen. Richard D. Curtin**, from director, Office of Missile and Satellite Systems, USAF Headquarters, to director of advanced technology, deputy chief of staff for research and technology, USAF Headquarters, July 1.

- **Brig. Gen. Gerald F. Keeling**, from commander, western contract management region to director of procurement, Air Force Systems Command, July 15.

first at Ft. Sill, Okla. and will then move to Ft. Bliss, Tex., for firing of the weapon. Each battalion will have four Pershing mobile erector-launchers assigned to it. They will eventually be integrated into the North Atlantic Treaty Organization forces.

Federal Aviation Agency rule issued last week will require supplemental airlines to fly "new or materially altered" aircraft 100 hr. before introducing them to service. Of this, 50 hr. must be logged on en route operations and 10 hr. must be at night. An almost identical regulation applies to scheduled carriers. New rule was conceived by FAA after the Nov. 9 crash of an Imperial Airlines' Constellation at Richmond, Va.

Static longitudinal stability wind tunnel trials on a 1.75% scale stainless steel Saturn model have been run by Ling-Temco-Vought, Dallas, Tex., in range from Mach 0.5 through Mach 5 with and without the Apollo spacecraft and escape tower fitted to model. Tests were directed by NASA's Marshall Space Flight Center, Huntsville, Ala.

Avco Corp. has purchased a 110,000-sq. ft. facility and 11 acres of land in Lowell, Mass., from Standard Steel Corp. for work by Avco's Research and Advanced Development Division on the Apollo manned spacecraft. First operation in the newly-acquired structure will be the development and fabrication of plastic heat shield material for the Apollo.

Gross weight of the experimental air cushion vehicle built by Ford's Aeronutronic Division was 7,000 lb. when it rose from the ground in a recent tethered test (AW June 4, p. 104).

Astronaut Applications

Washington—Applications have been received from 53 military test pilots and approximately 200 civilians seeking to be included in the next group of astronauts. National Aeronautics and Space Administration will begin screening the applications in a few weeks.

Defense Department already has conducted a preliminary screening to assure that its applicants meet the basic requirements. Applications have also been received from a number of NASA and Federal Aviation Agency civilian test pilots, who were described as highly qualified.

NASA will select 10 astronauts later this year as co-pilots for Gemini spacecraft and crewmen for Apollo vehicles. Qualifications are essentially the same as those for the seven Project Mercury astronauts (AW Apr. 23, p. 25).

Tiros 5 to Provide Tropical Storm Data

Washington—Tiros 5 weather satellite is scheduled to be launched from the Atlantic Missile Range this week to provide meteorological information on tropical storms, which generally reach a peak in late August.

The latest Tiros payload will be basically the same as the last two, and will weigh 285 lb. Heart of the instrumentation will be two videon cameras, one with a medium-angle lens and the other, a wide-angle lens.

Viewing area will be 450-mi. on each side.

Tiros 5 will be launched into an orbit with a 58-deg. inclination, in order to pass over more of the earth's cloud cover. Planned orbital altitude is 400 mi.

Previous satellites in the series were launched on 48-deg. inclinations.

Tiros' trajectory will place the payload over the northern hemisphere for 10 days, and then over the southern hemisphere for 30 days. Launch vehicle will be a Douglas Thor Delta, a vehicle which has been successful in its last eight missions.

Tiros 4, launched Feb. 8, remained active and transmitted useful cloud cover photographs until June 9.

News Digest

Radio Corp. of America, Burlington, Mass., will build three 482-L, air transportable, emergency mission support traffic control systems for Air Force under \$6-million partial funding contract awarded by Electronic Systems Division. Delivery is scheduled for the summer of 1963. Air Force says it needs 14 such systems, each contained in six mobile vans (AW Mar. 5, p. 39).

Skybolt astro-inertial guidance system designed by Northrop Corp.'s Nortronics Division to guide the Douglas Aircraft-built GAM-87-A Skybolt air-to-ground ballistic missile has been demonstrated successfully in preliminary testing in a C-131 aircraft. All elements of the system, including the star tracker, were exercised.

House Ways and Means Committee last week voted to extend renegotiation law without change for two years, to June 30, 1964.

First West German officers have arrived in the U.S. to set up a program to train West German personnel in operation of the Martin/Pershing tactical ballistic missile. They will be trained

FAA Enters Jet Crew Complement Fight

Proposal for extensive third pilot training viewed by engineers as move to enforce Feinsinger report.

By Robert H. Cook

Washington—Federal Aviation Agency has taken a hand in the crew complement dispute by officially recognizing the third pilot position on jet crews and proposing that extensive pilot and flight engineer training be required for this seat on four-man crews.

Expected FAA adoption of new minimum training regulations for all air crewmen, including the third pilot, would support findings of the Feinsinger Commission (AW Oct. 23, p. 55), which recommended three-man crews on all turbojets, pilot training for flight engineers and an eventual merger of the Air Line Pilots Assn. and the Flight Engineers International Assn.

As of late last week, FEIA was continuing to threaten walkouts against Pan American World Airways, Trans World Airlines and Eastern Air Lines, primarily over the crew complement issue.

FEIA feels that the FAA training proposal may be the result of Administrator Najeeb Halaby's threat last year to use "existing legislation" within the agency to settle the crew complement dispute along the lines of the Feinsinger recommendations (AW May 22, p. 36).

Last year FAA prepared regulation changes which would have recognized and established qualifications for the third pilot position on four-man crews, but the proposal was shelved because release of the first Feinsinger report made the proposal "ill timed," an agency spokesman said.

The proposal now under consideration emphasizes that the third pilot position is not required, but that minimum qualifications will be mandatory if the crewmen actively engages in either pilot or flight engineer duties. Flight engineer training demanded for this position by FAA is so extensive that FEIA fears its members may gradually be replaced by third pilots, who are members of the Air Line Pilots Assn.

Meanwhile, ALPA is exploring the possibility of demanding three-man crews on future short-range turbojets such as the BAC 111, Douglas 2086 and Fokker F-28, which, under present regulations, require only two-man crews. Last month the union sent questionnaires to all members asking for documentation of incidents which would point up the need for a third crew member on small jet transports, based on their experience with Viscount, Convair and Martin aircraft.

Airline reaction to the FAA proposal, as expressed by the Air Transport Assn., is a request that the agency not make its recommendations mandatory, but issue them as guidance material permitting a greater flexibility in training programs by the individual carriers.

Merger Questioning

Washington—American Airlines and Eastern Air Lines last week moved to bring Civil Aeronautics Board hearings in the American-Eastern Merger Case to an early end by drastically reducing cross-examination of witnesses (AW June 11, p. 40).

Noting that hearings were in their 23rd day and that only 12 witnesses had been heard, G. A. Spater, general counsel for American, told Examiner Ralph Wiser that intervenors had proposed to call some 40 additional witnesses for testimony. He said that "at the same rate they have managed to proceed in cross-examination, this would mean that we would be here until November."

Spater said American and Eastern planned to cross-examine but two of the 40 witnesses, which could bring the hearings to an end by the middle of this week.

One factor which could prolong the hearings into next week is the possibility that CAB's Bureau of Economic Regulation may conduct extensive cross-examination of merger opponents.

During the hearings last week, James W. Austin, president of Northeast Airlines, testified that the Eastern Air Lines New York-Washington shuttle had hurt Northeast so badly that the airline was cutting its shuttle frequency over the same route from 10 flights daily to 4 flights on July 9 (see story p. 47).

Aside from the increased costs the FAA's proposal could cause, the carriers feel it would hamper their ability to adopt new training techniques and that the establishment of mandatory minimums would strengthen union demands for more "nonproductive"—training—days to create a need for more crewmen.

As an alternative, ATA suggested that a greater reliance be placed on the various proficiency tests given crewmen, along with periodic meetings between the carriers and FAA field representatives to discuss training.

One of the major ATA objections is that the proposed rule would force the carriers to give expensive retraining to qualified air crews once a year. ATA has suggested that crewmen with qualifications on two types of aircraft be permitted to take a proficiency check and flight training in each type at least every 24 months.

Basic FEIA objection is that the minimum training being considered by FAA is not only inadequate for flight engineers, but that the third pilot—still not required by regulation—would be given the same amount of training as the flight engineer. The union claimed that current U.S. airline engineer training is far below that considered necessary for safety by either the U.S. military or foreign flag carriers, which provide two to three times the amount of training for their crewmen.

FEIA notes that although FAA stipulates that the third pilot is not required by regulation, he is considered a crewman under sections of the proposal dealing with ground school and flight training and must be trained in accordance. Part of the flight training would require operation of the flight engineer panel by all crewmen. Likewise, the third pilot would receive simulator training, whereas the flight engineer would not, the union contends.

"This is surely a strange anomaly in which we find the agency evincing more concern over unrequired crew members than over required crew members," the union declared.

The union urged a broad expansion of flight engineers training, with an emphasis on the specialist concept rather than crew training. It noted that it still has members who can cope with a variety of possible inflight emergencies "but they are a vanishing breed under the new training concept."

To correct this situation, FEIA con-

VC.10 Range Problem

British Overseas Airways Corp. is pressing for increased range capability in the Vickers Super VC.10 and is discussing delivery dates with Boeing Co. of long-range 707-420 and 520 versions in case the VC.10 cannot be modified satisfactorily.

Vickers has indicated the added range can be obtained, but 6-9 of BOAC's 30 Super VC.10s on order might be dropped if it is not. BOAC is concerned with matching the westbound non-stop capability of the long-range 707s operated by all its competitors on the Los Angeles to London polar route. The standard and Super VC.10s have satisfactory range for BOAC's other routes.

tends that FAA should set minimum training standards for flight engineers higher than those presently provided by most airlines and more comparable with that of many foreign carriers.

The union has suggested a greater emphasis on studies of the turbojet's electronic system during ground school transition courses totaling 200 hr. The present U.S. airline average is 130 hr., as compared with the 380 hr. of study provided by foreign airlines. The union also wants transition flight training of 20 hr., simulator training of 25 hr. and line check time of 25 hr., along with recurrent training of 40 hr. in ground school, 4 hr. flight training, 10 hr. of simulator time and a 4-hr. line check.

Transition flight training now provided for flight engineers by U.S. airlines averages about 19 hr., as compared to 40 hr. for foreign carriers, which also provide recurrent ground school training of 67 hr., as opposed to only 22 hr. afforded FEIA members.

Aeroflot to Increase Agricultural Work

Moscow—Aeroflot is being called on for greater efforts in agricultural aviation work to help boost the Soviet Union's lagging farm production.

Aeroflot Chief Yevgeny Loginov, interviewed by Pravda, reports Soviet civil aviation already has been ordered to hike its planned volume of agricultural aviation work to almost 168 million acres. Originally, Aeroflot had planned to hit 98.8-million acre mark by the end of the current seven year plan in 1965.

Communist Party plenum on agriculture last March resulted in crop spraying and fertilizing with chemicals by aircraft obtaining "particular importance," Loginov said.

He added that this year alone some 61.7 million acres are to be processed with half of this already accomplished.

FAA Cites Runaway Rudder Boost As Possible Cause of 707 Crash

By David H. Hoffman

Washington—Full left rudder applied suddenly and without warning by an uncontrollable boost system may have caused the crash of a Boeing 707 near New York International Airport last March, according to the Federal Aviation Agency. The Boeing Co. sharply disagreed.

In an alert bulletin telegraphed to all 707 operators last week, FAA said it was a "possibility, repeat possibility" that the left roll executed by the American Airlines jet was caused by sharp left yaw produced by a rudder boost system malfunction.

George C. Prill, director of FAA's Flight Standards Service, stressed that it was Civil Aeronautics Board's responsibility to issue the definitive finding on what made the 707 roll and plunge inverted into Jamaica Bay. But he gave this theory as a possible explanation for the accident, in which 95 persons died:

As the 707 departed Idlewild, gently banking in a climbing left turn, a cotter key that should have secured a bolt in its rudder boost power package may have worked free. For space reasons, the bolt had been installed upside down. Falling free, it may have allowed the boost system to direct 3,000 psi. of pressure against one side of the rudder.

At this point, the jet's fuel load would have shifted toward the low wing, adding inertia to the roll, FAA said. Only by throwing a switch that would have disconnected the hydraulic rudder boost system could the pilot overcome forces of this magnitude. Analysis of the jet's flight recorder indicates that when this switch was thrown the 707 was on its back, entering its fatal dive.

Boeing answered the agency's bulletin with a wire to 707 operators throughout the world in which it said: "No evidence has been established that would support theory that loss of bolt . . . or any other failure in rudder system linkage was associated with subject accident." Boeing added that hard-over rudder in itself "would not induce uncontrollable roll conditions."

These conclusions, the company said, were communicated to FAA and CAB before the agency issued its bulletin.

Meanwhile, it was reliably reported that CAB was pursuing still another theory to explain the accident, one that centered on an electronic failure within the jet's autopilot. If evidence supports this idea, the Board will conclude that hard-over rudder was applied inadvert-

ently by the jet's yaw damper, which is a subsystem of its autopilot.

Very few of the earlier 707s incorporate the type of bolt that may have caused the tragedy, but the American aircraft was one of them. As a safety measure, FAA urged operators of such 707s to secure this type of bolt with safety wire "as soon as practicable."

In a week-long series of flight tests in FAA's Boeing 720, the agency experimented with all other control malfunctions that could have been encountered by the American Airlines' pilots. Its tentative conclusion was that asymmetric forces generated by a runaway stabilizer, loss of both engines on the same side, seizure of the yaw damper, a jammed aileron or a split spoiler condition could have been overcome by the flight crew.

On American 707s, the rudder boost cut-off switch intentionally was placed well aft on the pilot's overhead switch panel to ensure against unintended actuation, FAA engineers said. If all crewmen on the flight deck had their safety belts locked when the incident took place, only the copilot could have disengaged the boost system. The switch was beyond the normal reach of the captain, third pilot and flight engineer, according to FAA.

FAA-Boeing consultations soon will produce an airworthiness directive that will order relocation of this switch to make it more accessible. The agency's present feeling is that the switch should either be moved nearer the captain on the overhead panel or installed in another spot that would enable "easy and sure pilot operation in the event of boost malfunction."

Any guard covering the switch should be shaped so that a pilot can identify it by touch, FAA feels.

In addition, Boeing and FAA now are working on a new design for the control linkage leading to the boost system power package. This would enable control of the boost system even after its primary linkage had been severed, thus preventing the hard-over rudder movement that follows failure of the present installation.

FAA officials were careful to point out that the ultimate truth of the "missing bolt" explanation for the Mar. 1 tragedy can never be proven, for neither the linkage nor the bolt were recovered from the Jamaica Bay mud. However, the complex boost package itself was dredged up and found to be in working order, and the boost cut-off switch was found in the off position.

Third-Level Service Transport Studied

By L. L. Doty

Washington—Local service airline industry last week disclosed plans to launch an immediate study of specification and performance requirements for a short-haul aircraft designed to serve low-density traffic areas which some government and industry officials feel should be served by a third-level class of carrier.

In a letter to Sen. A. S. Mike Monroney (D-Okla.), the Assn. of Local Transport Airlines (ALTA) proposed a basic program that would provide local service airlines with an aircraft employing the boundary layer control principle to permit short take-offs and landings at small airports. The letter was signed by Leslie O. Barnes, president of Allegheny Airlines.

Although the letter admitted that not all members supported the proposal, it did not indicate the extent of the differences of opinion on the subject of a third-level service.

Conflicting Views

At least one carrier member of ALTA is violently opposed to becoming involved in this type of operation and would prefer to see a new group of operators take over service into low traffic-generating areas. Barnes, representing the opposite, majority view feels that local service airlines cannot ignore this type of service and should make an effort to develop a low-cost operation to supplement their schedules in higher-density traffic regions.

Admitting that boundary layer control is a "highly complex and controversial concept," ALTA concluded that it appears to be the only promise of a major break-through in aircraft design and lower operating costs. ALTA said it had no reason to believe that any aircraft designed for short-haul, low-cost operations is being "actively or earnestly planned or developed by any major aircraft manufacturer" (AW May 21, p. 42).

Performance and specification standards for a 15-18 passenger airplane are now being prepared. Continued work on the program will be conducted in close cooperation with the Federal Aviation Agency. The letter gave no further details on specifications, but AVIATION WEEK learned that ALTA is considering a design employing two 1,050-shp. turbine engines that will power aft-mounted propellers. The aircraft would have short take-off and landing capability, climb at about 4,000 ft. per min., operate at speeds up to 400 mph. at a seat mile cost of 2 cents.

ALTA urged that funds be provided to develop a prototype. The association made no specific recommendations as to whether the funds should come from manufacturers, the military, government agencies or a combination of these groups.

Trial Flights

Before the aircraft is produced in volume, one or more of the models should be flown in scheduled service by a local service carrier east of the

Mississippi River, another west of the Mississippi and a third in Alaska, the group said.

ALTA will try to persuade smaller communities to reduce such charges as landing fees, rental costs and service expenses, and labor unions will be asked to restrict demands on such issues as wages and working rules.

The association urged a "realigning" of regulatory provisions and concepts to permit economic and safe operation of the new service. Specifically, ALTA endorses the use of two pilots—air taxi operators are allowed to have a single pilot on some aircraft—but it would like to eliminate the FAA requirement for a cabin attendant. ALTA also wants a modification of air traffic rules to simplify flight procedures in low traffic areas.

FAA Fund Requests Cut by \$100 Million

Washington—Budget Bureau pared more than \$100 million from Federal Aviation Agency's original Fiscal 1963 budget request, including \$12 million of the \$37 million sought for civil supersonic transport development, according to testimony released last week by a House appropriations subcommittee.

Original sum requested was \$913 million—\$810,800,000 was approved. Almost all of the 3,997 new employees the agency asked for in Fiscal 1963 were authorized. But the Budget Bureau ordered FAA to reduce its operations budget by \$33 million, its facilities and equipment budget by \$40 million and its research and development budget by \$15 million.

As sent to Congress, FAA's budget asked authority for 982 new air traffic control positions in U.S. centers and towers. Expansion of radar services in general and increased emphasis on radar handoffs are prime reasons for the expansion.

Questioned closely by Subcommittee Chairman Albert Thomas (D-Tex.), FAA officials confirmed that at least \$51.5 million has been spent to date in attempting to develop a semi-automatic traffic control system. Of this, equipment represents \$20 to \$22 million, they said. The largest single sum within FAA's \$50 million research and development request—\$16 million—is to shape this equipment into a test bed that can be used to evaluate new ATC devices.

Asked by Rep. Thomas if it would not be better to let the military proceed with supersonic transport research, FAA Administrator Halaby replied: "That is

just what we are doing." Earlier in the hearing, Halaby predicted the agency would "learn a great deal" about material fabrication, testing procedures, fuel performance at high speed and lubrication techniques from Air Force development of the RS-70.

Delay Asked In Action On Foreign Carriers

Washington — Civil Aeronautics Board last week urged Congress to await the report of an international air policy study before acting on bills that would empower the Board to regulate rates and schedules of foreign flag carriers flying to the U.S.

Appearing before the House Subcommittee on Transportation and Aeronautics, CAB Chairman Alan S. Boyd refused to recommend specific legislation on the subject until a presidentially-appointed, interdepartmental committee had evaluated existing policy.

Composed of CAB, Federal Aviation Agency, Budget Bureau, and State, Defense and Commerce Department representatives, this committee will issue its report this summer or in early fall, Boyd said. Because it is impossible to isolate portions of international air policy in "little boxes," Boyd said Congress should "tread water" until it can examine the committee's report.

On this point, Air Transport Assn. President Stuart G. Tipton took sharp issue with Boyd. Everything should not come to a halt during studies, Tipton told the subcommittee, arguing that the study probably would not be forthcoming until "the first of next year."

Three bills have been placed before Congress—one by CAB and two by ATA. The Board's bill would enable it to prescribe "reasonable" rates for both U. S. and foreign flag airlines and to suspend tariffs that appear unlawful. The first ATA bill would give CAB power to suspend proposed foreign tariffs but not to prescribe rates. The second would enable it to approve schedules filed by foreign airlines.

ATA has lodged these objections to the bill prepared by the Board:

- CAB does not need to fix, suspend or investigate rates charged by U. S. flag carriers and hence should not be empowered to do so. What the Board needs is the power to suspend "destructive foreign carrier rates."

- Enactment of the CAB bill would be self-defeating in purpose. Many bilaterals negotiated by the U. S. provide that if the Board is given rate-fixing power, a disputed rate would remain in effect during the governmental negotiations that ensued.

- Rate-making is a multi-lateral process and CAB cannot impose its will on foreign governments.

BOAC May Buy CL-44 Aircraft For New Combined British Carrier

New York—British Overseas Airways Corp. is negotiating with Canadair, Ltd., for the purchase of two Canadair CL-44 swing-tail cargo transports which would be operated by BOAC for the new BOAC-Cunard, Ltd. joint venture (AW June 11, p. 41).

The airplanes would be part of a block of 10 built by Canadair, primarily as a company venture, but with the assurance of the Canadian government that up to five would be bought for the Royal Canadian Air Force if none was sold otherwise.

Re-orders from Slick Airways and Seaboard World Airlines account for four more of the aircraft. The Canadian government agreement calls for removal of one aircraft from the government commitment for each one of Canadair's own airplanes sold, so should four remain unsold the Canadian government would be obligated to buy only two of them.

If the BOAC order is completed, it will mark the first sale of the CL-44 to a trunk passenger carrier, and may encourage Canadair to keep the CL-44 production line open. Delivery would be made this fall.

Title and operation of the aircraft would be handled similarly to the 10 Boeing 707s—two from Cunard and eight from BOAC—that will be provided the new company, according to Sir Matthew Slattery, BOAC chairman.

In the case of the 707s, BOAC-Cunard as nominal owner of 10 aircraft will operate none. Sir Matthew, in New York to explain the new venture to BOAC's North American employees, said that BOAC-Cunard will actually be entitled to the equivalent of approximately 10 hr. a day utilization for 10 707s, or a total of 100 hr.

If BOAC-Cunard in practice needs less capacity—only 90 aircraft hours daily, for example—BOAC will absorb the other 10 hr. through lease. On the other hand, if the new company needs more—110 hr. daily, for example—it can lease the additional 10 hr. in 707 time—or in Britannia, DC-7F or possibly CL-44 time.

BOAC will crew, victual, maintain and amortize the aircraft, and charge the new company either by the hour or by round trip—which has not yet been determined—on a cost basis alone. Both indirect and direct costs will be allocated.

Profit derived by BOAC-Cunard from revenues of its joint ticket sale operation will then be divided on the basis of capital contributed—70% for BOAC and 30% for Cunard. Value of the air-

craft contributed to capitalization of BOAC-Cunard is \$61 million and the two partners will put up an additional \$16 million total in cash.

BOAC expects to supply its share from working capital, Sir Matthew said. The cash amount will be equivalent to the accrued depreciation on the eight airplanes BOAC is contributing.

The 10 airplanes will be identified on the books of BOAC-Cunard and written down by the new company. But once handed over to BOAC, they will be utilized as part of the over-all fleet. BOAC-Cunard will be provided aircraft time from the entire pool.

Two major advantages will be derived from the BOAC-Cunard venture, Sir Matthew said.

- North American sales offices of BOAC and Cunard will be consolidated, providing enhanced sales capability and especially substantial savings in capital investment in facilities and in overhead. The latter costs for a medium-sized U.S. city might run \$750,000 annually.

- Flexibility in meeting capacity requirements efficiently can be obtained better by giving the new company access, in effect, to the entire BOAC fleet. Limited to only 10 aircraft, the new company would rank as a small airline, Sir Matthew said, and small airlines face a more difficult problem in tailoring capacity to fleet.

Slattery-Trippe Meeting

Informal talks have taken place in the U. S. between Sir Matthew Slattery, BOAC chairman, and Juan Trippe, president of Pan American World Airways. But, Sir Matthew said, the discussions have not touched on a possible merger of Pan Am and Trans World Airlines (AW May 28, p. 38).

"Pan American are very great friends of ours," Sir Matthew said, "even though we are great rivals. They are one of the great airlines of the world, which like BOAC, do not cheat."

One of the subjects discussed was just that, Sir Matthew said—"How to stop people from cheating."

The same subject—fare cutting and how to strengthen enforcement—also was under discussion at the International Air Transport Assn. Executive Committee meeting at Montreal early this month. Changes in the Breaches Committee by substitution of an impartial, outside judge in place of a commission composed of representatives of three other carriers was one solution proposed there.

CAB Affirms Hawaiian Route Awards

Washington—Civil Aeronautics Board last week lifted its stay on the domestic portion of the Transpacific Route Case, thus affirming its decision to grant U.S. mainland-Hawaii route authorizations to Northwest Airlines, Pan American World Airways, United Air Lines and Western Airlines (AW May 7, p. 37).

These awards will not go into effect immediately, however, as the Board action opens the door for petitions for reconsideration. In its order, the Board canceled the certificates of the four carriers on the Hawaiian route and will issue new certificates after handing down its decision on reconsideration.

It now appears that the Board will make a final determination of petitions for reconsideration on both the international phase of the case—excluding the U.S.-Tahiti portion—and the domestic phase simultaneously. The Board ordered that proceedings on the Tahiti route be expedited.

The Board said it would not reopen the record in the proceeding, but added that, by terminating the stay on the domestic routes, it "will be in a position on reconsideration to examine all facets of the proceeding and to take such action as may be called for by the public interest."

Final decision on reconsideration could be made as early as the end of this month. Oral argument on the U.S.-Tahiti portion has been set for June 27.

The Board said it canceled the certificates of the four carriers on the U.S.-mainland-Hawaii route because of "the numerous changes which have occurred in the basic route authority of the mentioned carriers as a result of decisions handed down in other proceedings in the period since the transpacific decision was issued." The merger of Capital Airlines into United is one such instance requiring a revision of route certificate.



NEW CARGO CHAMP. U. S. Air Force, flying a new Boeing C-135B turboprop cargo-jet, recently established ten new world cargo lift and speed records. These marks, certified by National Aeronautics Association, included lifting 66,000 pounds to altitude of 47,171 feet, and carrying same payload over 1,250-mile

closed course at 615.81 miles an hour. This new Boeing jet logistic transport has a cargo capacity of 82,000 pounds, and can haul 126 troops nonstop over the longest intercontinental routes. C-135Bs are used to fulfill the Military Air Transport Service's primary mission of airlifting missiles, cargo and troops worldwide.

Capability has many faces at Boeing



SPACE VEHICLE control systems are tested at Boeing with this satellite attitude control simulator. Optical sensor system controls attitude through reference to light-source simulating starlight. Other Boeing space research involves propulsion, guidance, space vehicles and systems.

MINUTEMAN, right, is U. S. Air Force's solid-fuel ICBM, which will be stored in underground blast-resistant silos ready for immediate launch. Boeing is Minuteman weapon system integrator.



DASH is U. S. Navy's Drone Anti-Submarine Helicopter, designed to operate by remote control from a destroyer. Shown here on unmanned test flight, DASH, designed and built by Gyrodyne Company of America, is powered by a 270-hp Boeing T50 gas turbine engine. Boeing gas turbines, designed for reliability and easy maintenance, are used in land, sea and air applications.

BOEING

Boyd Proposes General Marketing Study

New York—Airline study on an industry-wide basis of the marketing of air transportation—not just the sale of tickets—was suggested last week by Alan S. Boyd, chairman of the Civil Aeronautics Board.

"I believe the airlines could cover broader areas and get more for their money," he said, "if they would ante-up for an industry pot to study this subject on a planned outline. As it is now, I get the impression that each individual company delves into questions that tickle its fancy. This is good, but whether it is efficient, I am not prepared to say."

Boyd told a regional meeting of the Society of American Travel Writers here that industry effort to tap new markets is a sensible approach to fill empty seats, and no conclusions of the practicability of such an approach could be assumed before it is tried.

In this connection, Boyd singled out the Eastern Air Lines New York-Washington-Boston shuttle as the foremost experiment of this kind in recent years.

"I'm not in the business of passing out garlands to individual airlines," Boyd said, "but it took a lot of guts to put up the money to try out the shuttle idea. I—as a passenger—think it's the greatest thing ever."

Shuttle Round Trip

Boyd had flown to New York on the 10 o'clock shuttle on the morning of his speech, and the meeting was being timed for him to make the 3 o'clock shuttle back to Washington. He hoped to arrive in time to sign the CAB order in the Hughes Tool-Northeast case.

Air transportation has matured, Boyd said, and is a mode of mass transportation. As a corollary, he asserted that the welfare of the carriers rests in a low profit margin on a large volume business. Thus, the Board favors any type of fare that will provide substantial increases in airline passengers, Boyd said, and fares that will encourage travel to the U. S.

Boyd indicated this general philosophy did not apply to all fares necessarily. He was cool to the group fare, noting that the Board approved it though not regarding it as the alpha-and-omega answer to the promotional fares question, that it is an experiment and no more as yet. Its value, he said, is in showing that the North Atlantic carriers do see the wisdom of going to some sort of excursion fare for the future.

"Before someone asks the question," Boyd added, "we don't know what a spontaneous group is."

Neither did Boyd encourage the

idea of a fares laboratory, as proposed by United Air Lines President W. A. Patterson. This plan involved government funding, Boyd said, and some sort of government control would necessarily follow.

"The Board has a great deal of respect for Mr. Patterson," Boyd said. "We think he's one of the great men of aviation. He is a conservative operator of an airline, and the last thing he wants is the Board telling him how to run his business. We have no objection, though, to him telling us how to run ours because that's part of the game."

"I don't think for a minute even if we had the money—and we don't—that we would let United Air Lines or anyone else spend our money. It's an intriguing idea, but not realistic."

Boyd conceded that the subject of airline marketing would yield to no simple answers, that it is even difficult to know precisely what has been done since many reports in this area are held in confidential company files.

"Talking about airline marketing plans and objectives," he said, "is something like trying to identify a strand of spaghetti in an Italian restaurant. Where do you start?"

Boyd emphasized the interdependence of fare reductions, airline earnings and the reduction of costs and excess capacity through mergers, noting that:

- **Fares cannot be cut** as long as airline earnings are weak.
- **Poor earnings** mean poor market performance by airline stocks and resultant difficulty in attracting equity capital.
- **Mergers, though no panacea**, are one possible solution to immediate airline financial problems, if private investment cannot supply capital.
- **Increased earnings** in the foreseeable future that would make fare reductions possible—if they are possible at all—are most likely to result from favorable exchanges of routes among airlines and consolidation of facilities, equipment and personnel—whether by merger or some other means.

Mergers are unlikely to alter today's air route pattern, he said. In some areas or in the long run they may bring better service or lower fares. But between pairs of large cities, mergers cannot be expected to bring increased service, since too much capacity already is being offered, and may well mean less service unless the number of passengers increases sharply.

Asked about specific mergers, Boyd noted the presence of both C. R. Smith, president of American Airlines, and Malcolm A. MacIntyre, president of Eastern Air Lines. "But," he said,

"I'm in no position to perform the marriage ceremony here."

Referring to the United-Capital merger a year ago, he said that United suffered a rather severe case of indigestion as a result, though the problem now appears to be straightening out.

"From the Board's point of view," he said, "It's been very successful. Among other reasons, it has meant the maintenance of service on Capital routes and the substitution of better equipment on them."

Boyd said the real revision of basic route patterns will come with the advent of the supersonic transport. He estimated the U. S. would have such an airplane by 1972 or 1973, but that this country would be third in the field, probably following Russia and an English-French combination.

"The concept of our government," he said, "is that there must be some hope of such a transport operating economically. The Russians historically have been first with the worst. I hope they continue this program."

Eastern Air-Shuttle Profit Rise Continues

Eastern Air Lines last week said that its Washington-New York-Boston Air-Shuttle operation earned a net profit of \$700,000 in the first quarter of 1962 and profit for its first 12 months of operation totaled \$564,000.

The carrier said the Air-Shuttle yield per passenger mile was 6.34 cents in the first quarter of 1962, compared with the system yield per passenger mile of 6.1 cents. Load factors are "constantly above 50%," the airline reported (AW Apr. 9, p. 39), and averaged 53% in the first quarter compared with a system average of 53%.

The 95-passenger Lockheed 1049G Constellations used on the Air-Shuttle are fully depreciated and any depreciation assigned to the shuttle service represents such modifications as weather radar and distance measuring equipment, the airline said. Basic airframes of the DC-7Bs used nonstop between Boston and Washington are not fully depreciated, the company added.

Eastern reported that elimination of such expense items as reservations procedures, ticketing of passengers and in-flight food and beverage services enabled the carrier to attain a favorable ratio of the number of passengers to employees. It added that during the first three months of the year, the Air-Shuttle handled 60% of the airline passenger traffic moving in the Washington-New York-Boston market.

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Investigation of ATC Center Shift Sought

Washington—Federal Aviation Agency's plan to consolidate air traffic control centers in Texas and Louisiana has been attacked as an "uneconomical, unnecessary and harmful" maneuver by Rep. Henry Gonzalez (D.-Tex.), who is seeking a General Accounting Office investigation.

Gonzalez' charges, as well as others leveled at FAA contracting procedures in recent months, will be examined by the Senate when it passes on the agency's Fiscal 1963 budget this summer. Earlier, the Senate indicated it would demand thorough technical justification before endorsing the agency's next major research and development effort (AW Mar. 19, p. 40), which is to follow recommendations of the Project Beacon report on air traffic control.

Immediately at issue is the wisdom and legality of FAA's reallocating almost \$8-million worth of unappropriated Fiscal 1963 funds to build a new Air Route Traffic Control Center (ARTCC) in Houston. Concurrently, the agency would close down existing centers in San Antonio and New Orleans for reasons of "operational safety and economy."

Neither move was mentioned when FAA officials testified before the House Independent Offices Subcommittee on the agency's Fiscal 1963 budget.

San Antonio lies within Gonzalez's constituency. Houston, site of the new center, is the home district of Rep. Albert Thomas (D.-Tex.) who is also chairman of the independent offices subcommittee. However, according to Gonzalez, FAA's ARTCC reorganization involves far more than the obvious—"a simple contest between two congressional constituencies."

The \$7,734,200 FAA would divert once was earmarked for 27 Terminal VORs—very high frequency navigation stations built on airport land—97 single-channel VHF transmitters in agency Flight Service Stations and other ATC improvements, Gonzalez charged. His remarks were included in a 13-page statement heard by Thomas' subcommittee last week.

FAA's first explanation of how it would save \$700,000 annually by the consolidation "was not adequate," Gonzalez said. How, he asked, could such a saving be realized after FAA had just finished a \$2-million building for a new center in New Orleans, after it had paid \$810,000 in rent for unused facilities, after it had built another new center in Houston and paid moving expenses for 545 families?

Gonzalez then lodged an objection to the move in the form of a letter to FAA Administrator N. E. Halaby.

Halaby replied that the consolidation had been "irretrievably initiated," Gonzalez said, and the center would be closed on Sept. 1, 1964. In this exchange, Gonzalez said, Halaby dropped his estimate of the annual saving to be realized by the move from \$700,000 to \$400,000.

But Gonzalez disputed even this estimate, for, he said, it was based on the installation of a single ATC computer of an unknown type at Houston as opposed to two at New Orleans and San Antonio. "Take out the \$5,154,000 saving on the cost of one computer . . . and the figures on savings collapse," he said.

Gonzalez accused the agency of "past mismanagement" in attempting

to develop a specialized type of computer for use in a semi-automatic ATC system, and said FAA had already spent more than \$50 million in this area (AW May 14, p. 38). A workable model has not yet been perfected, Gonzalez said.

Without "definite assurance" that a computer would be programed at Houston by 1970, Gonzalez said, "no one here or in the agency can show savings in the Houston move in the next 16 years."

Questions based on these allegations were forwarded to the comptroller general by Gonzalez. Before the subcommittee agreed to FAA's request, it should await GAO's report, Gonzalez said.

Houston Plans 'Supersonic' Airport

By Erwin J. Bulban

Houston, Tex.—Start on construction of a new intercontinental airport, designed to handle supersonic transports, has been made by Houston city officials with approval of plans and specifications for an initial runway. Bids are being sought with a return date of June 27.

Houston's intercontinental airport, which will supplant current Houston International Airport in the mid-1960s, embraces a program which is expected to cost more than \$100 million by 1970 and marks a determination by that city to establish itself as the dominant air traffic center in the southwest region in both domestic and international operations.

Intercontinental airport will be located on a 6,000-acre site 15 mi. north of downtown Houston and approximately 30 mi. from the present International Airport. A major consideration in its location has been to provide the new facility with clear air space in order to ease air traffic management problems. A problem in the current airport is the fact that there are about 13 privately operated airports and a military air base within a 25-mi. radius, with the military base only five miles from the field. This necessitates coordination of landings and takeoffs from both airports. Approximately 650 landings and takeoffs currently are recorded daily at Houston International and the field is served by 10 airlines. Among these, KLM and Air France provide direct service to Europe and beginning July 1, Braniff and Pan American will provide through-plane service to London and Frankfurt via Dallas and Chicago.

Initial construction embraces a secondary runway of 8,000 ft. which probably will be completed in two years. The city is asking bids on concrete thicknesses of 12 in. and 14 in., although FAA criteria for this class field considers thickness of 10 in. and 12 in. The major runway system of the airport will embrace two additional parallel 12,000-ft. runways, each having parallel dual taxiways with high-speed turnoffs, capable of handling wheel speed of 60 mph. Plan is to have no intersecting runways or taxiways. Primary runways will be staggered, so that the landing runway is positioned farther north than the takeoff runway. This layout, with the terminal building between the primary runways, will place departing aircraft in takeoff position with minimum taxiing. On landing, the transports will have to taxi a minimum distance after braking to reach the terminal.

The city currently is writing specifications for the initial primary runway, which will be built to 9,400-ft. length with provision for extension to 12,000 ft. later. Construction on this runway is expected to start in mid-1963. Ramp area around the terminal building is programed for construction in mid-1964 and the city expects that it will begin operations at the new intercontinental airport in late 1965 or early 1966. Construction through this period is estimated at \$55 million—including \$15 million in federal funds.

Gate positions, radiating from the circular terminal buildings, will handle 40 aircraft initially with an ultimate capacity of more than 90 planes. Gates are planned so maximum distance from the terminal center to the most distant gate position will be 1,000 ft.

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Airlines Weigh Value of Radiotelephones

By Ward Wright

Washington—Widespread trunkline acceptance of Bell System's air-ground radiotelephone network for passengers may await a considerable increase in available communications channels and a brightening of the airline financial picture.

With few exceptions, trunklines communications men, who have been watching the progress of Bell's air-ground radiotelephone system from its beginning (AW Jan. 27, 1958, p. 90), have indicated they will take a hard look at the sales value of the system before committing their airlines to any equipment programs. Only American Airlines has scheduled an early test of the system.

Bell's air-ground radiotelephone network, when completed in 1965, will consist of 72 ground stations throughout the U. S. that will allow a passenger flying anywhere in the country to make and receive calls from almost anywhere in the world. Calls could even be made to passengers flying in other properly equipped aircraft.

The trunklines' cool attitude toward the system stems mainly from unanswered questions concerning the adequacy of present and proposed air-ground radiotelephone service, its sales value and its cost.

Experience Limited

During the experimental phase beginning in 1957, only three airlines—Northwest, Capital and United—participated in the tests. Of these three airlines, only two are now operating, and only one of these had any actual passenger experience with the air-ground system.

Northwest had air-ground passenger radiotelephones installed in four of its Boeing 377 Stratocruisers which were later removed before the aircraft were sold. United's only radiotelephone was installed in President W. A. Patterson's personal aircraft. At present, no air-ground radiotelephones are in service on any trunkline.

The main question trunkline communications officials have about the system is how much real service passengers will get from the six channels Bell and Federal Communications Commission are currently proposing for air-ground radiotelephone use.

All airline communications officers questioned by AVIATION WEEK conceded that there could be situations in which the air-ground radiotelephone would be of inestimable value to passengers. However, most noted that when these situations arise the limited number of channels available would almost nullify the system's utility.

For example, they say, when an aircraft loaded with passengers is unable to land at its destination due to weather or operational difficulties and is diverted to another airport, it would be most useful for passengers to be able to notify homes and offices of the change. However, under proposed channel availability, cities such as New York, Chicago and Washington initially will have only one channel each—enough for one call at a time.

More Stations

Aircraft operating at altitudes of 20,000 ft. and higher may be able to use as many as four ground stations, Bell engineers believe. But even this added capacity would be quickly absorbed if more than one transport had to be diverted.

Such situations might be eased by having stewardesses make lists of names and messages and calling them in to airline ground personnel, who could relay them with unlimited telephone facilities.

Another possible solution is channel splitting. The present proposal before FCC calls for six pairs of channels with 50 kc. spacing. Each channel would be composed of a pair of frequencies, one for the ground station and the other for the airborne unit.

Channel splitting would give 12 channels with 25 kc. channel spacing. FCC offers this plan as a possible solution should additional radio spectrum not be made available for air-ground radiotelephone use. Ultimately, public demand will determine whether more spectrum is set aside for such use.

Channel Scarcity Cited

Airline communications men feel 12-channel equipment with 25 kc. spacing is beyond the state of the art for practical airline use at this time. A spokesman for Aeronautical Radio Inc. (Arinc), an airline-owned organization which operates their ground radio facilities and is coordinating informal talks between Bell and the airlines on the air-ground radiotelephone, said he felt "40

to 60 channels would be needed to do a good job."

Another factor being weighed by airline sales and communications personnel is the radiotelephone's value as a sales tool.

There are two schools of thought on this. One holds that air-ground telephone is a valuable passenger service that will build good public relations. The other maintains that due to the limited number of channels, the frustration from being unable to place calls may have the opposite effect.

A communications official for National Airlines expressed optimism for the air-ground system. He felt the traveling public will want it and indicated National may adopt it when Bell's ground facilities are expanded to encompass a greater part of National's route structure. United Air Lines also expressed cautious interest in the system.

A communications official for Northwest, the only existing airline having passenger experience with the radiotelephone, said that when the first instruments were installed in 1957, initial passenger use was heavy.

In time, after the novelty wore off, radiotelephone use settled down to a small number of business people. If this is to be the pattern of future operations, he said, he doubted whether the installation would justify the expense. He said he would not try to sell Northwest management on any air-ground radiotelephone equipment at this time.

Shuttle Application

An Eastern Air Lines communications executive said his airline was evaluating the system from a "look-see" standpoint. Personally, he said, he felt it was "highly questionable whether six channels would do the job." An Eastern sales official said the airline was evaluating the radiotelephone from the angle of its usefulness in air shuttle operations, though for other operations he felt it "wouldn't bring in a dime."

A communications chief for a trunkline operating in the Northeast U. S. described the system as a "gizmo" as far as trunkline use is concerned, but admitted the service was valuable for business aircraft. He felt the radiotelephone system should await further development of communications satellites, which could provide sufficient channels, rather than employ Bell's present ground station concept.

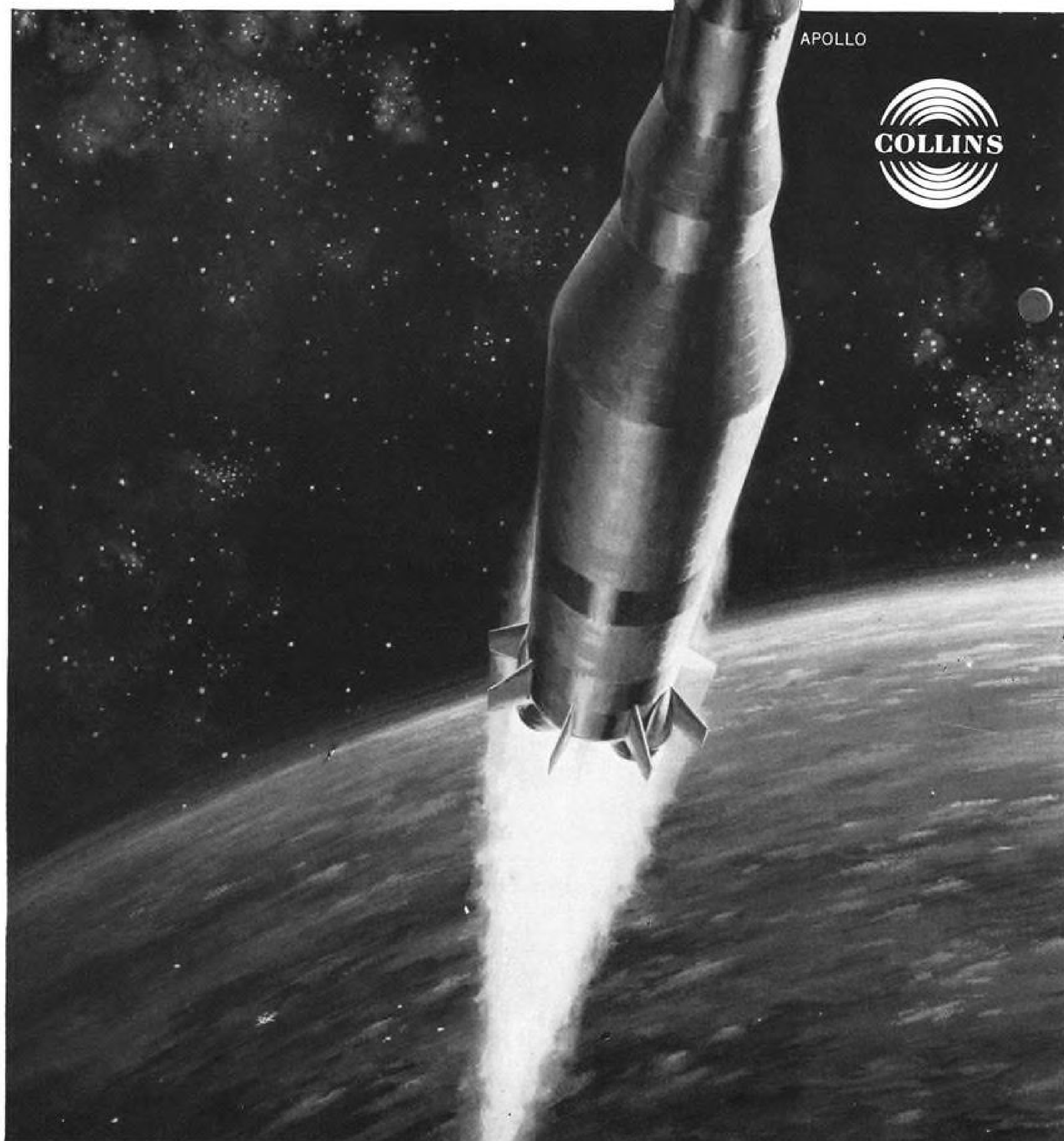
A third question in the minds of airline communications officials is cost. At least three trunkline communications officers felt that with the airline financial picture what it is today, this is a poor time to begin planning equipment

Anti-Collision Conference

Washington—Federal Aviation Agency has scheduled an industry conference here July 12-13 for discussion on the potentialities of airborne collision prevention devices in air traffic management. The conference, to be held at the Mayflower Hotel, will be open to representatives of industry and to airspace users. Progress to date in evaluating several experimental systems and techniques will be reported.

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purchases for a system with such little proven benefit.

The only currently manufactured radiotelephone for airline use is General Motors' Deleo Radio unit which is expected to sell in the neighborhood of \$3,500 when it is marketed. Development of the unit was recently transferred from GM's AC Spark Plug Division. Installation costs for the 25 by 5 by 9 in., 30.7 lb. unit are not known at present. A Trans World Airlines communications officer said he thought \$7,000-\$8,000 was a realistic total price for equipment and installation. He added that TWA had no "firm plans" for installations now. Northwest said it cost about \$1,000 to install the units in its Stratocruisers.

Under the present Bell proposal, the airlines would have to buy, install and maintain their own equipment.

An American Airlines communications officer said he believed the airlines would ultimately have to share in the revenue from the calls to offset the cost.

Bell's proposal now before the FCC for rule making calls for six pairs of FM channels in the 450-mc. mobile band.

In addition to six frequencies, a common signaling channel on a frequency of 454.99 mc. with a ± 5 kc. deviation would be provided. This channel would allow air and ground stations to notify each other electronically when calls were coming in.

Ground stations will be placed about 200 mi. apart. Transmission areas of adjacent ground stations will have some overlap and will be assigned different channels to prevent aircraft flying in nearby zones from mixing signals. The nearest co-channel stations would have 500 mi. spacing. The system gives its maximum range to aircraft flying above 5,000 ft.

Each ground station would transmit a "dial tone" on its own channel. A passenger wishing to make a call would select channels until he found one with the clearest dial tone, indicating he had found the correct channel of the nearest ground station. The ground station would then be alerted over the common signaling channel and the call placed. Airborne calls would be collect or billed by credit card.

In a ground-to-air call, the caller would have to give the operator some guidance such as airline name, flight number, approximate location of the aircraft, destination and times of departure and arrival. Once the aircraft's approximate location had been determined the operator would route the call to the ground station nearest the aircraft.

The operator would then signal the aircraft over the common signaling channel by dialing the aircraft's identification number, followed by an addi-



Douglas Tests Mach 3 Transport Model

Douglas Aircraft Co. engineers prepare a 1/60-scale model of a Mach 3 (2,000 mph.) jet transport for one of a series of wind tunnel tests at the company's Aerophysics Laboratory. Douglas recently received seven contracts from the Federal Aviation Agency to study materials, aerodynamic and structural phases of supersonic transport design (AW May 28, p. 28). Under the contracts, Douglas is teamed with McDonnell Aircraft Corp. The work is part of FAA's studies to determine whether the U. S. should subsidize development of a civil supersonic transport. Douglas and McDonnell will contribute \$890,000 each in the cost-sharing arrangement with FAA, which is funding the contracts for \$956,000.

tional digit identifying the ground station talking channel. The proper talking channel would then be selected or indicated for the passenger who then may take the call.

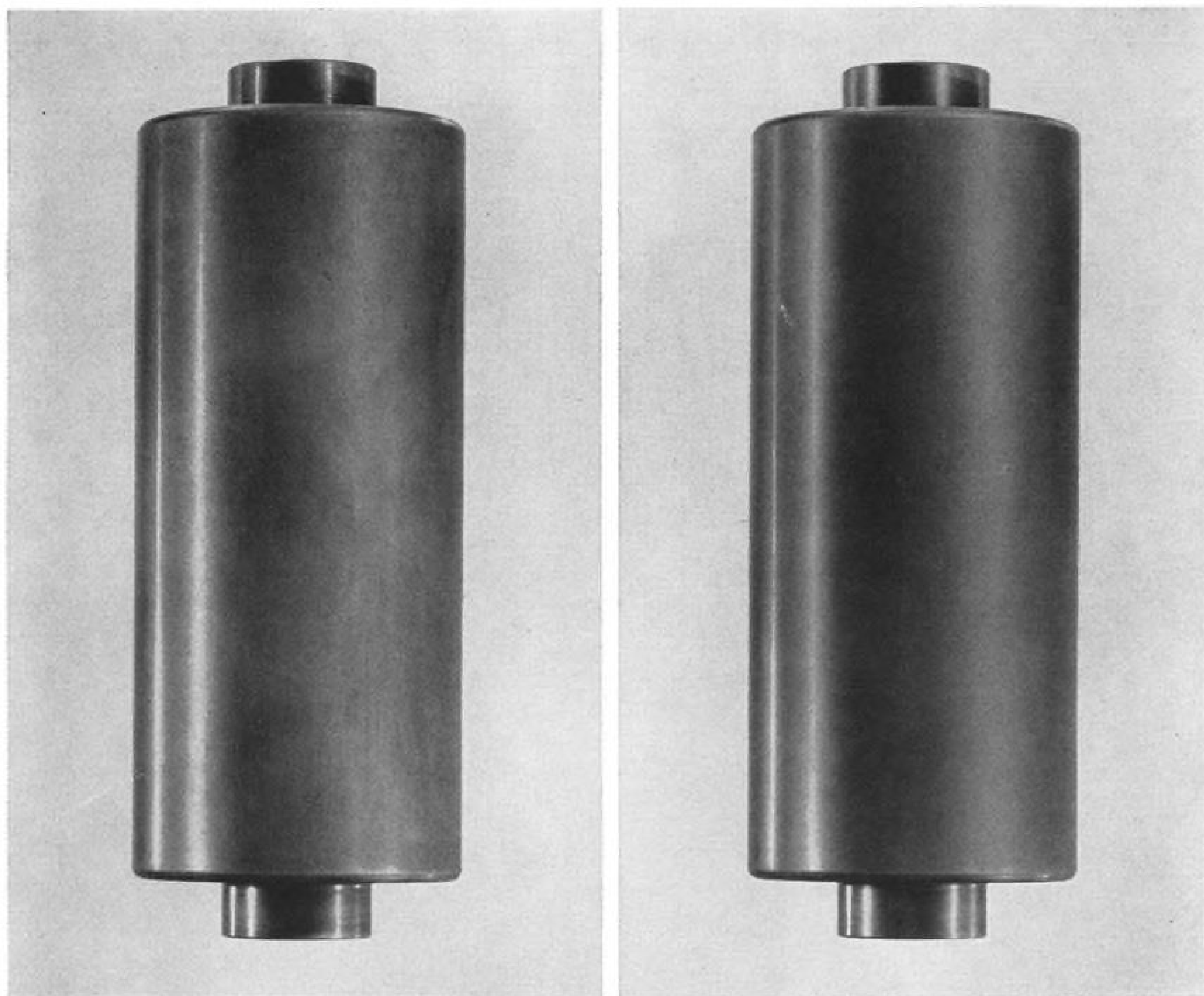
A passenger receiving a fading signal as his aircraft leaves the range of the ground station would jiggle the hook to signal the operator. The operator would then reroute the call overland to the adjacent ground station. The passenger would then be instructed to the new channel.

Although still in the developmental stage, the Bell air-ground system has presently operating five stations positioned strategically among the most heavily-traveled air routes in the north-eastern U. S. Early last month FCC

authorized five new developmental stations to be located near Elmira, N. Y., Beckley, W. Va., Dayton, Ohio, Vincennes, Ind., and Boston.

After June 30, Bell's six-channel system will be ready for operation as proposed, barring any last minute changes by FCC. The new stations, coupled with the five now operating, will give Bell complete coverage of the quadrant of the country north of Virginia and east of the Mississippi.

After this expansion phase, Bell says the next step is to extend coverage to a strip between San Diego and San Francisco. From there, Bell says it will expand its ground station facilities into the Southeast to link Florida and north-eastern air routes.



Which linkpin would you choose?

Each of these look-alike linkpins was sold as a replacement part for Pratt & Whitney Aircraft's famed R-2800 Engine.

The linkpin on the left is a "bargain price" engine part. The linkpin on the right is a Pratt & Whitney Aircraft *original equipment part*. Although the bargain linkpin resembles the genuine part, it is made of metal that is too soft for this application. Cracks which begin in minute defects beneath its plated surface could result in failure, causing major engine damage.

The genuine Pratt & Whitney Aircraft part is carefully engineered to endure flex loads as severe as 15 tons 20 times every second. Material used in

the genuine linkpin meets specifications precisely. So do all of the more than 50 operations required in its production. These processes provide the long-term reliability which is the key to genuine economy in piston engine parts.

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SHORTLINES

► **Boeing Co.'s** jet aircraft in scheduled service have carried 25.5 million passengers and flown more than 600 million miles. The company says it has delivered 290 commercial jet aircraft, now operating with 26 airlines.

► **Delta Air Lines** has asked for temporary authority to serve Huntsville, Ala. on its southern transcontinental route to Los Angeles via Dallas-Ft. Worth, pending Civil Aeronautics Board action on its request for permanent authority. Delta said the stop would link Marshall Space Flight Center in Huntsville with other missile test and launching facilities in Texas and the West Coast.

► **Eastern Air Lines** has opened a 300-car parking lot at Logan International Airport in Boston with a free bus shuttle linking the lot with the Eastern terminal. Parking lot prices will be equal to those of other airport parking facilities.

► **Flying Tiger Lines** freight traffic for May in the New York-Newark, Los Angeles and San Francisco markets rose 37% over the April total. The carrier attributes the increase to introduction of Canadair CL-44 air freighters in these areas last month.

► **Icelandic Airlines** this month took over ramp services, dispatching, and maintenance at Iceland's Keflavik Airport. The services were formerly performed by the Icelandic government.

► **International Flight Information Manual** listing entry, passport, visa and public health requirements, airports of entry, and regulations and restrictions for 130 foreign countries and islands is available from the Superintendent of Documents, Government Printing Office, Wash. 25, D. C. for \$1.

► **KLM Royal Dutch Airlines** will begin service on July 9 between Amsterdam and Dubrovnik, Yugoslavia, a tourist center on the Adriatic Sea. Flights using Convair 340 equipment will leave Amsterdam every other Monday and travel via Munich to Dubrovnik.

► **Pan American World Airways** has begun jet service between Miami and St. Croix, Virgin Islands with two round trips weekly. Flight is under 3 hr., with a 45-min. stop in San Juan.

► **West Coast Airlines** flew 33,863 passengers in May, 1962—10.3% more than May, 1961. During the same month, revenue passenger miles increased 10.9% over May, 1961.

AIRLINE OBSERVER

► New four-engine Soviet transport with two powerplants mounted in single pods on either side of rear fuselage (AVW Mar. 19, p. 42) is under development by Ilyushin design group. Planned designation is Il-62. It is expected to be operational by 1964 or 1965.

► Despite a disappointing volume of Memorial Day travel, domestic trunkline traffic climbed 11.7% during May and local service revenue passenger miles rose 17.3% over the same period last year. Trunkline load factor, however, dropped to 51.3%. First-class revenue passenger miles fell 10% in May, while coach traffic climbed 30.2%. Available seat miles for the trunk carriers in both categories climbed 19%, while local service available seat miles rose 14.9%. Local service load factor for the period was 41.7%.

► Northwest Airlines has purchased three Boeing 707-320B transports powered by Pratt & Whitney JT3D-3 turbofan engines for delivery in June and July, 1963. At the same time, the carrier ordered two additional Boeing 720B turbofan medium-range transports to bring its fleet of this model to 11. Purchase will be financed through modification of prior credit agreements and from such company cash resources as depreciation reserves.

► Egypt's United Arab Airlines owes substantial sums for interline travel to other airlines serving Egypt. Problem is regarded as political rather than economic because the Egyptian government will not permit the airline to join International Air Transport Assn. clearing house, which handles interline payments. At least one airline, British Overseas Airways, is planning to terminate interline arrangements with the Egyptian carrier.

► Department of Commerce survey of Central and Caribbean areas finds market potential for used and new aircraft in these sections is limited, although the U.S. will continue to be the principal supplier for any aircraft sold. Of all countries in these areas, Mexico offers best market potential, but the survey warns that future exports will face increasing competition from the small but growing Mexican aircraft industry.

► United Air Lines has authorized use of such portable electronic equipment as standard radios, recorders and dictating machines by passengers in flight. Operation of FM radio receivers is still banned and pilots may request passengers to refrain from using other electronic equipment when instrument flying conditions prevail.

► Aeroflot has added an innovation to its Mi-4 helicopter shuttle service between downtown Moscow and Vnukovo and Sheremetyevo airports. Flight steward now serves as the conductor, collecting 1 ruble 50 kopeks—about \$1.66—from each passenger. Regular airport-city helicopter schedules were suspended during the winter.

► Continental Air Lines will inaugurate free limousine service to passengers connecting with Continental from other carriers at Chicago's O'Hare Field and Los Angeles International Airport. The long distance between airline locations at the Chicago airport is emphasized by the fact that travel time between flights will be cut to 10 min. by use of the limousine service.

► Eastern Air Lines has closed 16 city ticket offices throughout its system at locations where operating costs were unreasonably higher than gross ticket sales.

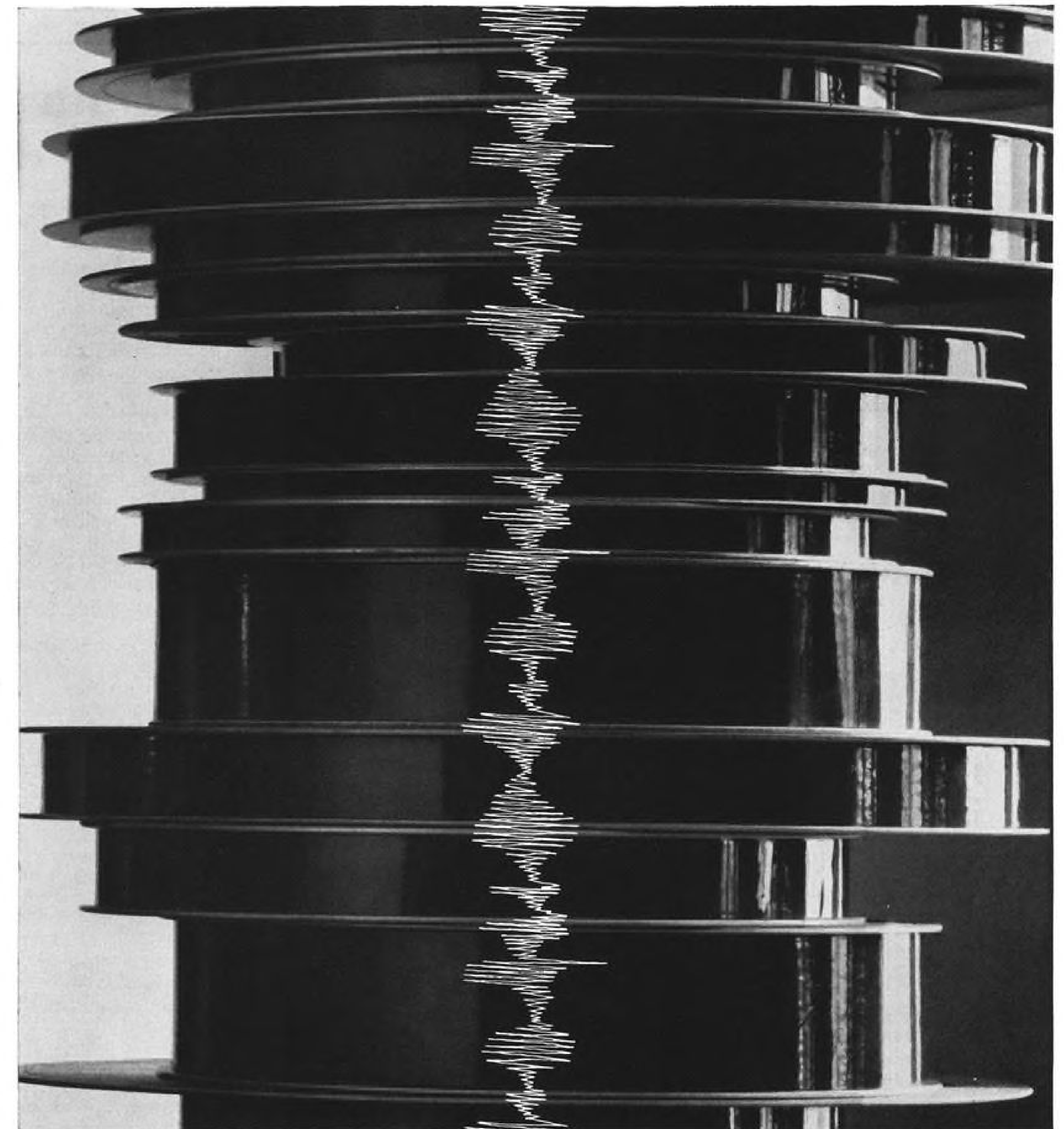
► Pakistan International Airlines, which entered the transatlantic market a year ago, is planning its next route expansion eastward to Tokyo and Bangkok. The extension probably will not be introduced for a year or two, but bilateral agreements already have been negotiated. Meanwhile, the airline is studying the Boeing 727 and the BAC 111 as a replacement for Viscounts now in domestic service. The 727 is favored over the de Havilland Trident but there still is some question as to whether the Boeing plane may be too large for the carrier's requirements.

► Association of Local Transport Airlines has named its group to meet with a Civil Aeronautics Board committee to work out a plan to reduce subsidy. No date for the meeting has been set.

Airline Traffic—March, 1962

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U.S. Mail Ton-Miles	Express Ton Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-All Revenue Load Factor %
DOMESTIC TRUNKS								
American	648,700	492,051	54.3	2,861,510	1,253,538	12,829,583	64,055,914	51.0
Braniff	203,912	95,664	54.5	550,150	198,295	1,211,106	11,122,048	45.4
Continental	114,501	72,263	43.9	350,111	111,287	778,351	8,171,098	37.4
Delta	348,504	230,519	61.5	881,739	392,458	2,176,108	25,606,602	52.1
Eastern	805,593	456,746	53.7	1,591,207	647,651	3,170,796	49,415,133	43.5
National	173,601	125,961	51.3	444,034	87,979	1,551,218	14,250,300	41.8
Northeast	134,038	72,489	53.6	167,970	63,102	323,657	7,505,720	44.7
Northwest	158,206	105,611	46.6	757,796	288,070	1,617,019	12,792,234	40.5
Trans World	383,102	336,137	49.9	1,803,569	851,406	5,235,785	40,112,082	42.6
United	917,568	598,336	50.4	4,396,658	1,351,453	10,457,084	73,549,545	46.5
Western	153,614	87,762	50.5	333,930	107,102	426,681	9,270,953	41.1
INTERNATIONAL								
American	10,529	11,995	69.2	6,480	523	207,231	1,496,149	69.8
Braniff	9,135	12,268	48.1	66,019	---	224,975	1,572,236	44.4
Caribbean Atlantic	49,501	3,505	65.2	2,697	---	18,784	350,815	61.9
Delta	911	1,240	30.8	1,079	---	17,427	150,815	30.0
Eastern	43,132	61,656	59.3	149,084	3,096	431,574	6,533,278	54.7
Mackey	13,474	2,353	45.5	---	276	8,057	239,584	38.6
Northwest	19,485	37,241	50.8	1,935,214	2,812	915,061	6,773,901	55.2
Pan American								
Alaska	3,936	3,593	26.4	49,648	3,913	204,618	631,539	33.3
Atlantic	134,315	166,887	49.3	3,210,422	---	7,892,193	28,402,010	51.3
Latin America	118,100	154,451	61.9	653,361	4,852	4,767,150	21,428,807	63.6
Pacific	43,463	176,037	65.1	4,087,994	16,958	5,210,251	27,393,370	65.0
Panagra	12,685	23,406	73.3	106,114	---	735,698	3,336,084	66.6
South Pacific	124	345	23.5	1,511	---	729	30,574	21.6
Trans Caribbean	9,077	14,186	62.8	---	3,671	210,831	1,419,918	60.9
Trans World	23,817	75,619	52.3	2,403,020	---	2,947,510	13,167,687	59.5
United	16,253	40,444	61.8	390,680	12,291	327,475	4,857,779	56.6
Western	6,092	9,396	66.1	9,617	---	31,603	1,008,498	56.6
LOCAL SERVICE								
Allegheny	69,853	14,827	38.3	33,222	42,618	91,739	1,579,942	41.6
Bonanza	33,411	8,560	55.8	7,734	3,333	15,949	848,688	56.8
Central	28,359	5,881	38.1	19,966	10,461	30,063	623,371	36.5
Frontier	28,641	7,817	34.5	23,094	11,730	60,339	844,337	36.8
Lake Central	35,979	5,739	38.4	11,495	26,090	21,635	607,630	39.9
Mohawk								
North Central	82,781	14,546	39.3	46,657	49,322	68,475	1,564,297	40.9
Ozark	52,106	9,362	44.9	21,816	30,621	37,750	982,538	48.9
Pacific	37,602	8,704	47.7	18,012	4,743	11,803	868,563	48.4
Piedmont	44,935	9,355	41.1	16,728	18,631	30,531	960,964	42.7
Southern	37,066	6,716	32.3	25,613	17,893	27,138	713,818	35.1
Trans-Texas	30,308	7,184	34.0	21,912	13,103	38,566	761,411	34.4
West Coast	32,026	7,590	39.7	16,576	5,780	23,348	770,434	40.3
HAWAIIAN LINES								
Aloha	25,816	3,843	57.7	3,252	---	4,383	316,001	50.3
Hawaiian	33,100	4,953	55.3	5,177	---	163,500	567,619	57.8
CARGO LINES								
Aerovias Sud Americana	---	---	---	---	---	198,523	198,523	63.0
Flying Tiger	769	2,971	68.5	14,845	29,563	19,976,938	20,318,406	79.6
Riddle - Domestic	---	---	---	8,880	3,706	5,576,048	5,588,634	64.4
Overseas	4,345	29,531	94.9	11,679	879	2,399,591	5,365,261	84.3
Seaboard World	---	---	---	738,014	---	4,886,329	5,951,891	66.0
Slick	691	4,032	69.2	---	---	6,913,645	7,296,994	78.8
HELICOPTER LINES								
Chicago Helicopter	8,575	149	32.4	1,274	1,463	---	16,981	26.9
Los Angeles Airways	3,770	134	38.4	5,242	2,597	---	20,693	43.4
New York Airways	13,176	245	46.9	437	792	565	25,125	48.1
ALASKA LINES								
Alaska Airlines	6,846	5,736	33.6	58,200	1,892	609,202	1,246,681	52.3
Alaska Coastal	3,250	332	56.7	3,689	---	4,828	42,704	63.7
Cordova	1,975	298	37.7	5,012	---	25,241	60,865	48.2
Ellis								
Kodiak	736	37	38.5	507	---	1,004	5,267	43.2
Northern Consolidated	2,304	706	34.4	73,384	53,638	53,638	204,890	58.2
Pacific Northern	7,403	5,886	33.8	150,319	9,371	374,813	1,173,832	53.6
Reeve Aleutian	956	1,074	28.3	69,827	---	54,996	206,277	37.0
Western Alaska	647	32	60.3	691	---	981	4,776	59.8
Wien Alaska	3,273	860	35.6	57,082	---	152,829	298,812	50.6
Avalon	4,645	290	42.8	602	---	227 ¹	28,385	44.1

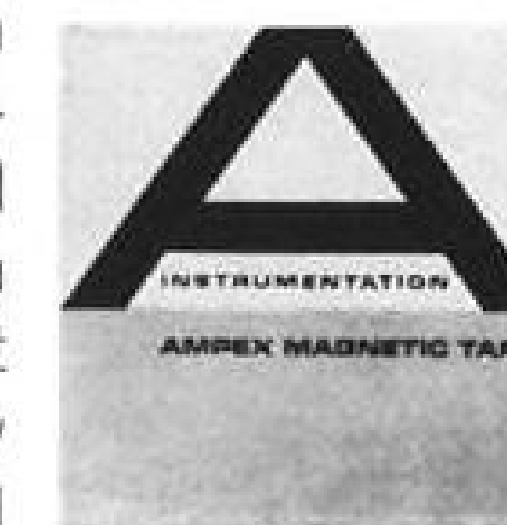
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Star-Field Tracker Gives Attitude Data

By Philip J. Klass

Ithaca, N. Y.—Non-inertial attitude reference for space vehicles, called a star-field tracker, which eliminates the need for gyros and stabilized platforms, is undergoing tests here at General Electric's Advanced Electronics Center.

Experimental model weighs 25 lb., but a production design version which substitutes a static chopper for the present mechanical rotating one is expected to weigh less than 10 lb., according to Lawrence Snowman, project engineer.

New device, like a conventional single star tracker, can be used to establish a precise direction in space. But because it makes use of a multiple star field for reference, it also provides data on the vehicle's roll, pitch and yaw axis attitude with respect to the vector.

Unlike a single star tracker which must be aimed close to the star it is to track to prevent locking onto the

wrong star, the new star-field tracker is expected to be able to orient itself by comparing the configuration and orientation of the star field it sees with a built-in map of a portion of the celestial sphere.

Preliminary tests to date, using an artificial star field, have confirmed predicted performance and the device will shortly be moved outside for tests using the natural star field, Snowman says.

Concept of a star-field matching device is not original with GE. The problem is more difficult than it appears at first examination. A star-field tracker must be able to recognize the desired field configuration regardless of its angular orientation.

The most frequently proposed design approach involves using a digital computer to perform the complex task of correlation with a prestored map of the celestial sphere, a large matrix of photodetector elements, or both.

General Electric has attempted to

substitute electro-optical ingenuity for such complexity in its design. The matching of the viewed star field with the desired star field is performed optically in such a manner that a single photo-multiplier tube serves as the detector and correlator, and no computer is required.

Theoretical analysis, tentatively confirmed by tests to date, indicates that the device will be able to detect vehicle attitude changes as small as 30 sec. of arc in all three axes.

Star-field tracker consists of an objective lens which focuses the parallel light rays from each star to a point at the focal plane of the lens, beyond which the light rays begin to diverge. (See sketch.) Beyond the focal plane is located the reference map of the desired portion of the celestial sphere which contains small circular holes precisely located to correspond to the position of each star.

Holes in the reference map are intentionally made smaller than the diverging beam from each star to provide an indication of tilt misalignment of the device with respect to the star field.

If the star tracker is properly oriented with respect to the celestial field, the light rays from each star will pass through the corresponding hole in the reference map, and then will be focused by a second lens to converge on the "correlation plane" at which the photodetector is located.

When the tracker is precisely oriented, the light rays from all of the stars will be superimposed onto a single spot on the photodetector. If the tracker is tilted slightly, indicating a deviation of space vehicle attitude, decorrelation occurs and the spot on the photo detector will be translated and slightly elongated in the direction of translation. This provides an error signal that gives both the magnitude and direction of the tracker/vehicle tilt with respect to the reference celestial field.

If the vehicle should rotate about its yaw axis, rotating the celestial field with respect to the reference map, the superimposed star image spot on the photodetector will increase in size and decrease in intensity. This provides an error signal which indicates the magnitude of space vehicle/tracker rotation, but does not indicate the direction of rotation.

To resolve this ambiguity, the engineering model uses a reference map which contains two complete sets of holes representing the celestial star

field. One set of the holes is rotationally displaced with respect to the other to provide two separate correlation functions in which the difference between the two outputs indicates both the magnitude and direction of rotational misalignment.

The reference map in the engineering model is a copper disk in which the celestial star-field apertures have been etched by a conventional photo process. During the initial star field acquisition mode, the reference map is rotated by a small servo motor in the tracker until it is oriented properly with respect to the celestial star field, as indicated by correlation of the spot on the photodetector.

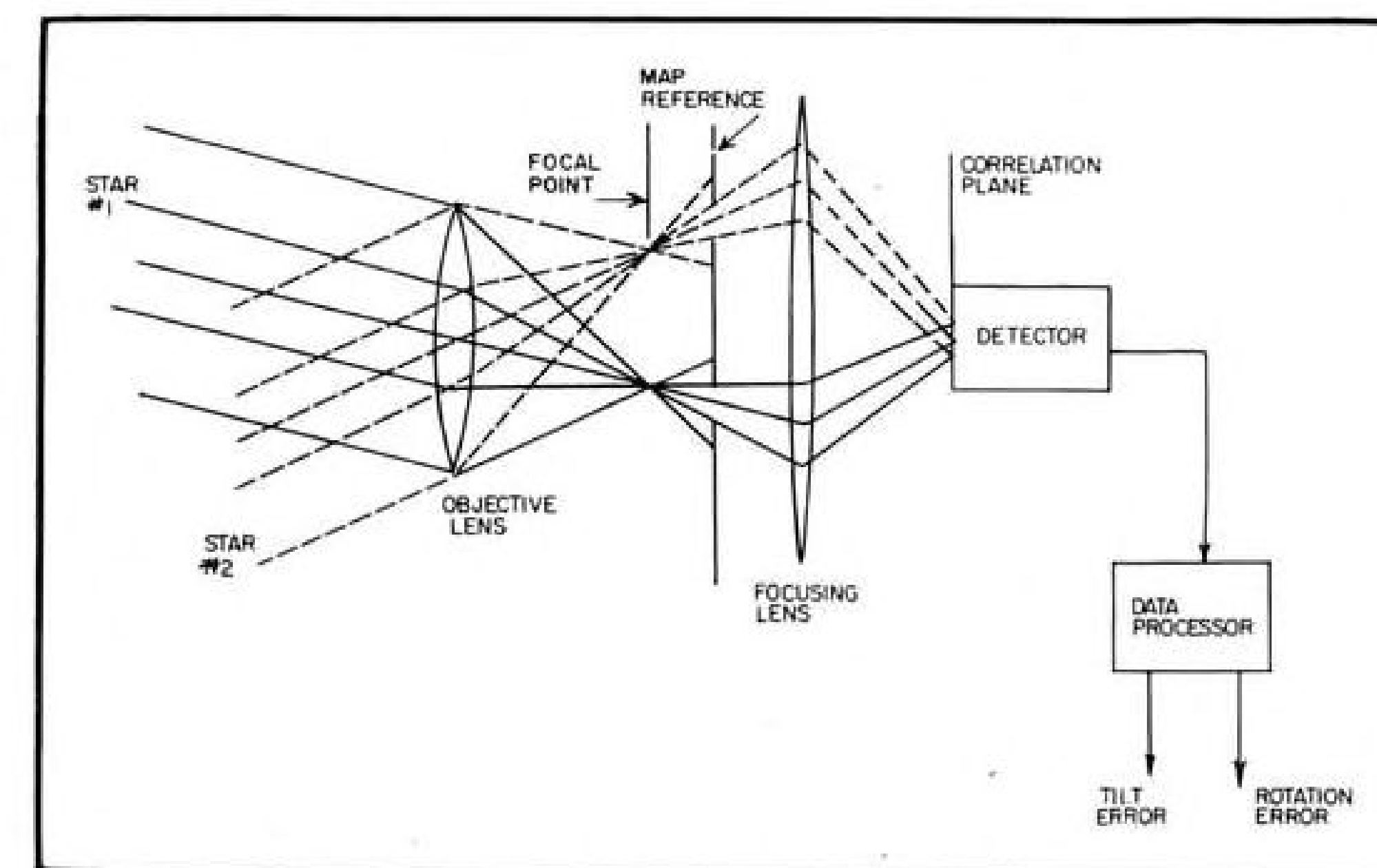
Engineering model uses a Cannon f/1.2 35 mm. camera lens with a 2-in. focal length and a 46-deg. field of view for the objective lens. The field lens is an f/0.39 stacked fresnel unit with a 1.4 in. focal length. Resolution requirements are not critical for the latter because the correlation function takes place at the reference map and the field lens need only serve as a light collector, Snowman says.

The device uses a rotating FM type chopper with a split reticle and an Ascop 541-A end-on photomultiplier tube with an S-11 surface for the detector. For use in a space vehicle, the GE device initially must be pointed to within approximately 10 deg. of the center of the celestial star field to which it is to align itself and the vehicle for the correlation technique to perform properly.

Assuming that the vehicle is traveling in the ecliptic plane, this does not appear to be a difficult requirement to meet. One possible acquisition arrangement which GE has considered is to use a simple shadow-box sun tracker which could align the vehicle to the sun so that axis of a gimbal mounting the star-field tracker would be aimed at the sun. The star-field tracker would then scan by rotating about this axis.

In one revolution of the star-field tracker about its gimbal axis, it would look at two known star fields, the one facing the ecliptic plane from above and the other facing it from below. By choosing one of these for the reference map in the device, it should be able to initially acquire an attitude reference to within 10 deg. without use of inertial systems for pre-orientation.

The correlation technique which GE uses minimizes the possibility of interference from planets or nonstellar light sources with the field of view, Snowman says. Additionally, it provides increased sensitivity because the light from several stars is focused onto a single spot on the photodetector. Present estimates are that the star-field tracker can be used with stars down to third or fourth magnitude.



STAR-FIELD TRACKER consists of objective lens which focuses light rays from stars to point, after which they diverge slightly before passing through reference map holes. Light rays then are focused by objective lens, bringing them onto photodetector. When tracker is properly oriented in azimuth, pitch and roll, all star images will be focused on a single spot.

New Radar Device Sorts, Displays Weather Information by Altitude

A new accessory for ground-based weather radars, which sorts out and displays rainstorm activity at each of six different altitude layers on individual scopes, will soon be delivered to USAF's Rome Air Development Center for evaluation.

The new constant-altitude plan-position indicator (Cappi) is designed for use with the widely deployed AN/CPS-9 military weather radars and its Weather Bureau counterpart, the WSR-57. The equipment was designed and built, under RADC contract, by the Aerospace Division of Aeronca Manufacturing Co., Baltimore.

Existing weather radar scopes display rainfall at a wide range of altitudes during a single scan because of the angle which the radar beam makes with respect to the horizontal. Thus, the inner portion of the scope displays precipitation at a low altitude, while the outer portion of the scope shows rainfall at high altitudes.

A more convenient display for use by weather forecasters would be one in which all of the storms at one altitude layer were displayed on one scope, while those at another altitude were shown on another. This is the function that Aeronca's new Cappi performs, being able to display storms at any six different altitude layers selected by the operator. The equipment corrects for earth curvature so that the altitude layers displayed are, in effect, curved shells around the earth's surface.

The six cathode ray tubes are photographed onto a single 35 mm. film strip which is developed automatically in one

minute and then projected onto a ground-glass screen. The automatic film processor was developed by Chicago Aerial Industries under Aeronca subcontract.

To enable an operator to study the progress of a storm, the equipment permits recall and projection of any previous film frame. Green and red filters are provided so that the current situation can be displayed in one color while the earlier situation is superimposed in the second color.

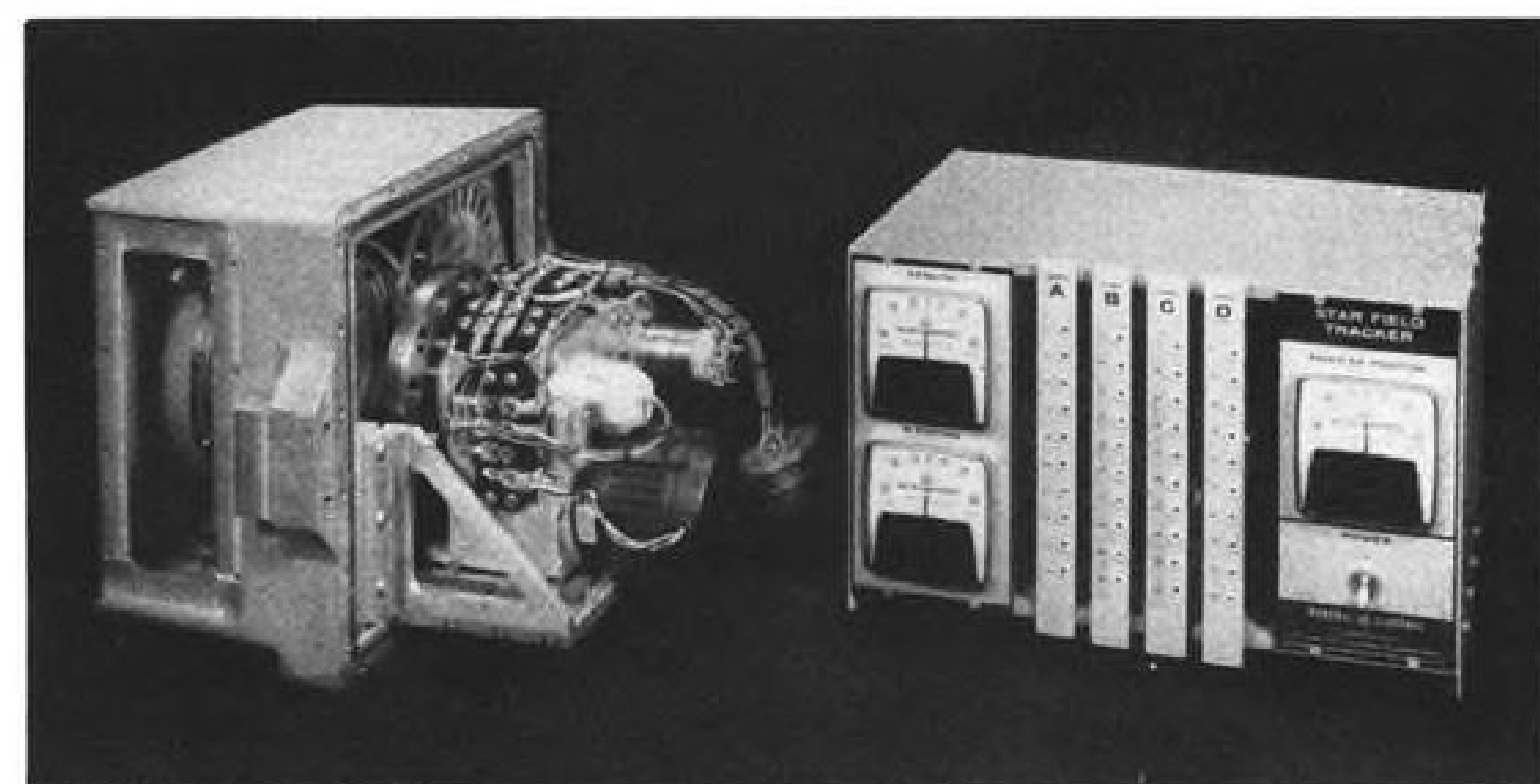
The equipment uses 5-in.-dia. cathode ray tubes whose display is magnified approximately 1.3 times when projected onto the screen. The projected display is bright enough to permit viewing in a room with an ambient light illumination level of 50 foot-candles, Aeronca says.

Principle of Operation

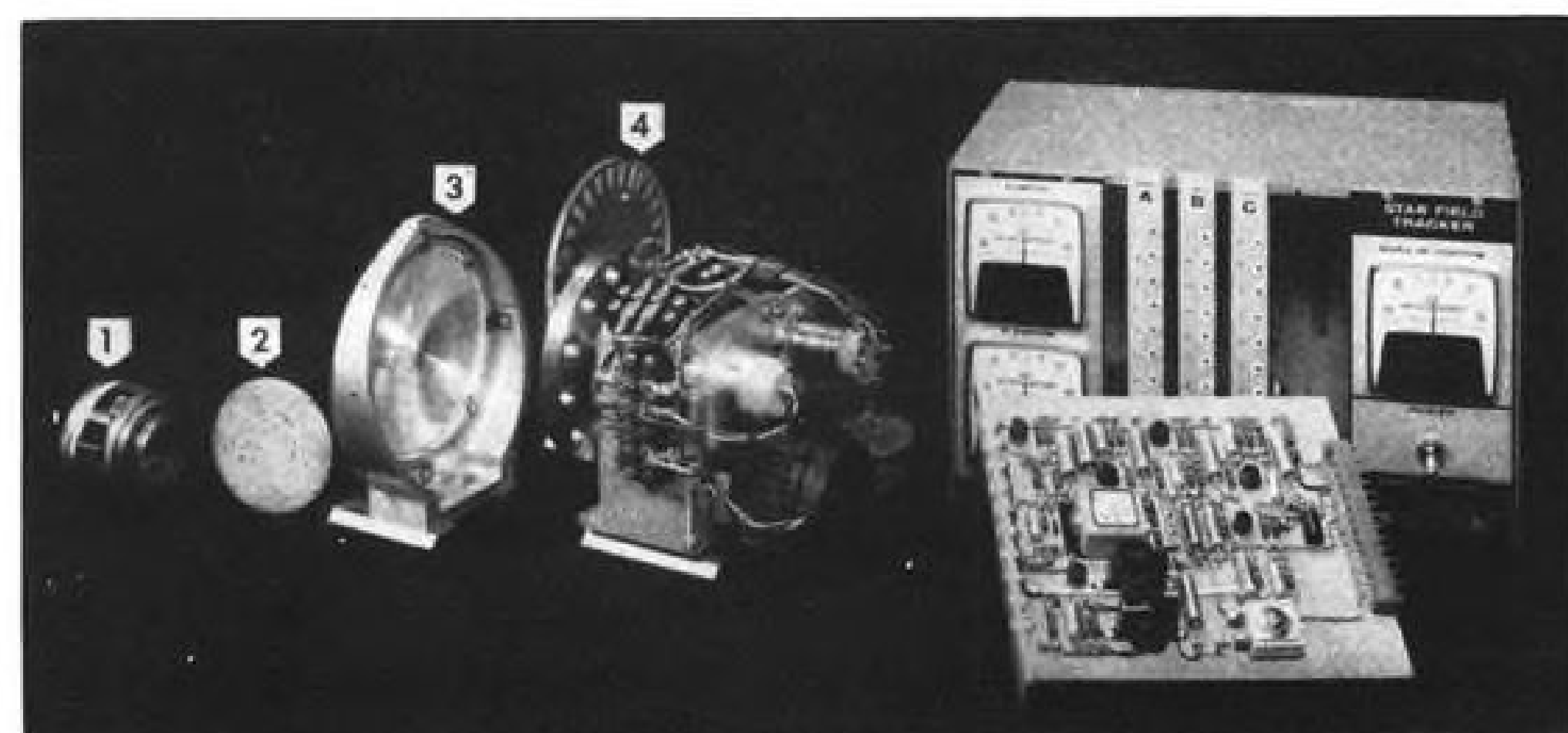
The Cappi equipment controls the elevation angle of the weather radar automatically so that its pencil-shaped beam sweeps out 20 deg. of vertical coverage during a series of 18 rotations in azimuth. After the 18th rotation, the antenna is automatically depressed to zero degrees elevation angle and the process is repeated.

At any particular elevation angle, the signal echos from rainfall are separated according to the altitude layer at which they occur, a function of their slant range and antenna elevation angle, and displayed on the appropriate scope.

At any instant in time, only a narrow band on each scope will be painted, but during the course of the complete 18



STAR-FIELD TRACKER, engineering model of an attitude reference system for space vehicle use, requires no inertial instrumentation. Unlike single star tracker, the new device can provide attitude reference about roll, pitch and yaw axes.



DISASSEMBLED VIEW of engineering model of General Electric star-field tracker shows (1) objective lens, (2) reference aperture map, (3) focusing lens and (4) rotating chopper wheel. Prototype weighs 25 lb. but production version should weigh under 10 lb.

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Systems Design • operational and functional mission analysis, optimum time-bandwidth utilization, redundant system organization for reliability, phased arrays, digital and voice communications, and A-J secure communications.

Equipment Design • solid state receivers, transmitters and transponders, distributed parameter microwave equipment, digital Modems, controls and displays, low-level switching circuits, and digital data processing circuitry.

Familiarity with State-of-the-Art • spread spectrum techniques, visual spectrum intelligence transmission, statistical theory of communication, integrated circuit applications, multiple logic element techniques, organization of digital data handling systems, correlation and phase-lock techniques, and coding and modulation.

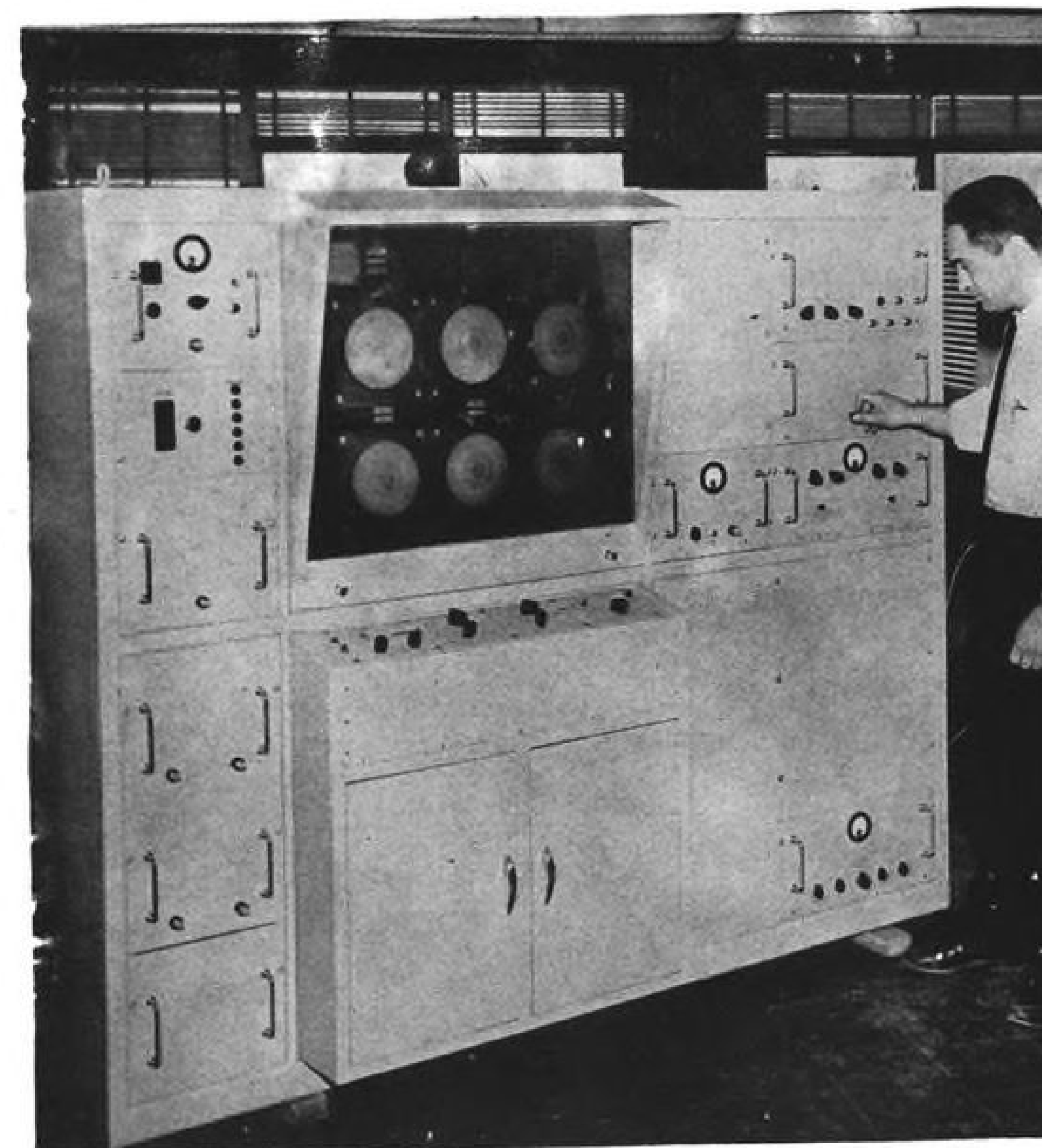
We are particularly interested in the programs on which your experience was obtained, and the extent of your technical responsibility. Please address this information to our Manager of Engineering for immediate and confidential attention.

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NEW WEATHER RADAR ACCESSORY sorts out and displays rainstorm activity at each of six different altitude layers on individual scopes. New device was developed by Aeronca's Aerospace Division for Rome Air Development Center evaluation.

azimuth rotations, each at a different elevation angle, the time-exposed 35 mm. film frame will obtain a full scope picture.

The Aeronca equipment uses a logarithmic receiver with a dynamic range of 70 db., enabling it to determine echo intensity without manual readjustment of the gain control.

The echo intensity is quantized into seven levels, one of which is the background noise level.

The other six can be selected in increments of 5 db. or 10 db.

All seven levels are available for recording on tape or processing by digital computer, but only four levels of storm intensity are presented on the scope displays. The least intense display level is used for background noise, with the second, third and fourth levels presented at increasingly bright levels. If the core of a storm produces an echo which exceeds level four, it is inverted and shown as a black hole in the center of the intensely bright storm area.

The equipment contains provision for equalizing the intensities of all six altitude scopes so that each gray level on all scopes has the same intensity. Range markers can be displayed on the scopes, if desired.

The Aeronca equipment is capable of producing a new situation display every minute, if the radar antenna scan rates permit this speed.

When used with the AN/CPS-9 radar, a new display can be produced every five minutes.

The Cappel display is mounted in a console-type cabinet which measures 66 x 81 x 24 in. deep. The cabinet contains the rear-projection display, radar receiving and video processing equipment and the antenna programmer.



► **Probing Laser Radiation Effects**—Interaction of radiation generated by optical masers with target material is to be investigated in an effort to develop models with which to analyze shocks in materials in a program sponsored by the Air Force's Special Weapons Center. In a companion program, AFSWC will explore one of the more difficult problems in this field—the measurement of high-intensity radiation. The latter program, scheduled for 15 months duration, will require a study of measurement methods, then the analysis of new



Engineered Environment

Birds that burrow? Yes, the puffins do. The puffin also "flies" under water—using his wings—as well as in the air.

Does your new weapons system need to be self-adapting to extreme ranges of environment? American Air Filter has proven capability to supply and install complete environmental systems capable of over 20 thousand hours mean time between failures (MTBF).

Our project experience includes Minuteman, Nike Zeus, Atlas and Pershing, plus two decades of pioneering portable support equipment for USAF aircraft and cold weather bases.

This American Air Filter capability to perform under difficult design criteria extends from research through prototype to full scale manufacturing. Inquire: Defense Products Division, American Air Filter Co., Inc., 310 Third Street, Rock Island, Illinois, Phone 788-9311.

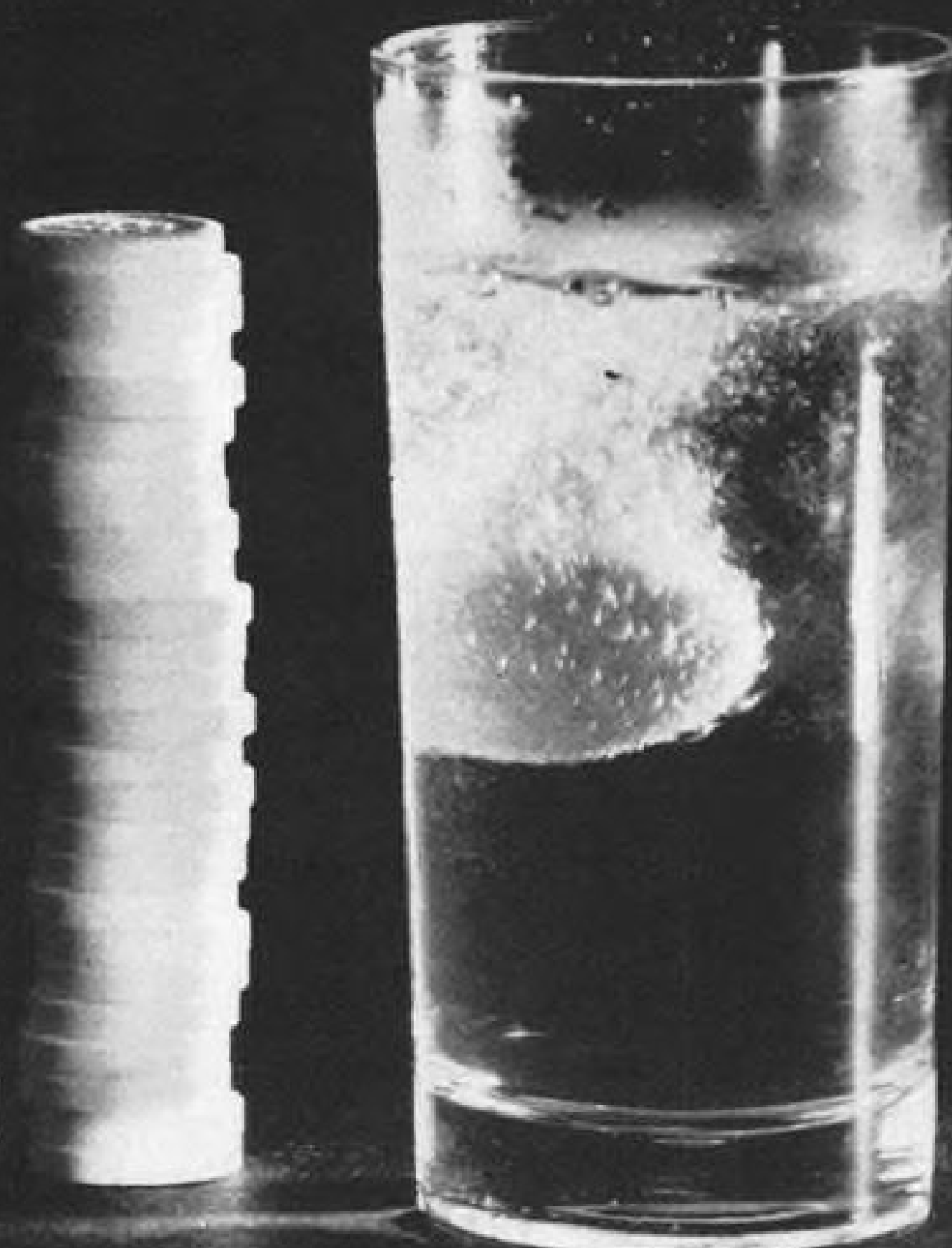


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ENGINEERED ENVIRONMENTAL SYSTEMS

HYBRID



SELTZER TABLETS. GLASS OF WATER. UNMIXED, YOU HAVE AN INERT SOLID, AN INERT LIQUID. MIX THEM, YOU HAVE IMMEDIATE REACTION. WHAT DOES THIS SIMPLE THERAPEUTIC SYSTEM HAVE IN COMMON WITH UTC ROCKET PROPULSION DEVELOPMENT? UNITED TECHNOLOGY CORPORATION IS WELL ALONG WITH A DEVELOPMENTAL HYBRID ROCKET MOTOR, IN WHICH A LIQUID OXIDIZER IS BROUGHT INTO CONTACT WITH SOLID FUEL. THE RESULT IS A WHOLLY NEW KIND OF PROPULSION SYSTEM, COMBINING TRADITIONAL SOLID PROPELLANT RELIABILITY WITH THE HIGH PERFORMANCE FIGURES CHARACTERISTIC OF LIQUID ENGINES. UTC'S HYBRID OFFERS UNLIMITED START-AND-STOP CAPABILITY, AND HIGHER SPECIFIC IMPULSE THAN ANY OTHER NON-CRYOGENIC SYSTEM. APPLICATIONS: HUGE BOOSTERS, SOFT LUNAR LANDINGS, ORBITAL CHANGES OF SPACECRAFT, CONTROLLABLE BALLISTIC MISSILES. ANOTHER STATE-OF-THE-ART ROCKET DEVELOPMENT BY UTC.



United Technology Corporation
P. O. BOX 358, SUNNYVALE, CALIFORNIA

SUBSIDIARY OF UNITED AIRCRAFT CORPORATION
**U
A**

methods and development of devices for exploiting these methods.

► **Signed on the Dotted Line**—Major contract awards to avionics manufacturers announced recently include the following:

- **Pan American World Airways**, \$1 million contract to provide facilities for development and testing of advanced surveillance systems at Army Electronic Proving Grounds, Fort Huachuca, Ariz.
- **Sperry Gyroscope Co.**, Great Neck, N.Y., supplemental contract for \$7 million for instrumentation of C-4 ships to be used on Atlantic Missile Range.
- **Collins Radio Co.**, Dallas, \$1.2 million contract for MX-103 multiplex equipment to be used at 23 stations of a 92-station microwave system to be installed in the Central Treaty Organization (CENTO) countries of Turkey, Iran and Pakistan. Company also reports a \$2 million contract from Aeronautical Radio, Inc., for C-8000 communication switching system to interconnect Arinc communication center in New York with airline offices throughout the country.

- **Minneapolis-Honeywell Aeronautical Division**, \$1 million second-source initial contract to cover tooling and initial production of gyroscopes for North American Autonetics Division, to be used in Minuteman ICBM.
- **Raytheon Surface Radar and Navigation Operation**, North Dighton, Mass., \$5.6 follow-on contract for AN/SPG-51 fire control radars for use with Tartar ship-to-air missile. Company also has received \$4.4 million Navy Bureau of Ships contract for production of sonar transducers, to be performed by Raytheon's Submarine Signal Operation, Portsmouth, R.I.

- **Controls for Radiation, Inc.**, Cambridge, Mass., research contract from Rome Air Development Center to study nature of hazardous X-radiation generated by high-powered radar equipment.

- **Joint-venture association of Page Communications Engineers**, a Northrop subsidiary, River Construction Corp., Ft. Worth, a subsidiary of Morrison-Knudsen Co., and Curran & Co., Great Falls, Montana, will construct Minuteman missile communications network at Ellsworth AFB, S.D., under \$5.5 million Air Force contract.

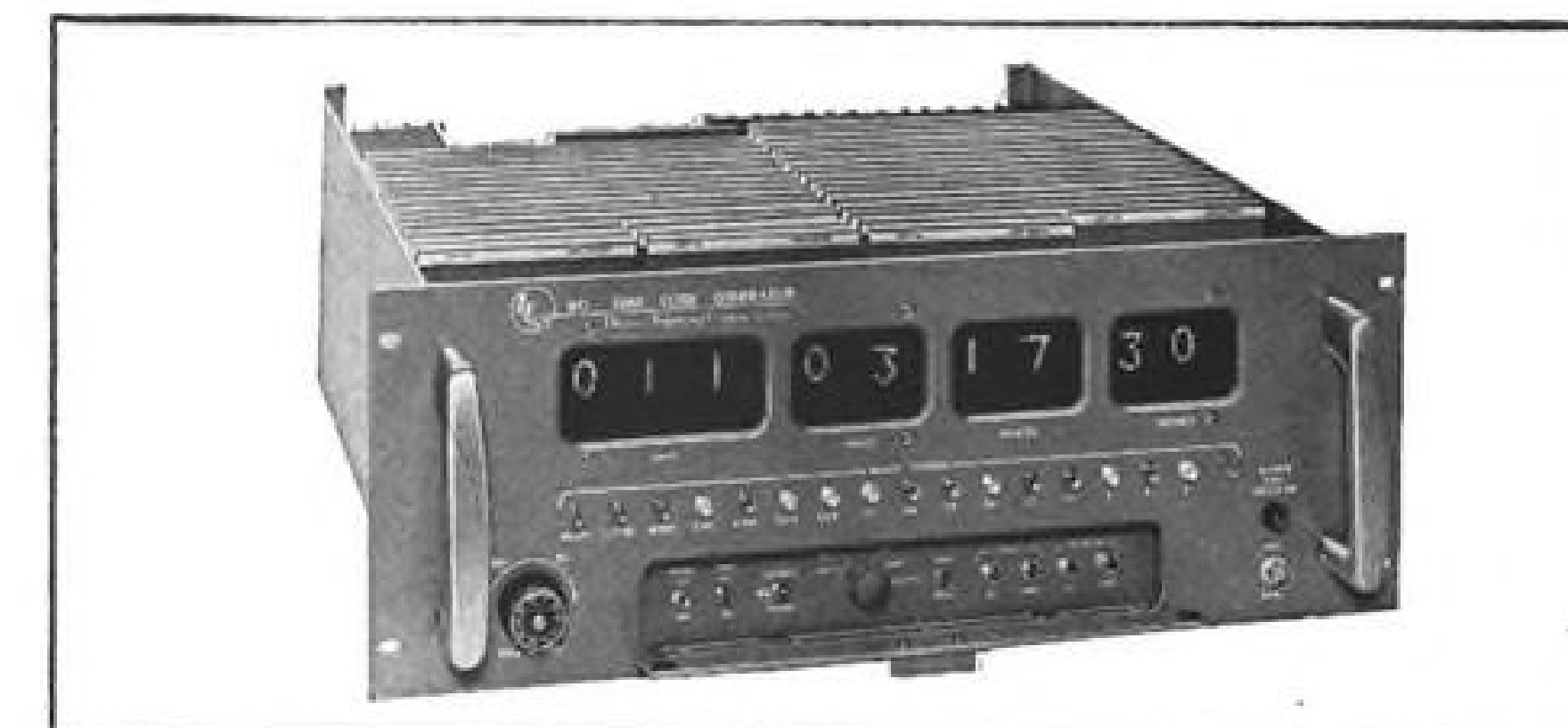
- **Transitron Electronic Corp.**, Wakefield, Mass., \$750,000 award from North American's Autonetics Division for high reliability semiconductors for use in Minuteman guidance system. Also, \$1.2 million subcontract for wired structural packages to Radio Corporation of America's Data Systems Division, Van Nuys, Calif.

- **General Precision's Link Division**, Binghamton, N.Y., contract from Flight Safety, Inc. for flight simulator for the Grumman Gulfstream.

- **General Precision's Link Division**, Binghamton, N.Y., contract from Flight Safety, Inc. for flight simulator for the Grumman Gulfstream.

FOR FOUR TIME

ALL FOUR IRIG FORMATS ON ONE COMPACT CHASSIS WITH EECO 811 TIME CODE GENERATOR



EECO 811 IRIG FORMATS

	A	B	C	D
Time Code Format	34 Bit BCD Code identifying days, hours, minutes, seconds and 1/10 seconds and a 17-bit binary code identifying time of day in seconds.	30 Bit BCD Code identifying days, hours, minutes, seconds and a 17-bit binary code identifying time of day in seconds.	23 Bit BCD Code identifying days, hours and minutes.	16 Bit BCD Code identifying days and hours.
Code Frame Length	0.1 second	1 second	1 minute	1 hour
Code Scan Rates	1000 pps	100 pps	2 pps	1 ppm
Code Carrier Frequency	10 kc	1 kc	1 kc or 100 cps (switch selection)	1 kc or 100 cps (switch selection)

An all solid state, card construction, precision "metronome" for the most demanding range or laboratory instrumentation. Supplies all four serial IRIG time-code formats with an accuracy of better than 1 second a month. Frequency stability is 1×10^{-8} per day at laboratory temperatures; 3×10^{-8} per day throughout entire operating range of -20°C to $+55^{\circ}\text{C}$. Parallel code output. 10 pps and 1 pps synchronizing pulses. Synchronizing pulse for controlling external control element scanner. Both digital and resolver time shift for fast, accurate synchronization with WWV or other time standard. Operates on 115v ac $\pm 10\%$, 50-400 cps, 1 amp, with power supply on same chassis.

Specify small (7" x 19" x 17"), light (32 pounds) EECO 811 Time Code Generator as the heart of your instrumentation and be assured of accurate time correlation. Investigate EECO's new reduced prices on various models of timing equipment.



Electronic Engineering Company of California

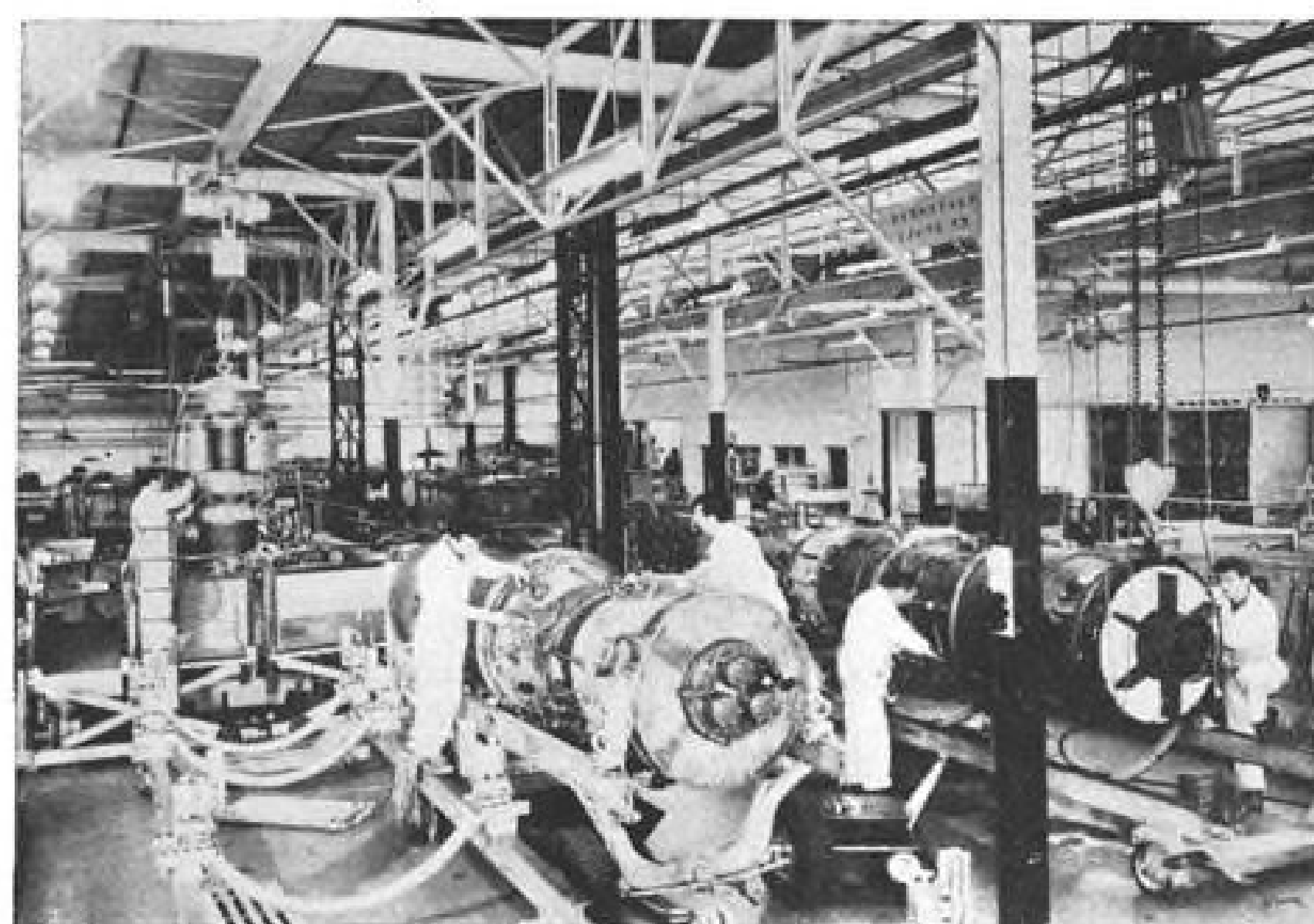
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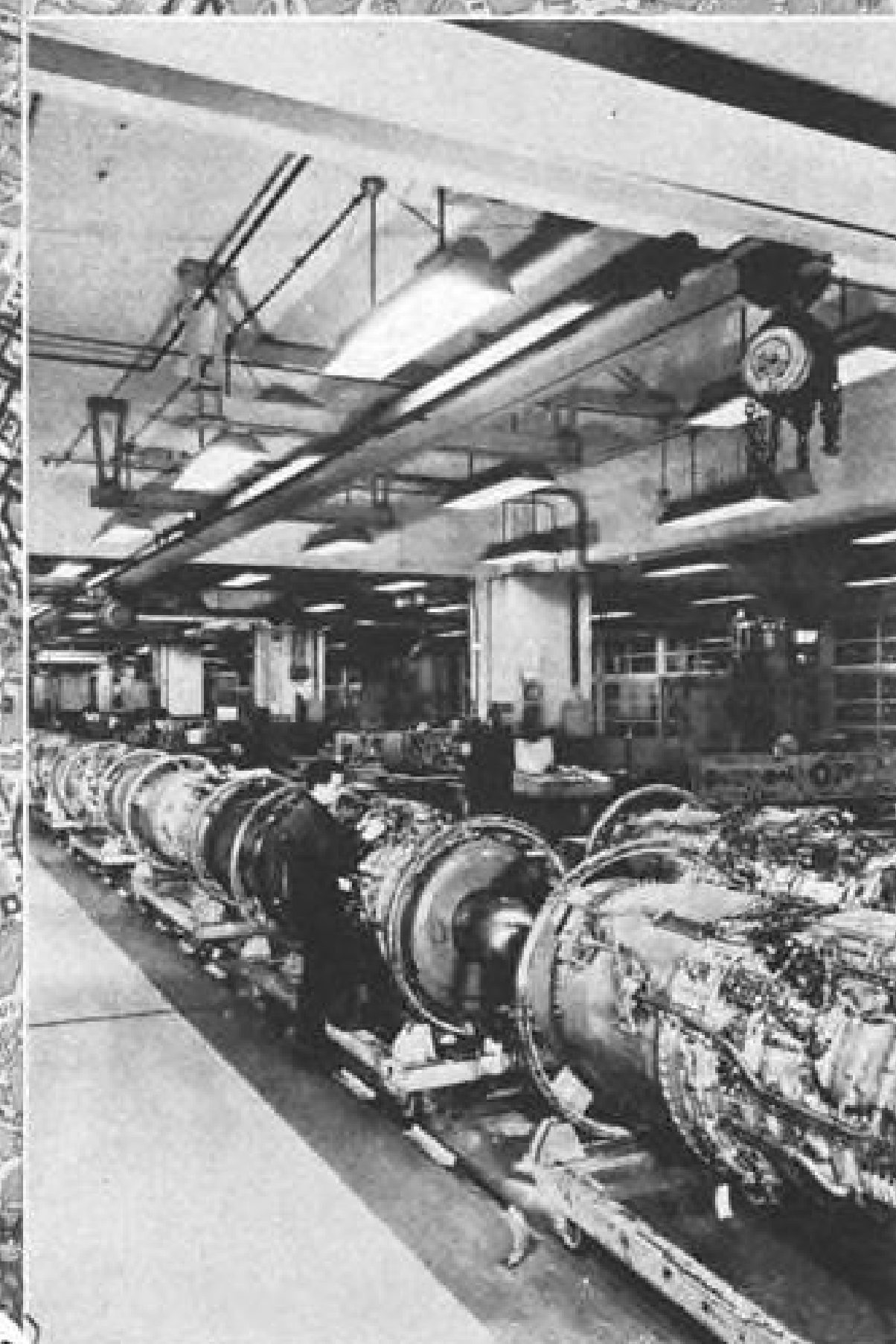


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AT VILLAROCHE**

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SNECMA is not only the home of the family of ATAR jet engines which have a production measured in thousands and of which the most recent example is the ATAR 9C of 6.000 kilogram thrust équiping the Mirage III and Mirage IV, it is also an unique industrial group adapted to the most advanced techniques.

11.000 exceptionally experienced engineers, technicians and specialists make use of 5.500 ultra modern machine tools spread amongst 5 centers round Paris.

Not counting the present production of ATAR engines at the KELLERMANN factory, the repair of Hercules and PRATT and WHITNEY engines at the BILLANCOURT factory and the metal foundry at GENNEVILLIERS, SNECMA is preparing a promising future through its research teams working at the laboratories of its Atomic Division, Technical Division and of ELECMA which groups all Electronic Divisions.

With its past exceptional experience of turbo-jet production SNECMA will, through the dynamic quality of its research teams, bring in France and Europe an essential contribution to the conquest of space.



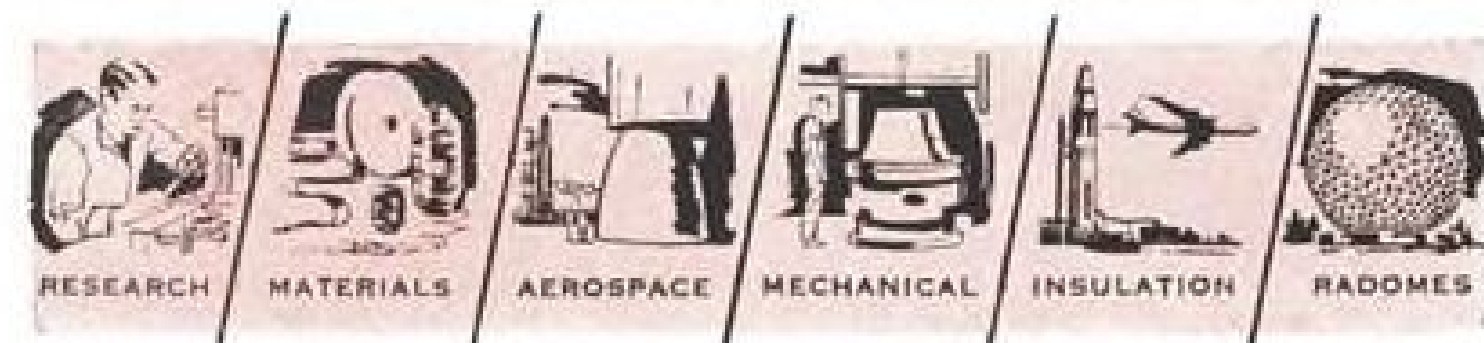


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Engineering Department. No obligation for consultation or proposals. *Capabilities Brochure available upon request.*

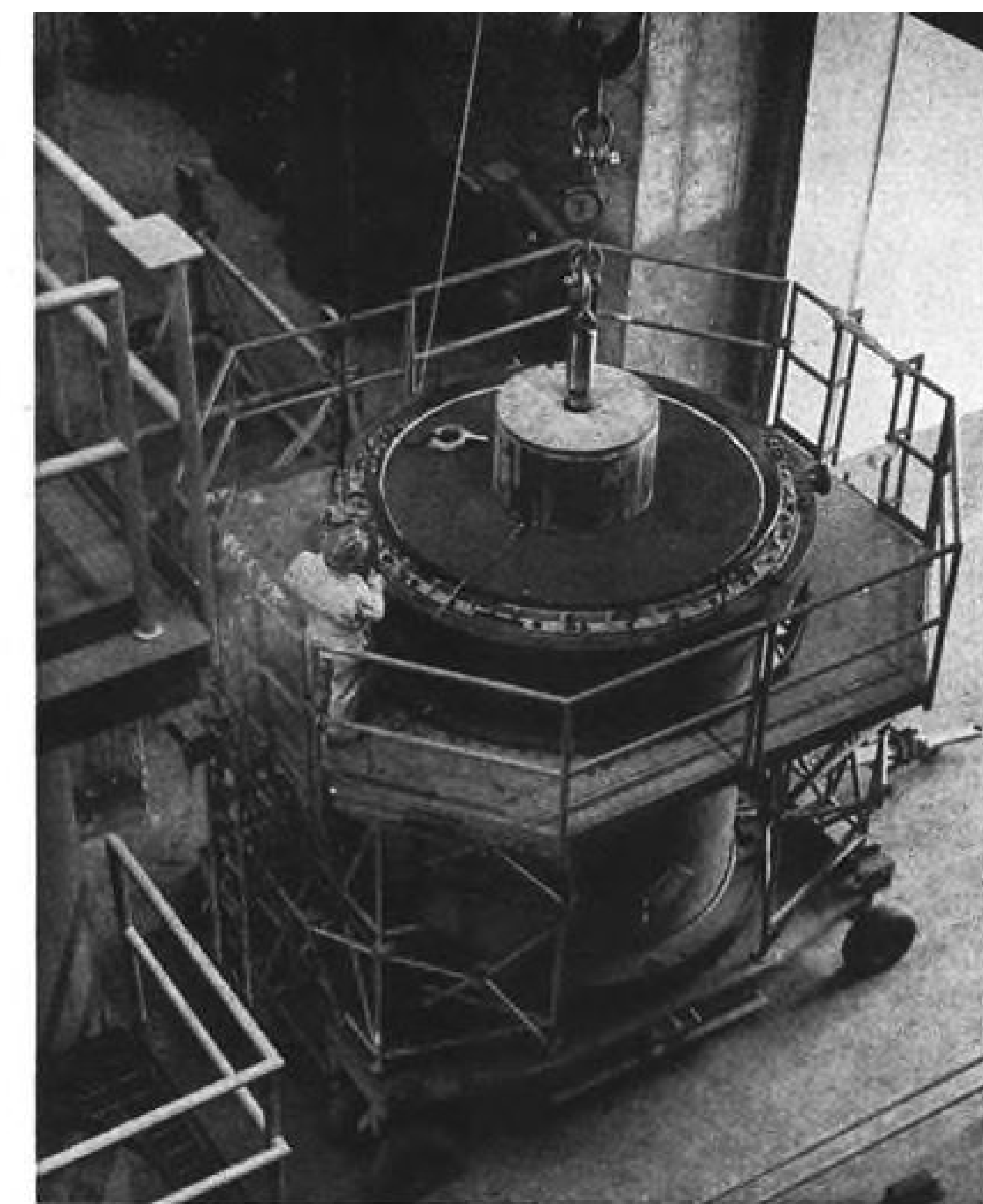
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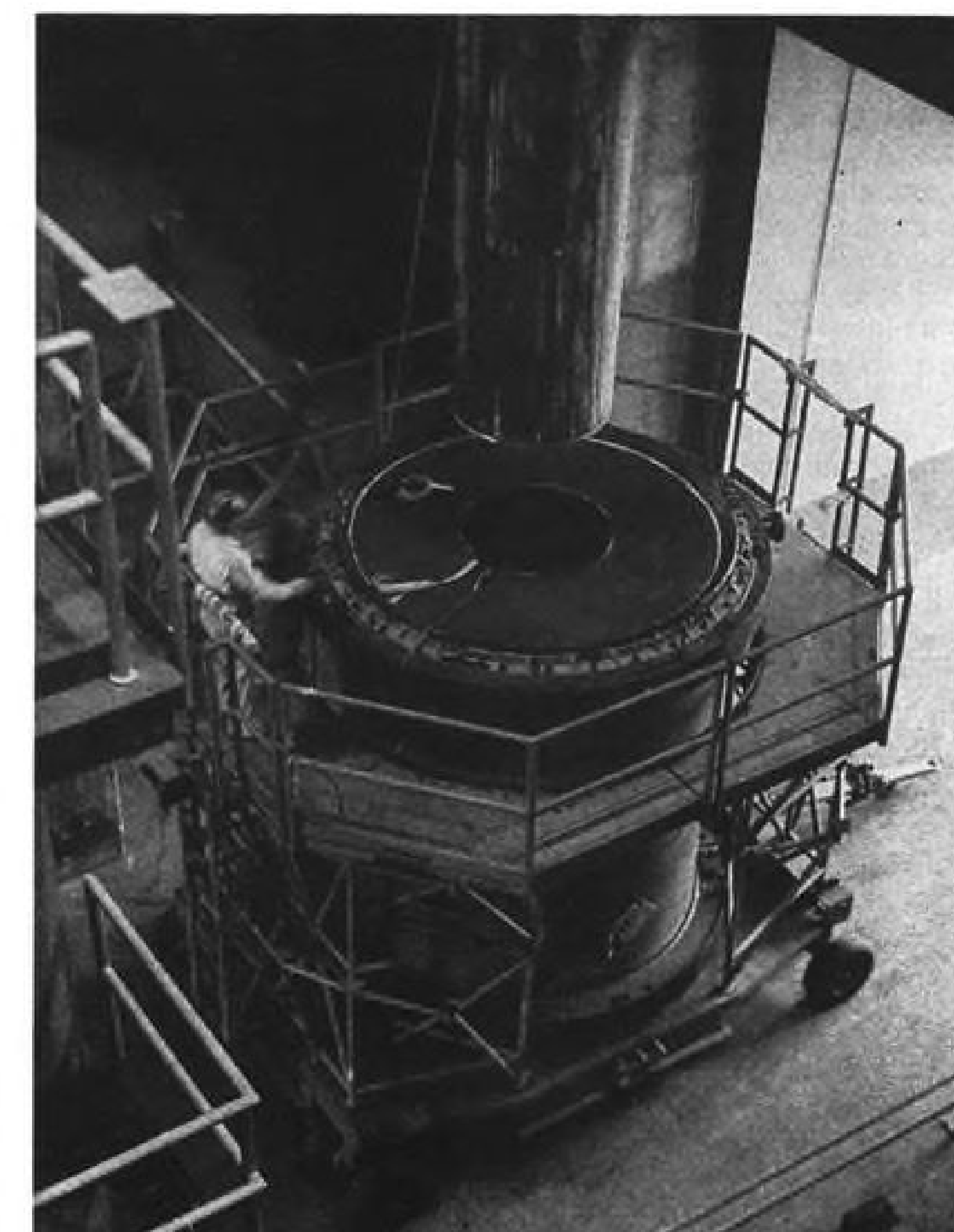
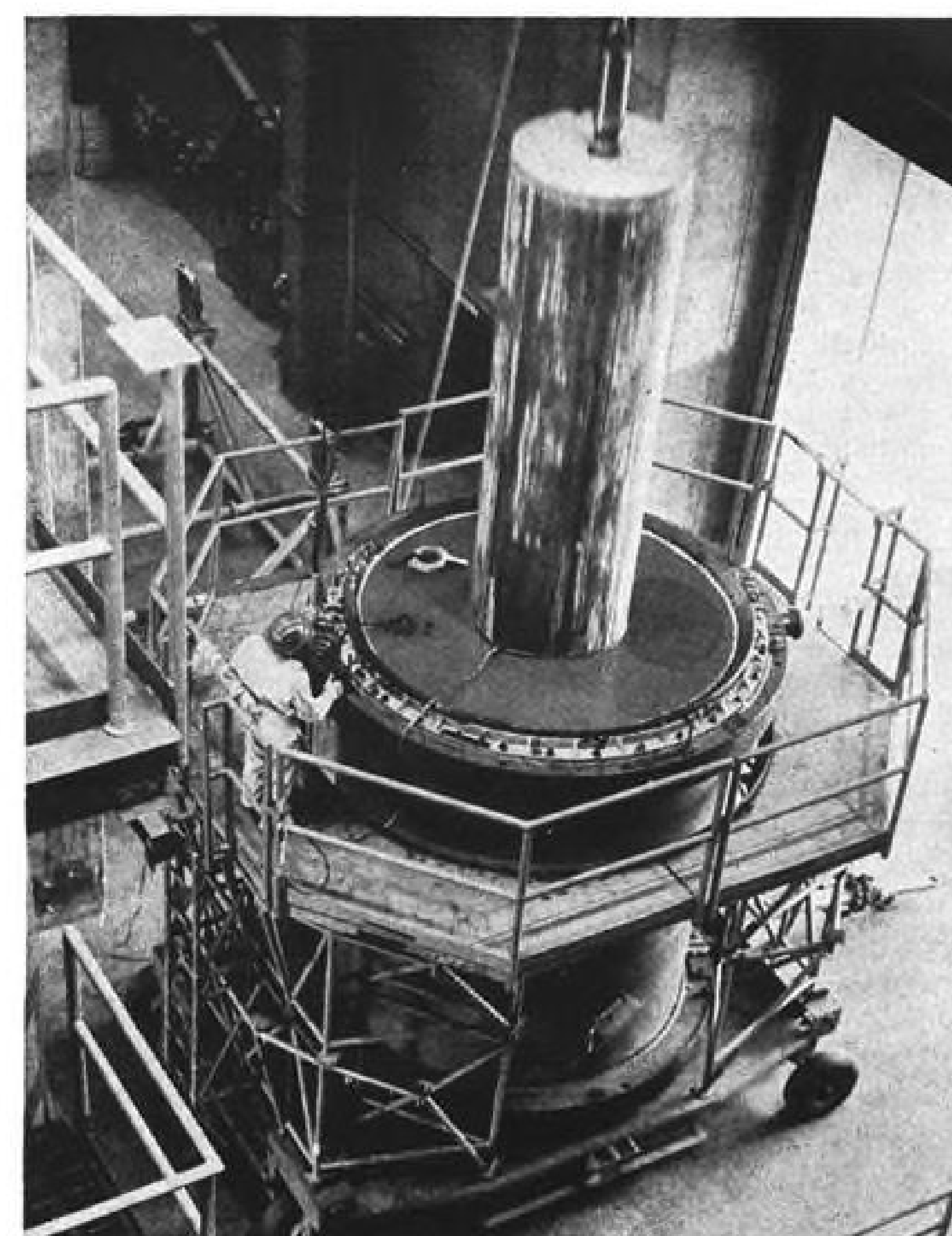


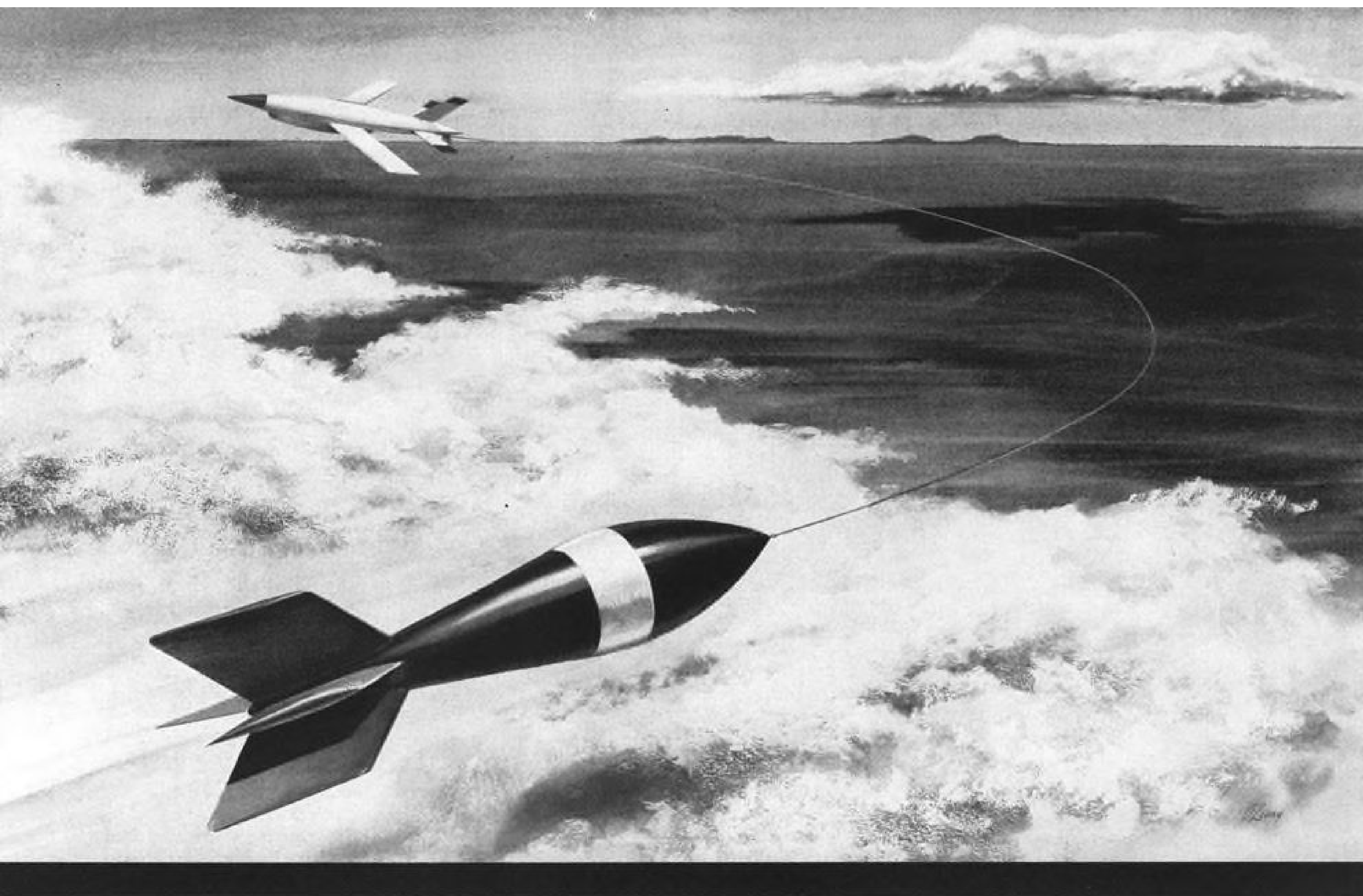
Core Removed From Aerojet's Motor Segment

Dolly (upper left) moves a center unit of Aerojet-General's five-segment solid-propellant motor from the curing oven to a handling area at the company's Sacramento, Calif., Solid Rocket Plant. The 5,000-lb. steel and mahogany core is then removed from the hardened propellant (upper right and below). Three of these 100-in. diameter, 11-ft. long center segments, plus two end caps,

were joined to form a 53-ft. long, 119-ton motor which was fired recently by Aerojet (AW Mar. 5, pp. 11, 70). Each center segment contained over 26 tons of propellant; total propellant in the motor was 107 tons.

The solid-propellant motor developed approximately 600,000 lb. thrust over a 98 sec. firing time.





From the Air Force QF-80 and QB-17 to the Army 124-E... SIX YEARS OF DEL MAR DRONE/TOW TARGET EXPERIENCE

Early in 1955, Del Mar Engineering Laboratories demonstrated the feasibility of conducting interceptor firing exercises against tow targets that were carried aloft and launched in-flight by droned aircraft. This pioneer work was done in cooperation with the U.S. Air Force's Drone Group at Field 3 Eglin Air Force Base. The drones used at that time were the QF-80 and QB-17.

A short time later, Del Mar, working with the Air Force Armament Center, introduced still another new concept—*The Piggyback Tow*. It consisted of an *unexpendable* sophisticated Delta Wing Target (complete with Kinescore missile scoring equipment) from which was launched an *expendable*, low-cost, radar-reflecting tow target.

Since then, Del Mar has gone on to lead in state-of-the-art developments of a vast variety of weapons training systems tailored to meet the specific needs of the various branches of the Armed Services... and more than 100,000 Del Mar targets have been employed in military operations throughout the Free World.

Today, Del Mar is participating with the makers of the Army's 124-E drone—Ryan Aerospace of San Diego—in the development of a drone/tow system employing the Del Mar tow target and Ryan Firebee drone. The new system is being developed for use in training Army missile batteries.

The Ryan Firebee/TOWBEE system will provide the U.S. Army with all of the safety and the cost savings associated with an unmanned tow system.

For more information on manned or unmanned tow target systems and related weapons training concepts, write Dept. AW-1836.



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QF-80 droned aircraft with Del Mar DF-4RC radar-reflecting tow target.



Del Mar Piggyback Tow and DF-4RC radar-reflecting tow target.

NASA Contracts

National Aeronautics and Space Administration recently awarded the following contracts and research grants:

HEADQUARTERS, WASHINGTON, D. C.

Case Institute of Technology, Cleveland, Ohio—\$250,000 for experimental and theoretical research in plasma dynamics.

Operations Research, Inc., Silver Spring, Md.—\$60,000 for planning study of launch vehicles technology and requirements.

Cornell Aeronautical Laboratory, Buffalo, N.Y.—\$240,000 for experimental study of heat transfer to nuclear-rocket nozzles.

North American Aviation, Inc., Canoga Park, Calif.—\$50,000 for Phoebus feed system.

Secretary of Army, Washington, D.C.—\$500,000 for support of NASA launches at rocket research facility at Fort Churchill.

AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.

Cortelyou & Cole, Inc., Palo Alto, Calif.—\$60,000 for modifications to provide office and laboratory space in 7x10-ft. wind tunnel building.

LANGLEY RESEARCH CENTER, LANGLEY FIELD, VA.

Air Products & Chemical Corp., Washington, D. C.—\$256,000 for cryogenic helium gas purifier system.

Jackson & Moreland, Inc., Boston, Mass.—\$317,000 for design and engineering services for lunar landing research facility.

GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.

Aerjet-General Corp., Sacramento, Calif.—\$204,000 for design study of large unconventional liquid propellant rocket engine and vehicle.

Lockheed Aircraft Co., Sunnyvale, Calif.—\$196,000 for rocket instrumentation and installation in Aerobee 150A vehicles and study of resulting telemetered data.

Electro-Mechanical Research, Inc., Sarasota, Fla.—\$66,000 for low power pulse code modulation telemeters.

Computer Applications, Inc., New York, N.Y.—\$1,322,000 for computer program for Goddard Institute of Space Studies.

Planning Research Corp., Los Angeles, Calif.—\$92,000 for reliability study for orbiting geophysical observatories.

Sperry Rand Corp., Long Island, N.Y.—\$89,000 for study and development of a radio frequency mass spectrometer.

University of Alaska, College, Alaska—\$200,000 for maintenance and operation of Minitracks A and B.

General Mills, Inc., Minneapolis, Minn.—\$61,000 for dual magnetic tape unit AD/ECS-37 computer system.

Philco Corp., Palo Alto, Calif.—\$500,000 for relay test station antenna system.

Watkins-Johnson Co., Palo Alto, Calif.—\$65,000 for development and fabrication of rugged low power traveling wave tube for Project Syncom.

Army Ordnance Missile Command, Redstone Arsenal, Ala.—\$171,000 for rocket motors.

Navy Bureau of Weapons, Washington, D.C.—\$84,000 for rocket motors for use as third stages in Delta launch vehicles.

MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.

Blount-Todd, Cape Canaveral, Fla.—\$419,000 for fabrication, installation and checkout of Saturn steel launch pedestal.

Republic Aviation Corp., Farmingdale, N.Y.—\$250,000 for fabrication and engineering services for design of large airframe tooling and components.

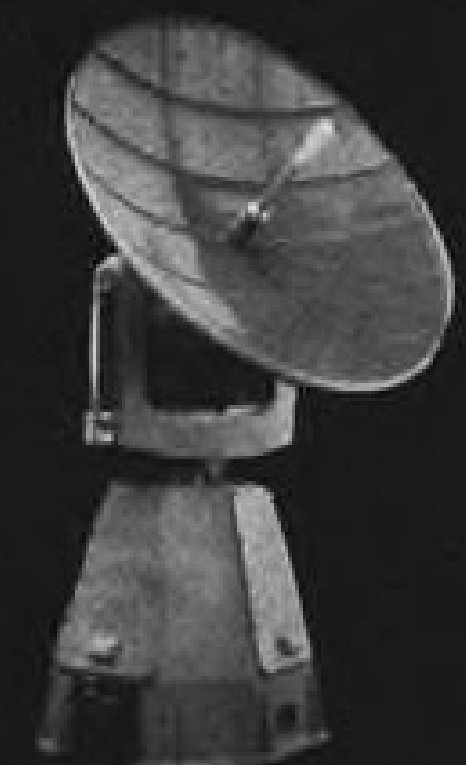
General Dynamics Corp., Fort Worth, Tex.—\$179,000 for investigation of combined effects of radiation and vacuum on engineering materials.

Chrysler Corp., Detroit, Mich.—\$71,000 for fabrication of valve items for Saturn.

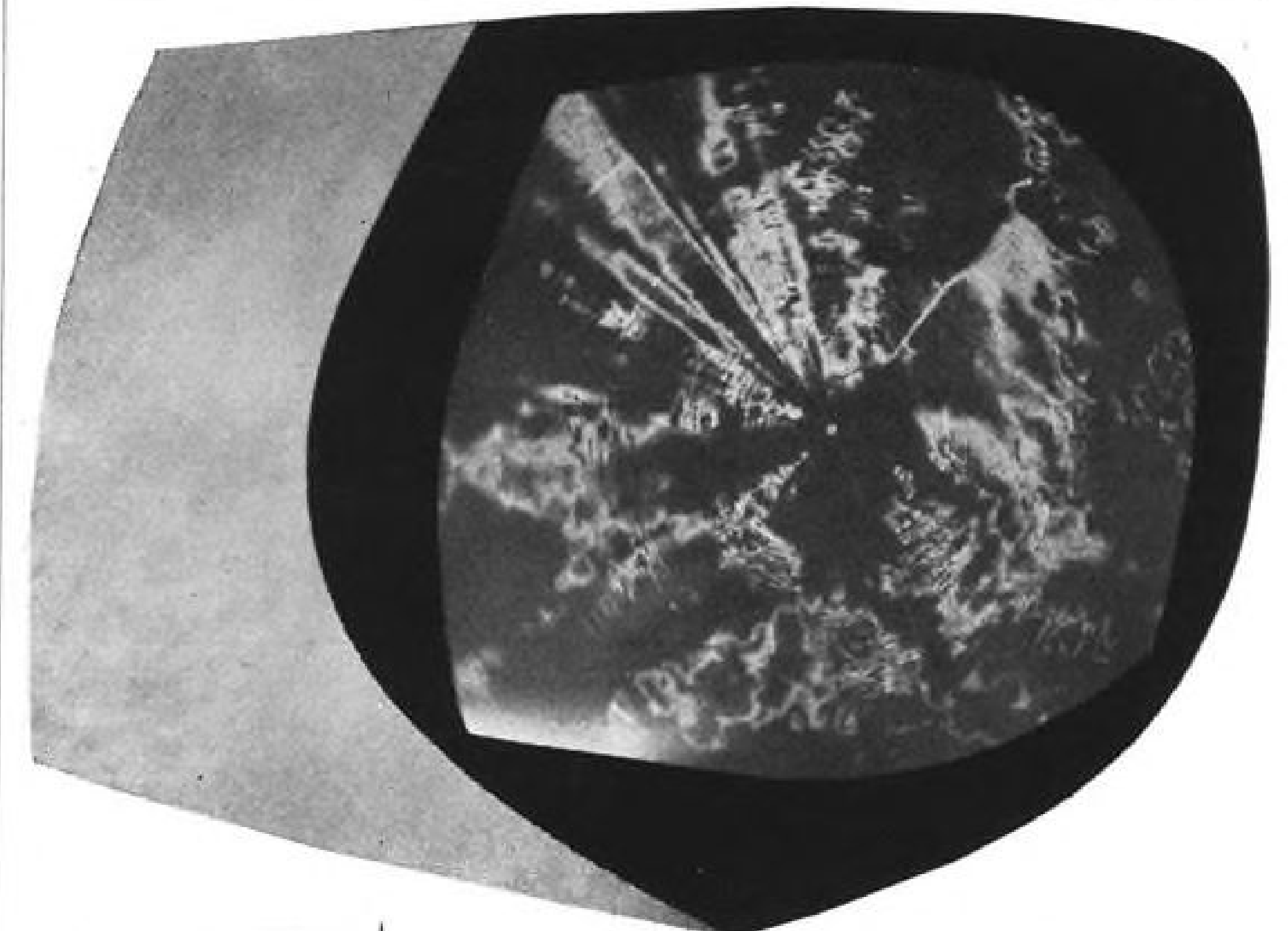
Hayes Corp., Birmingham, Ala.—\$1,012,

SELENIA ADVANCED WEATHER RADARS IN EUROPE

chosen by the most progressive meteorological services



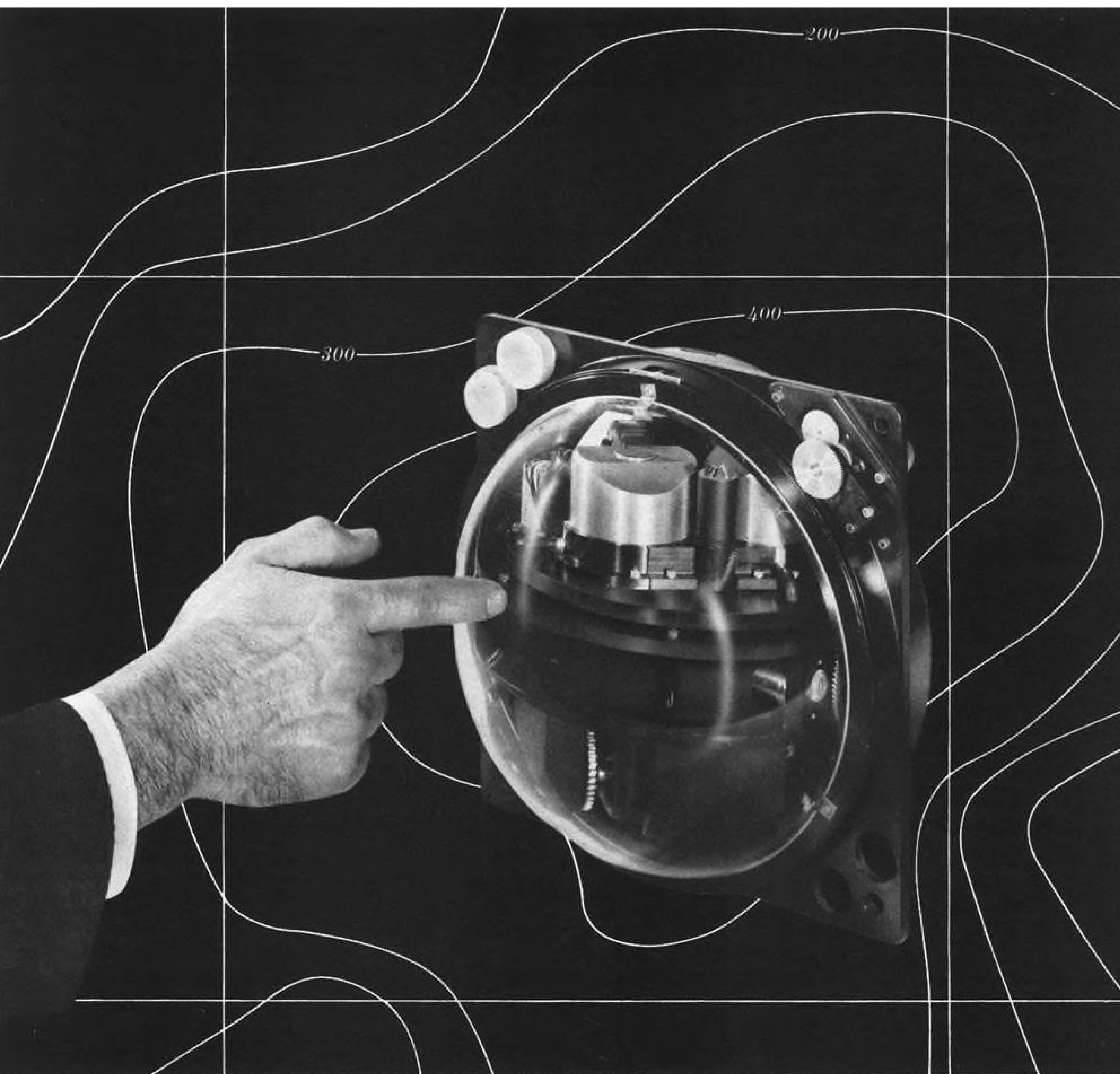
Accurate and flexible enough for use as a scientific instrument, yet rugged and reliable for everyday use, SELENIA WEATHER RADAR is the choice of many European weather services. Selenia high-power, low-cost weather radars detect storm formations at great distances. The combination of the Pencil-Beam antenna, flexible scanning modes and calibrated iso-echo gain control quickly determines the altitude and extent of the zones of dangerous precipitation and turbulence. Inexpensive weather balloons can be automatically tracked with Fire-Control accuracy to determine wind speed and direction at various altitudes. These radars are also available for trailer mounting and for installation on weather ships using stable platforms.



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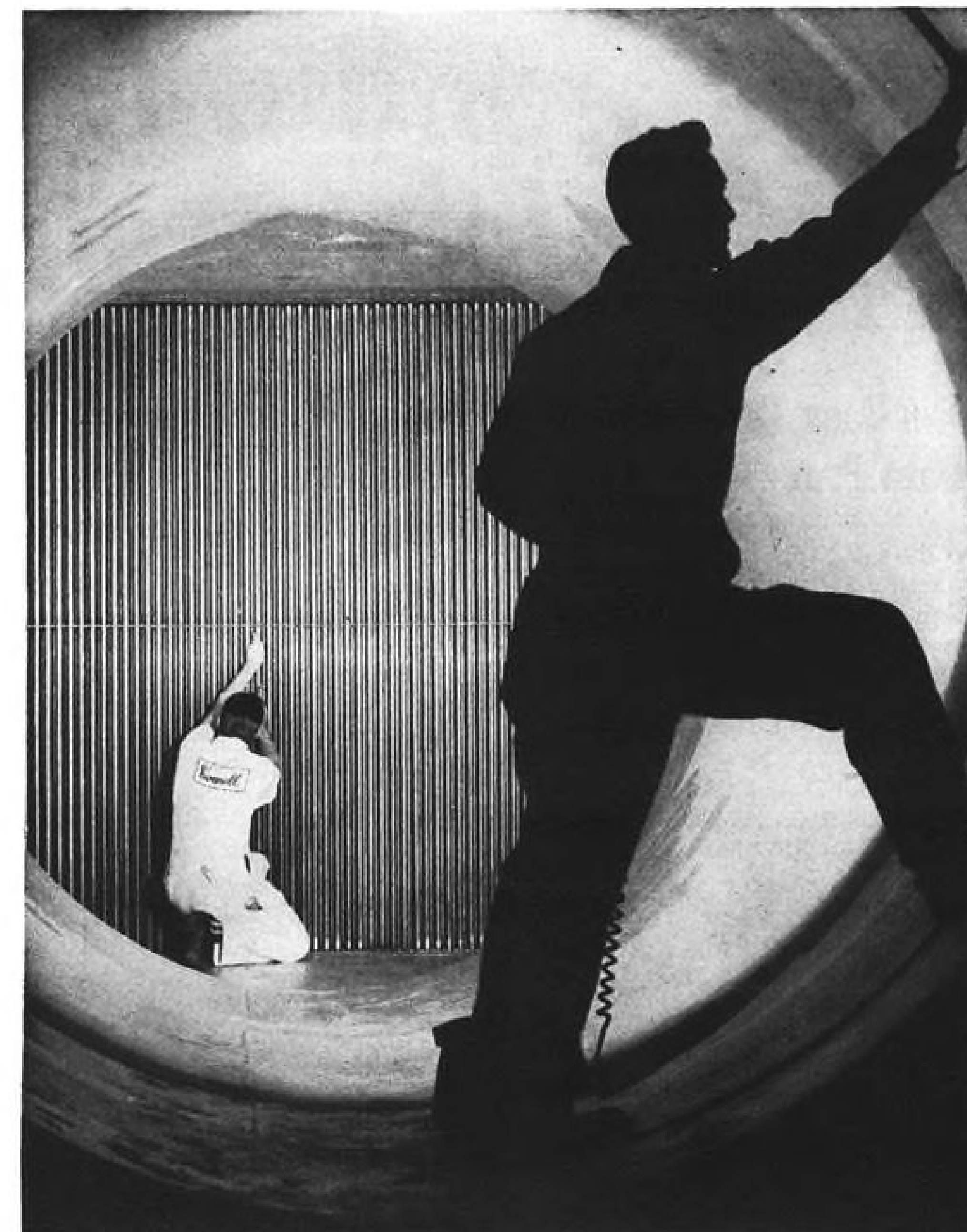
How to put your finger on precise location

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2-9



FORD INSTRUMENT CO.
DIVISION OF SPERRY RAND CORPORATION
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Cooler Installed in Cornell Wind Tunnel

Cooler, framed by circular test section, is being installed in Cornell Aeronautical Laboratory's wind tunnel which is designed to test missile configurations for long durations. Cooler absorbs heat up to 9,000F. The unit weighs 20,000 lb. and measures 12 x 14 ft. Wind tunnel is designed to test missile models at speeds up to and including Mach 20, is 4-ft. thick and is equipped with 888 copper tubes. Completed tunnel will cost \$5 million.

000 for engineering, fabrication and other related services for Saturn.

Columbia Broadcasting Systems, Inc., Stamford, Conn.—\$150,000 for research and development of solid film lubricants.

Thompson-Ramo-Wooldridge, Inc., Cleveland, Ohio—\$61,000 for development and fabrication of ion engine power supply.

Republic Aviation Corp., Farmingdale, N.Y.—\$250,000 for fabrication and assembly of Saturn components as required utilizing numerically controlled equipment.

Auburn University, Auburn, Ala.—\$84,000 for research to determine correct radar reflectivity figure for sea water.

Hugh J. Baker & Co., Indianapolis, Ind.—\$119,000 for fabrication, delivery, installation and checkout of gantry assembly for Saturn.

Thompson-Ramo-Wooldridge, Inc., Cleveland, Ohio—\$83,000 for research and development of propellant feed system for ion engines.

Blount Brothers Construction Co., Montgomery, Ala.—\$3,348,000 for construction of propellant storage and transfer systems at Complex 37, Atlantic Missile Range.

Teleprompter Corp., New York, N.Y.—\$57,000 for group communication visual presentation systems completely installed

with components and material.

Army Engineers, Los Angeles, Calif.—\$60,000 for site adaptation study, soil investigations and topographical survey for F-1 engine test stand sites.

Army Ordnance Missile Command, Redstone Arsenal, Ala.—\$50,000 for scientific and technical effort in theoretical and laboratory experimental program for spectroscopic studies.

Air Force Systems Command, Arnold AFB, Tenn.—\$86,000 for wind tunnel test time in T-1 test cell for Saturn SA-5 configuration at Mach 1.6 and 3.0 on furnished model.

Army Engineers, Jacksonville, Fla.—\$18,761,000 for acquisition of approximately 24,000 acres of land lying to north and west of present boundaries of Cape Canaveral; \$550,000 for preparation of bid documents for contracts and to provide management for construction phase of LC34 umbilical tower.

Air Force Systems Command, Arnold AFB, Tenn.—\$670,000 for cell and cell systems including LN₂ liner diffuser and ejectors.

Army Ordnance Missile Command, Redstone Arsenal, Ala.—\$60,000 for technical library services.

TESTING TAKES EQUIPMENT

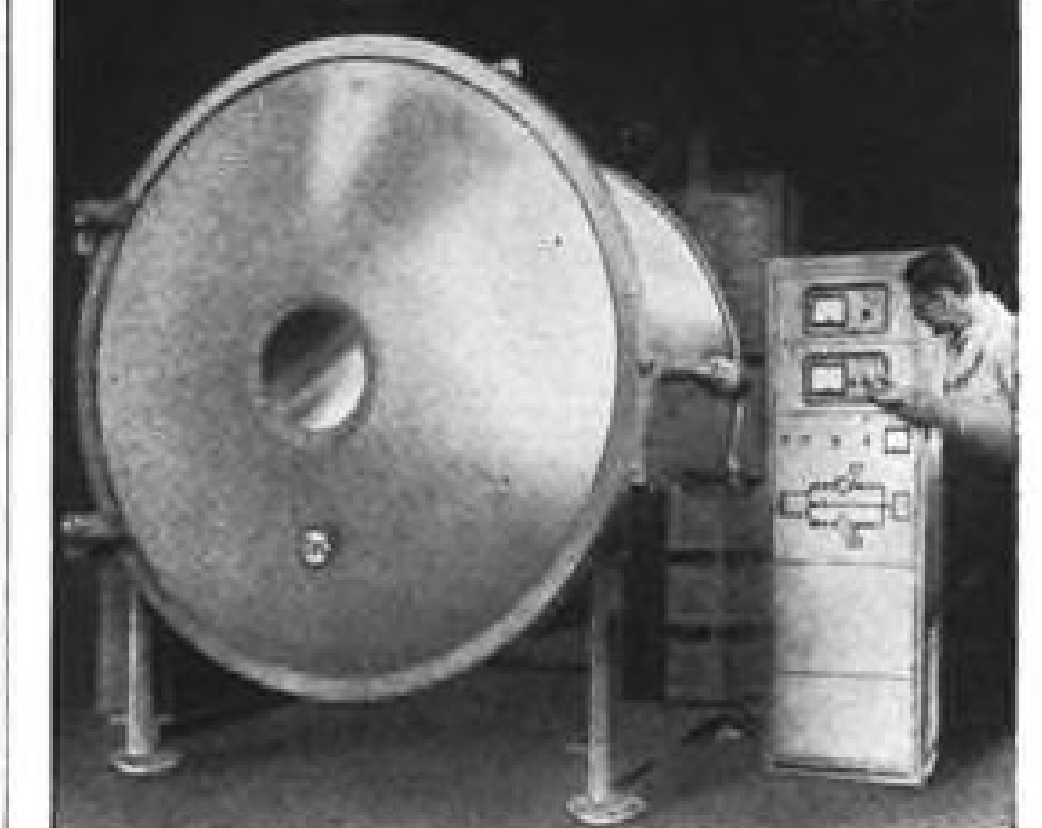
AEROTEST, a completely equipped facility, is qualified to perform all types of testing for the aerospace and electronics industries, including:

THERMAL VACUUM and ULTRA HIGH VACUUM • NUCLEAR and ULTRA VIOLET RADIATION • CRYOGENIC • SHOCK • VIBRATION • ACOUSTIC • RADIO INTERFERENCE • MONO and BI-PROPELLANTS • PNEUMATIC and HYDRAULIC • PLUS GENERAL ELECTRONIC SYSTEM and COMPONENT EVALUATION and QUALIFICATION

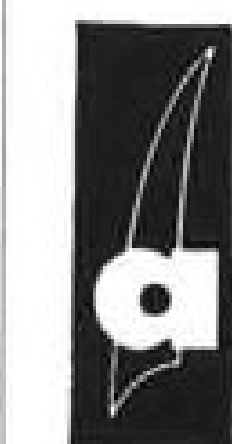
AEROTEST'S position as the foremost independent aerospace testing laboratory is indicated by some of the projects with which it is associated. Among these are:

TIROS • MINUTEMAN • DYNA-SOAR • ATLAS • TITAN • REDSTONE • APOLLO • ECHO

THERMAL VACUUM CHAMBER



A recent addition at Aerotest is the thermal vacuum chamber illustrated. Six feet in diameter and five feet long, it is being used to test complete satellites and space probes. The chamber can be pumped down to 10⁻⁶ Torr. Also available are smaller chambers for economical testing of sub-systems and components.



If you have a testing requirement, write:

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Comac Road, Deer Park, Long Island, N. Y.

3 engineers...and why they moved to Honeywell

Arthur Langlieb, Senior Development Engineer,

and formerly of New Jersey... "I was most attracted by the apparent high level of professional work being done at Honeywell. I have since found that with my experience, I am encouraged to spend as much of my time as possible doing purely technical work—the kind of thing I want to do most! This minimizes the amount of non-technical work that the company feels can and should be done by others."



Currently we are looking for scientists and engineers in microelectronics, instrumentation, systems analysis and control; for such projects as Apollo, Gemini, X-15, Mercury. If qualified, fill in and mail the coupon. Address: Mr. Roy Richardson, Technical Director, Honeywell Aeronautical Div., 2654 Ridgway Road, Mpls. 40, Minn.

Honeywell



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Jim Bass, Computer Data Processing,

and formerly of California... "One of the most important reasons I came was the knowledge that I could continue my education as I worked. And once I arrived in Minneapolis I was happy to find that not only was the University of Minnesota only ten minutes away, but Honeywell also encouraged me to go on with my schooling on a tuition-reimbursement basis! ...another reason was the small work groups. You don't feel like a number."



John Brewer, Senior Development Engineer,

born in Minnesota, and recently from Los Angeles... "For one thing, my family missed the four seasons we have out here... but more importantly, I suppose, was the fact that I wanted to work for a company I knew was foremost in controls in the U.S., and I wanted to have some control over what I designed and developed. To stick with a project from start to finish—to nurse it along—this Honeywell wants me to do."



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To explore professional opportunities in other Honeywell locations, coast-to-coast, write: Mr. H. G. Eckstrom, Minneapolis-Honeywell, Minneapolis 8, Minn.



Temperature Compensated Servo Motor Tachometers

Now available are servo motor tachometers which operate reliably over a wide ambient temperature range. For example, from 0°C. to 85°C., this Size 11 will maintain a speed sensitive voltage to within 0.3%, a phase shift to within 1°, and a tachometer linearity of 0.07% from 0 to 3600 rpm.

Write For Data Sheet 20C673

WRIGHT MACHINERY COMPANY

Division of Sperry Rand
Durham, North Carolina
Telephone 682-8161

NEW AEROSPACE PRODUCTS

Missile Gyro

Device, designated "Genie Jr.," has been developed for use in guidance systems of medium- and short-range tactical missiles.

Gyro is 3 in. long and only slightly more than 2 in. in diameter weighing less than one pound. Turbine-type gyro wheel is accelerated by a hot gas charge to an operating speed of 42,000 rpm. in less than 100 milliseconds after ignition, according to the manufacturer.



At top speed, the gas nozzle retracts automatically, and the gyro mechanism is uncaged and ready for firing. Only one electrical impulse is required to initiate the sequence, and no separate uncaging signal is needed.

After 60 sec. of operation, the mechanism's angular velocity is rated at 50% of maximum. The 2-deg.-of-freedom gyro has pickoffs in both axes. One gyro can supply reference for a spin-stabilized missile, and two can stabilize all three axes of a flying missile, the manufacturer reports.

Instrument Division, Lear, Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.



RPM. Limit Warning System

System developed for turbine-powered Bell HU-1 helicopters is said to detect minimum and maximum rpm. limits of engines and rotor from the tachometer generators and instantly flash a warning to the pilot by light and audio signals.

The manufacturer reports that the

NEW FLEXIBLE PERMANENT SEALANT

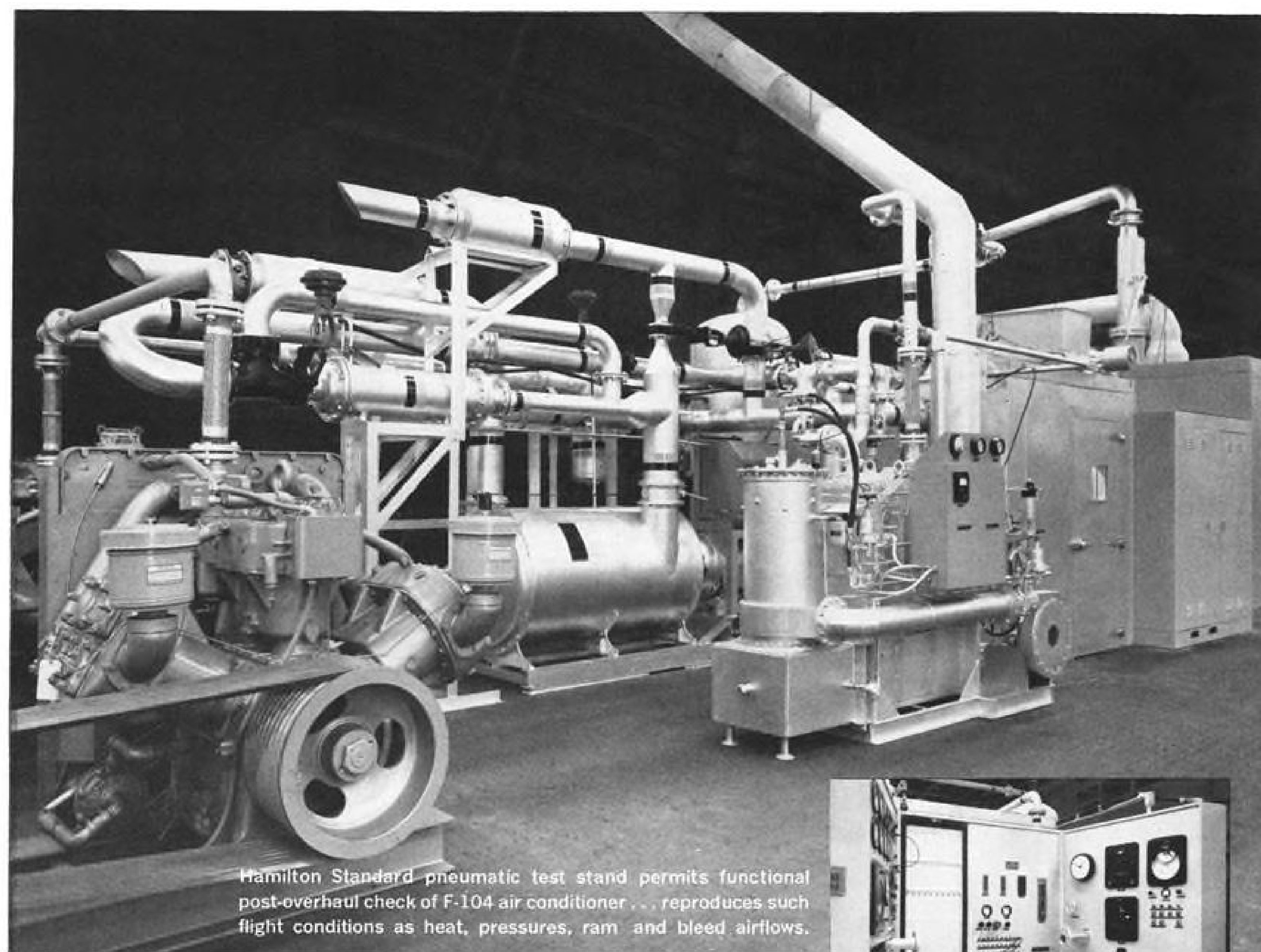


- seal metal joints, sheet work
- seal leaks
- insulate wiring and terminals
- use as adhesive for pre-fabricated silicone rubber

For a thousand jobs, just squeeze it on and it's on to stay! No pre-mixing or priming. RTV-102 silicone rubber adheres to almost anything — glass, metal, plastics, tile, wood, silicone rubber. Sets in minutes, cures in a few hours, forms a resilient rubber that never dries out, cakes or cracks. Resists moisture, grease, weathering, many chemicals, and temperatures from -75°F to 500°F.

RTV-102 won't sag on vertical surfaces, can be smoothed over large areas, "gives" with vibration and flexing. For free evaluation sample plus technical data, write on your letterhead describing your application to Section J670, Silicone Products Department, General Electric Company, Waterford, N.Y.

GENERAL ELECTRIC



Hamilton Standard pneumatic test stand permits functional post-overhaul check of F-104 air conditioner... reproduces such flight conditions as heat, pressures, ram and bleed airflows.

Flight lab for the F-104 air-conditioning system

The Lockheed F-104 Starfighter's air-conditioning and pressurization system "flies" within this pneumatic test stand, designed and built by Hamilton Standard.

Two electrically driven 150-hp reciprocating compressors in the test stand simulate engine bleed air. This air, routed through aftercooler-water separator, surge tank, and furnace, is then supplied to the turbine fan and the test chamber. A 150-hp turbine compressor simulates ram air. Capacity: bleed air, 55 lbs/min at 200 psig, 480°F; ram air, 130 lbs/min at 6 psig, 400°F; pressure, up to 1 lb/min at 550 psig.

Building test stands of this type demands a

high degree of technical competence in systems engineering, electrical circuitry, pneumatics, hydraulics, electronics, and packaging. At Hamilton Standard, these capabilities are integrated with quality manufacturing.

Hamilton Standard has produced test stands for environment conditioning equipment, jet engine fuel controls, propellers, and a broad range of related aerospace systems and components. For the solution to your aircraft and missile test equipment problems, write: Sales Manager, Ground Support Equipment, Hamilton Standard Division of United Aircraft Corporation, Windsor Locks, Connecticut.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

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A

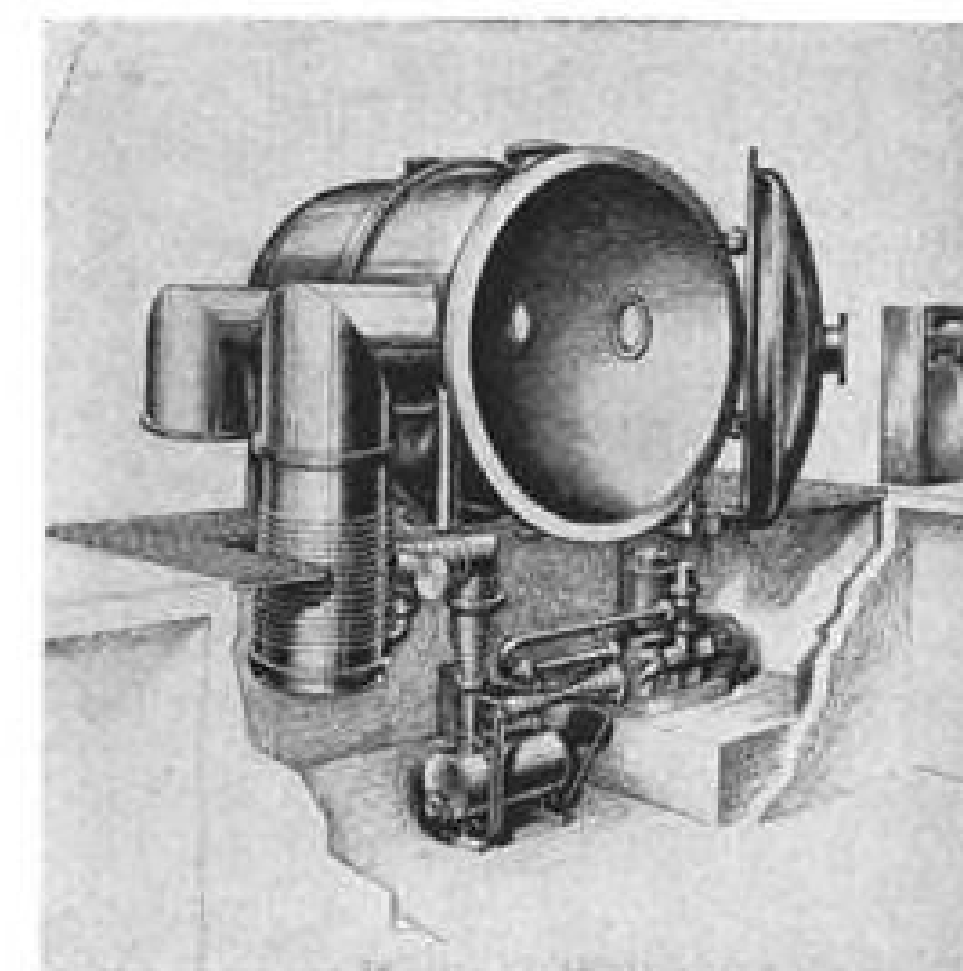
AEROSPACE & INDUSTRIAL ENGINE CONTROLS • ENVIRONMENT CONDITIONING SYSTEMS • GROUND SUPPORT EQUIPMENT • TURBINE STARTERS
SOLAR POWER GENERATORS • STATIC POWER SYSTEMS • AUTOMATIC STABILIZATION SYSTEMS • ELECTRON BEAM MACHINES • PROPELLERS

system has applications in conventional jet aircraft as well as helicopters. The system also detects turbine governor failure, power train failure, and rotor overspeed or underspeed during auto-rotation. It also has provisions for predicting turbine compressor stall and governing engine rpm. The system is designed for fail-safe operation and has a power drain of 1/2 amp. at 28 v.d.c.

Bell Helicopter Co., P. O. Box 482, Ft. Worth 1, Tex.

Space Simulation Chamber

Chamber designed for aerospace research and development operations is 8 ft. long and 8 ft. in diameter with a volume of 500 cu. ft.



The chamber includes a pumping system and controls for operation in the 1×10^{-6} Torr. range. The manufacturer says the device can reach a pressure of 5×10^{-7} Torr. in five hours or less. Chamber can be fully opened at one end by a hinged, 8-ft.-dia. flanged, dish-head door. The chamber has 12-in.-dia. view ports and 6-in.-dia. feed-through ports. Pumping system has a 32,000 liters per sec. diffusion pump, and a 32-in.-dia. connection is included for addition of another pump to upgrade the system.

Liquid nitrogen-cooled heat sink provides a cylindrical work envelope 7 ft. in diameter and 8 ft. long. Heat sink is designed for operation from ambient temperature to -320°F.

Chicago Bridge & Iron Co., 901 W. 22nd St., Oak Brook, Ill.

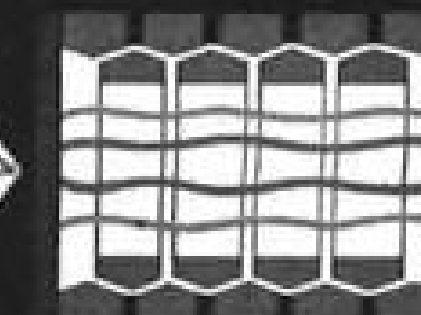
Solar Simulator

Portable simulator device is designed for use in laboratories and research centers to duplicate the sun's exact emission at the edge of the earth's atmosphere.

Simulator uses vacuum deposited interference filters and two lamps, one xenon and one tungsten, which can illuminate an area of 20 sq. cm. with full sun intensity. The device operates at a power input of 1 kw.

Optical Coating Laboratory, Inc., 2789 Giffen Ave., Santa Rosa, Calif.

Reduce Shock Forces

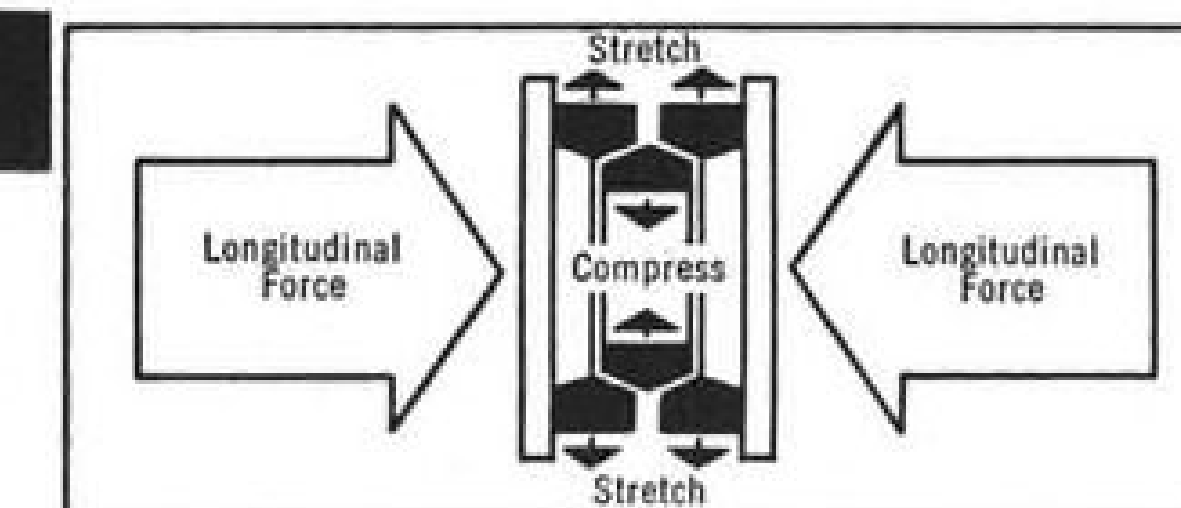


Edgewater Steel Company

EDGEWATER RING SPRINGS HIGH CAPACITY IN SMALL SPACE

Great capacity to absorb shock or vibration in a smaller space is made possible by the unique design of Edgewater Ring Springs. The smallest standard size—less than one inch diameter—resists axial forces up to 3150 pounds. The largest—19 3/4 inches diameter—will take almost a million and a half pounds force. A great variety of springs can be made within this minimum and maximum size.

The drawing below shows how the tensile and compression strengths of steel are used to provide a uniform, predictable rating for each size. An important characteristic of Edgewater Ring Springs is the damping effect. Friction, inherent in a ring spring, effectively dampens recoil, oscillations and harmonic vibrations.

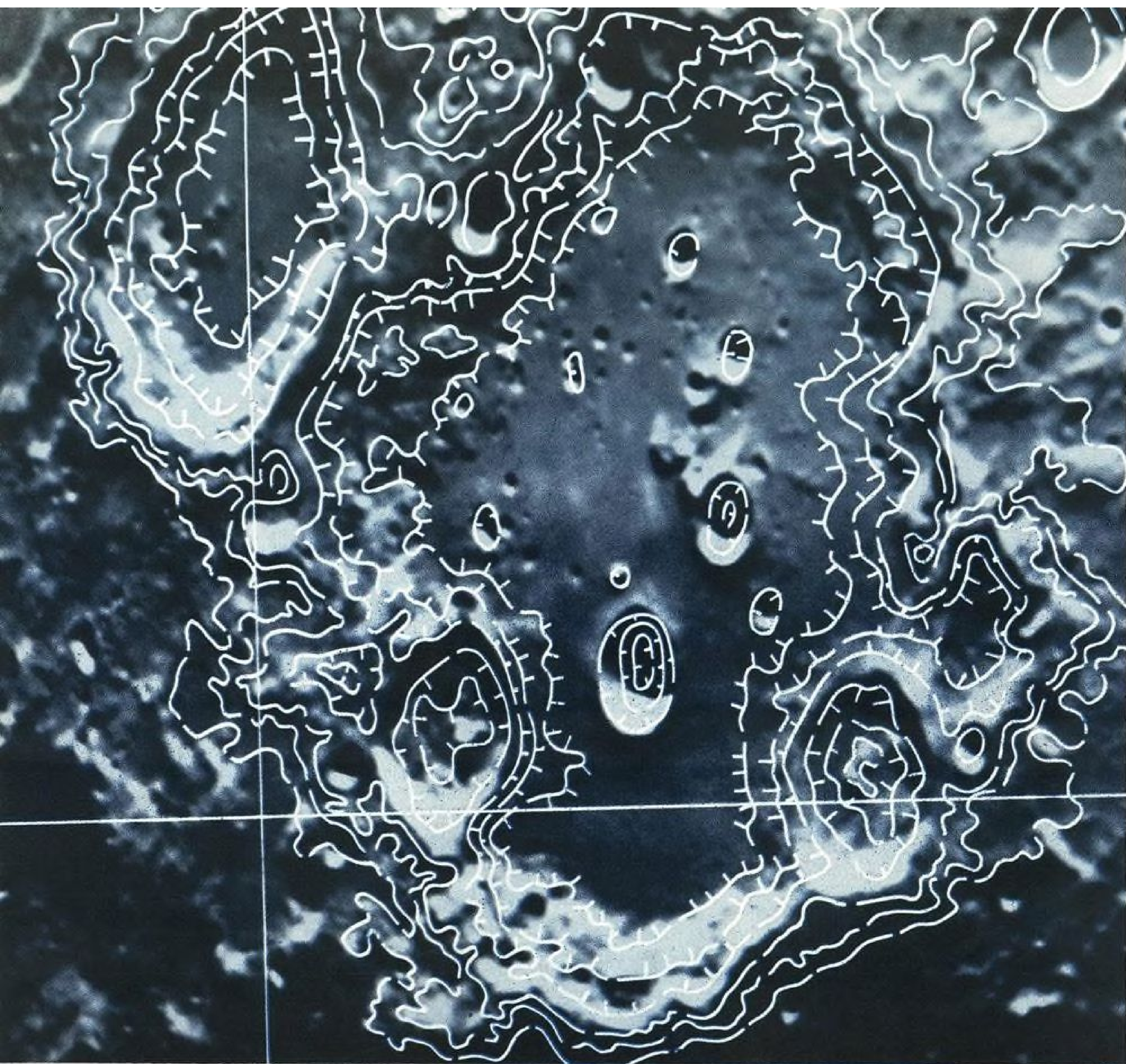


Edgewater Ring Spring element. Axial force expands outer rings, contracts inner rings. Travel is determined by number of elements.

Write for additional engineering information regarding applications, loading characteristics, permissible travel, space limitations, and other pertinent information.

EDGEWATER STEEL COMPANY
P. O. BOX 478 • DEPT. A.W. • PITTSBURGH 30, PA.





HOW TO MAP THE MOON

An electronic imaging system designed by Fairchild can survey the lunar surface with resolutions up to one meter. Charts of this precision can help our first moon explorers locate themselves with pinpoint accuracy. But how to make them? Fairchild studied the problem in depth, designed a system that can acquire terrain data from a lunar satellite, receive and process the data on earth, then convert it to highly detailed maps. The system can also provide high resolution photos of potential landing sites.

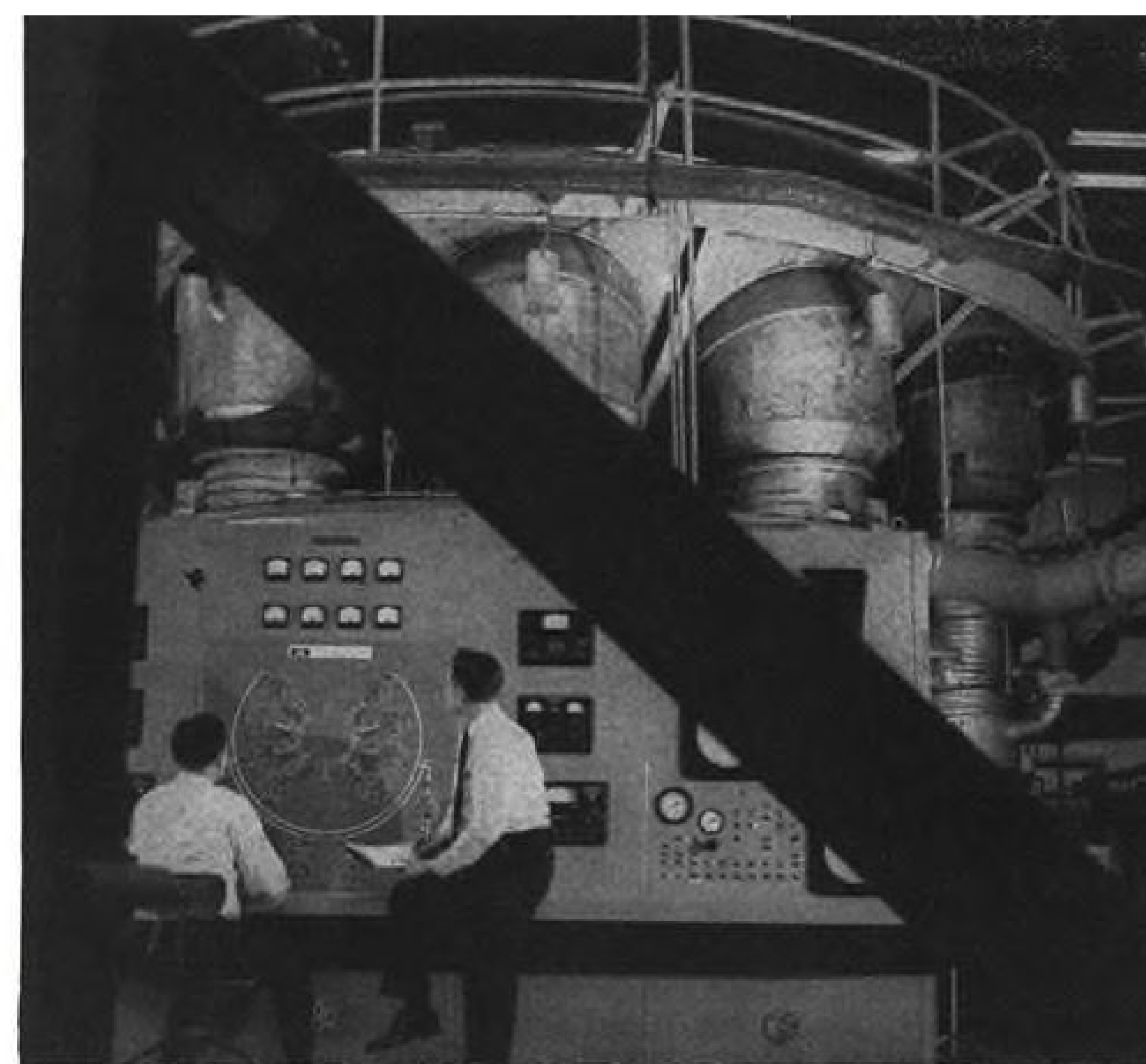
Advanced systems like this illustrate Fairchild's unique combination of capabilities in electronics, photography and in cartographic and data processing technologies. Other examples are outlined in a brochure, "Facilities and Capabilities—an Eye to the Future." For your copy, write Dept. 12, 750 Bloomfield Ave., Clifton, N.J.



DEFENSE PRODUCTS DIVISION

SYOSSET, N. Y. / CLIFTON, N. J.
LOS ANGELES, CAL. / PALO ALTO, CAL.

A COMPLETE VISUAL IMAGING SYSTEMS CAPABILITY

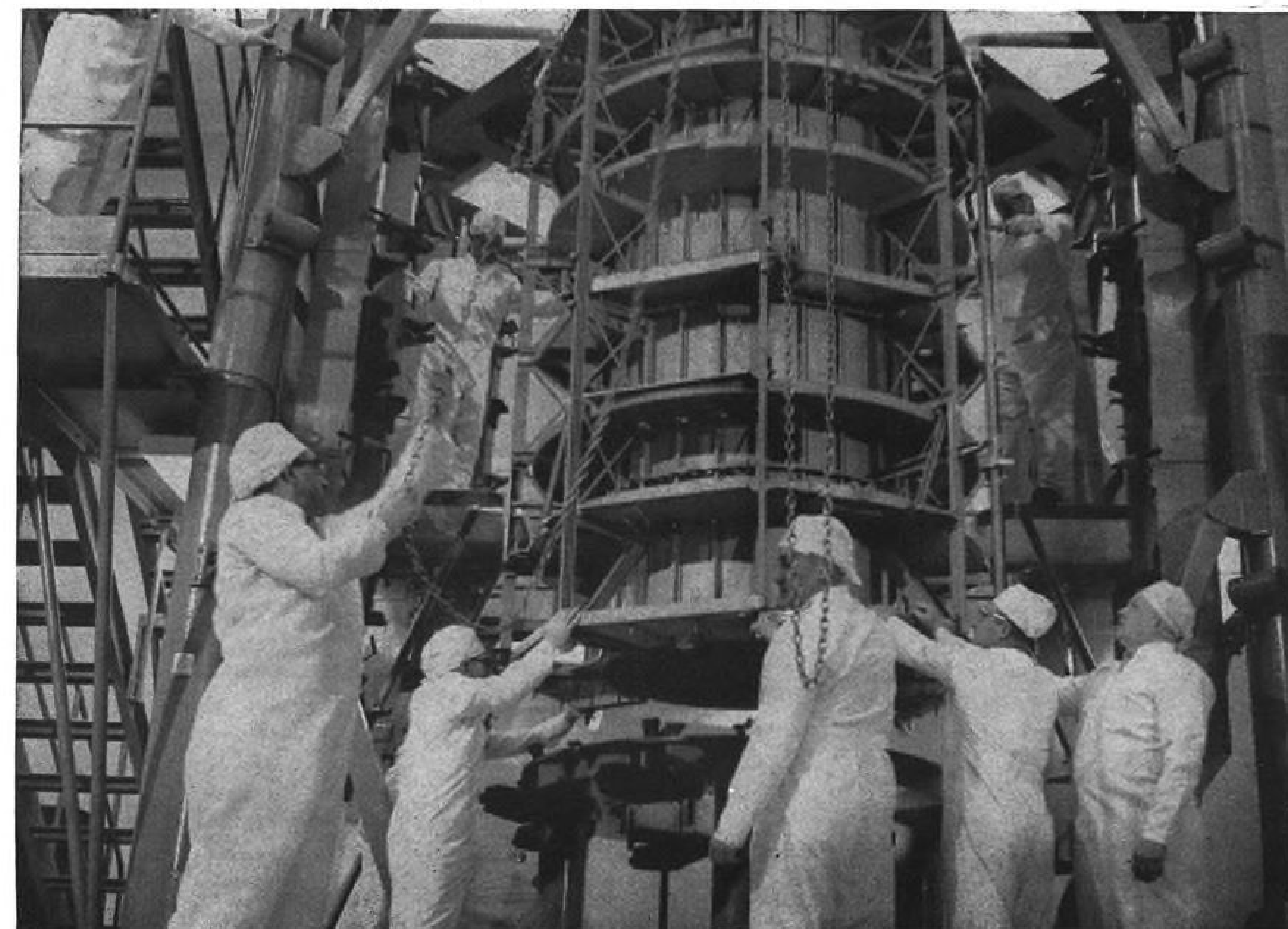


Environmental space chamber (left) at Grumman Aircraft Engineering Corp. is used to simulate vacuum conditions up to 200 mi. altitude in testing the Orbiting Astronomical Observatory (OAO). Echo 2 communications satellite canister assembly (right) is shown mounted on shaker table in Grumman space simulation center. All facilities shown are at the Bethpage, N.Y., plant.



Grumman Tests OAO, Echo 2 Satellite Assemblies

Grumman technicians prepare structural test model of the OAO satellite for testing in the clean room at the company's space simulation center (see cover). Satellite is scheduled for launch in late 1963 into 105-min. circular orbit at 500 mi. altitude to measure precisely the entire celestial field. OAO will weigh 1.5 tons, heaviest U. S. satellite developed to date.



AVIATION WEEK and SPACE TECHNOLOGY, June 18, 1962

**AEI Unit Designed to Operate
Continuously for 3 Years
Without Additional Lubrication
or Adjustment**

Here's 2100 lbs. of fail-proof 400-cycle power for ground support, designed and manufactured by the motor-generator experts of American Electronics, Inc. This motor-generator was developed for The Boeing Company for use at Minuteman hard sites. Though detailed performance data are under wraps, certain general characteristics of this new AEI unit are worthy of note.

**Designed to Perform Even
If Outside Power Fails**

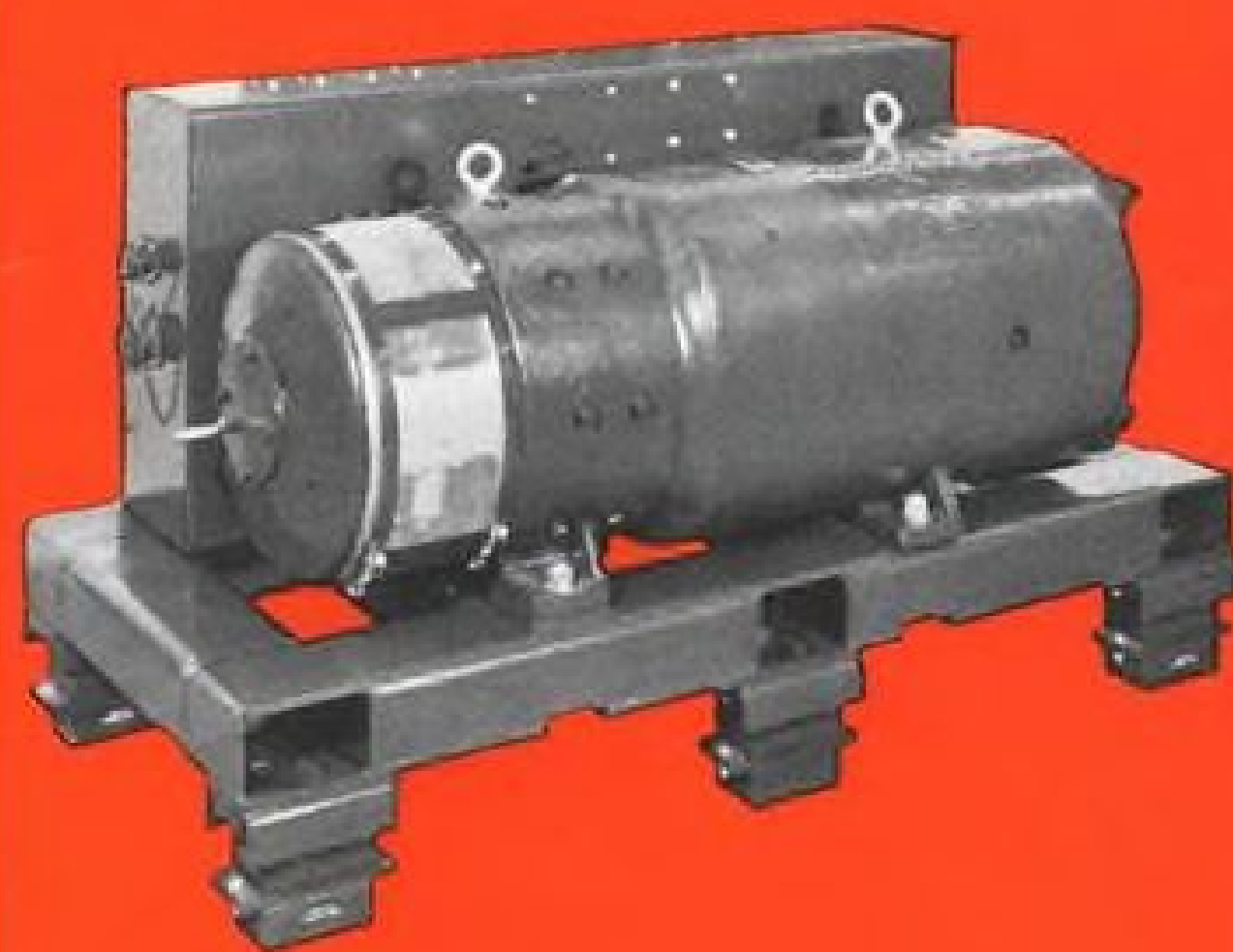
This all-in-one motor-generator draws current from the regular power lines; its AC-DC motor-generator delivers continuous 400-cycle power for the needs of the application. But integrated into the unit is an emergency DC motor powered by batteries. If the outside power source fails, the DC motor cuts in automatically—takes over immediately and continues to drive the generator.

**Designed for 3 Years
of Continuous Duty with
No Downtime!**

AEI's reliable design featuring an alternator without brushes or slip rings, delivers outstanding performance under the most stringent conditions. The unit was designed for continuous operation over a 3-year period—without maintenance, without downtime. Shock tests demonstrated it has a capability of withstanding extremely high "g's" while running under full load—which is no small point in favor of a unit to be used in the national defense.



MOTOR-GENERATOR DELIVERS 3 YEARS OF FAIL-PROOF POWER AT THE BOTTOM OF THE MINUTEMAN SILO



AEI AMERICAN ELECTRONICS, INC.
FULLERTON, CALIFORNIA

**AEI Know-How Means
Reliable Performance**

The special motor-generator unit described here is very special, indeed—both in application and function. But it shares a common characteristic with all other AEI motor-generators—and with all the products made by AEI. That common denominator is reliability. Since its inception, AEI has been building experience both broad and deep in rotary equipment and associated sub-systems. AEI's Rotary Power products run the gamut from high-frequency power supplies to high-speed turbine powered generators. Prime contractors, industry, and the military count on these and all AEI products for top reliability.

**AEI Thinks Ahead to the
Future of Aerospace**

AEI design-engineers have been responsible for practical advances in a variety of products for aerospace. Continuing R & D programs insure that more such advances will be forthcoming. Most of the nation's missile and satellite projects now employ one or more AEI products. AEI can supply your needs, too. For a picture of AEI activities, write for our comprehensive brochure.

Engineering Opportunities

Fresh ideas are always welcome at AEI. Qualified engineers who would like to expand into a creative environment are invited to write, too.

Address inquiries to American Electronics, Inc., Dept. AW-662, 1594 East Ross Ave., Fullerton, Calif. Telephone TRojan 1-3020. TWX FUL CAL 8110 • WUX.



AIR/SPACE INSTRUMENT CAPABILITIES

Rich in experience, ASTEK engineers pioneered in the development of many of today's standard air and space instruments and systems. ASTEK is now working on new advanced projects that will significantly contribute to the routine operation of advanced aircraft, missiles and space vehicles.

ASTEK
INSTRUMENT CORP.
ARMONK, NEW YORK

PRODUCTION BRIEFING

Avco Corp.'s Lycoming Division, Stratford, Conn., will produce Mark 5 re-entry vehicles for the Minuteman ICBM under an \$8.1-million contract from USAF's Ballistic Systems Division.

The Garrett Corp.'s AiResearch Mfg. Division, Phoenix, Ariz., has received a \$200,000 contract from Atomics International Division of North American Aviation, Inc., to develop power conversion components for the Snap (Systems for Nuclear Auxiliary Power) program.

General Electric Missile and Space Vehicle Department will produce re-entry nose cones for the Air Force's Titan 2 ICBM under a \$16.75-million contract from Ballistic Systems Division.

Moog Servocontrols, Inc., will produce electrohydraulic servovalves for the Navy's Terrier-Tartar missile systems under a \$500,000 contract from General Dynamics/Pomona.

Ling-Temco-Vought has received a \$1.19-million contract from the Army to produce launchers for the Sergeant surface-to-surface missile.

Greenhut Construction Co., Pensacola, Fla., will modify the Saturn booster static test tower at National Aeronautics and Space Administration's Marshall Space Flight Center under a \$900,000 contract. Work will consist of rigging the west side of the tower to accommodate tests of the Saturn C-1 booster.

General Dynamics/Convair will fabricate and test a titanium component suitable for use in supersonic aircraft, missiles or space vehicles under a \$98,000 contract from USAF's Aeronautical Systems Division. General Dynamics will select the part, which must be of general design and configuration, such as a fuselage frame or bulkhead, to be applicable to advanced aircraft or spacecraft. Test program will simulate critical combinations of loads and temperatures up to 1,000F which would be encountered by advanced space vehicles.

Sikorsky HSS-2 twin-turbine helicopter has been selected by the Japanese Defense Agency for use in that nation's anti-submarine warfare operations. An initial order of 11 helicopters is planned as a result of negotiations carried out by United Aircraft Corp., Sikorsky's parent company, through Mitsubishi Heavy Industries Reorganized, Ltd., Japanese licensee for manufacture and sale of the HSS-2.

JACK & HEINTZ



A.C. VOLTAGE REGULATOR

The Jack & Heintz 51158 A. C. Voltage Regulator is a combination transistor magnetic amplifier, 3 phase average sensing type regulator designed for a missile application. Of single deck construction, all external electrical connections plug into the rack mounted 51158. Circuit connections are failproof—joined with ERSIN Multicore 5-Core Solder—assuring the highest degree of reliability in operation.



ERSIN Multicore 5-Core Solder costs Jack & Heintz a trifle more than ordinary solders—but this is more than compensated for by the vital savings realized through more joints-per-pound, and virtually no costly rejects due to cold or H/R joints. For production efficiency, guaranteed by 5 cores of exclusive ERSIN flux and fast melting thin-wall construction, quality manufacturers have come to rely on ERSIN Multicore, the world's finest cored solder.

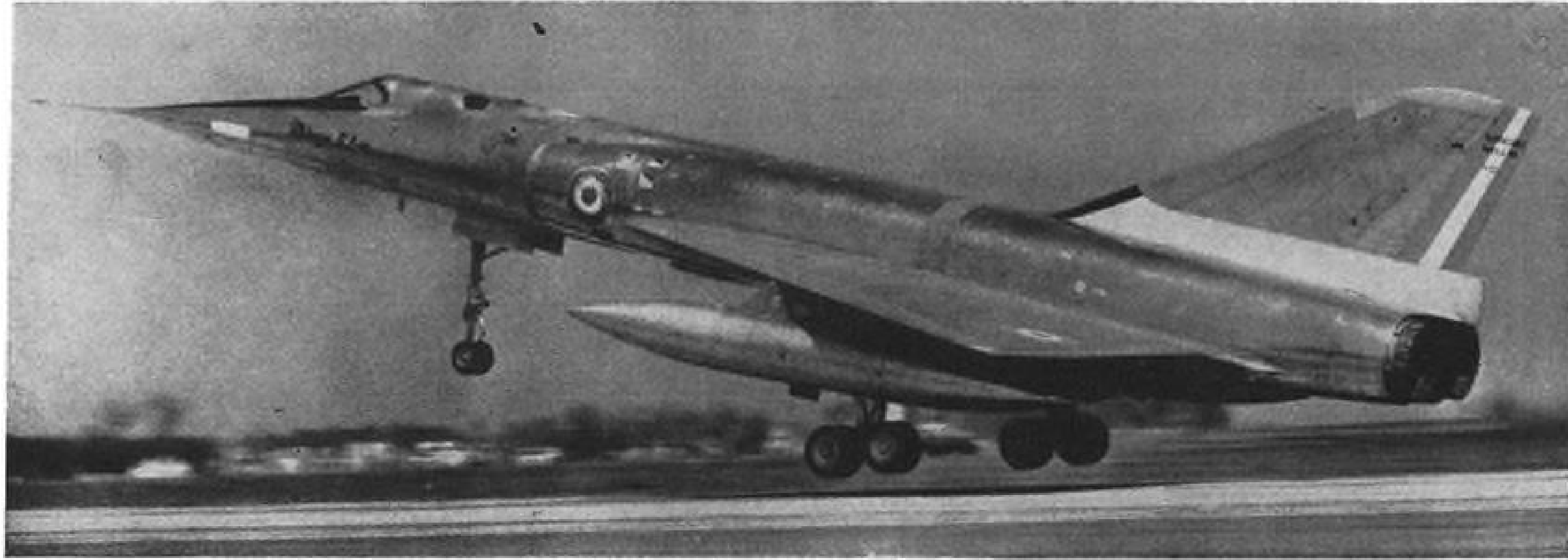
Multicore is approved under all applicable Federal Specifications



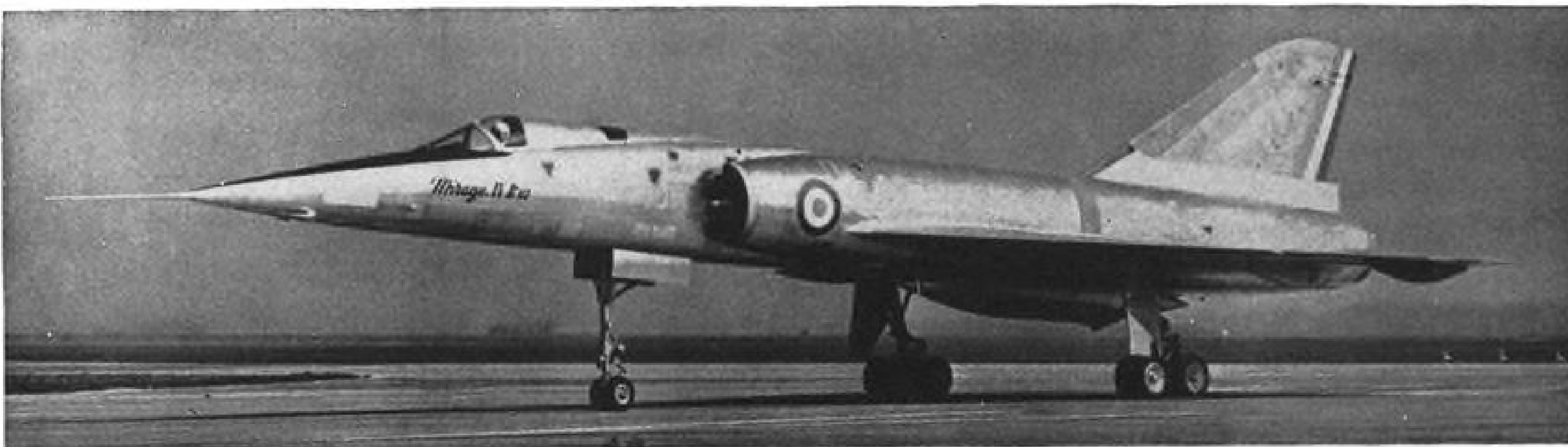
ERSIN
Multicore
5-CORE SOLDER

MULTICORE SALES CORPORATION
PORT WASHINGTON • NEW YORK

AERONAUTICAL ENGINEERING



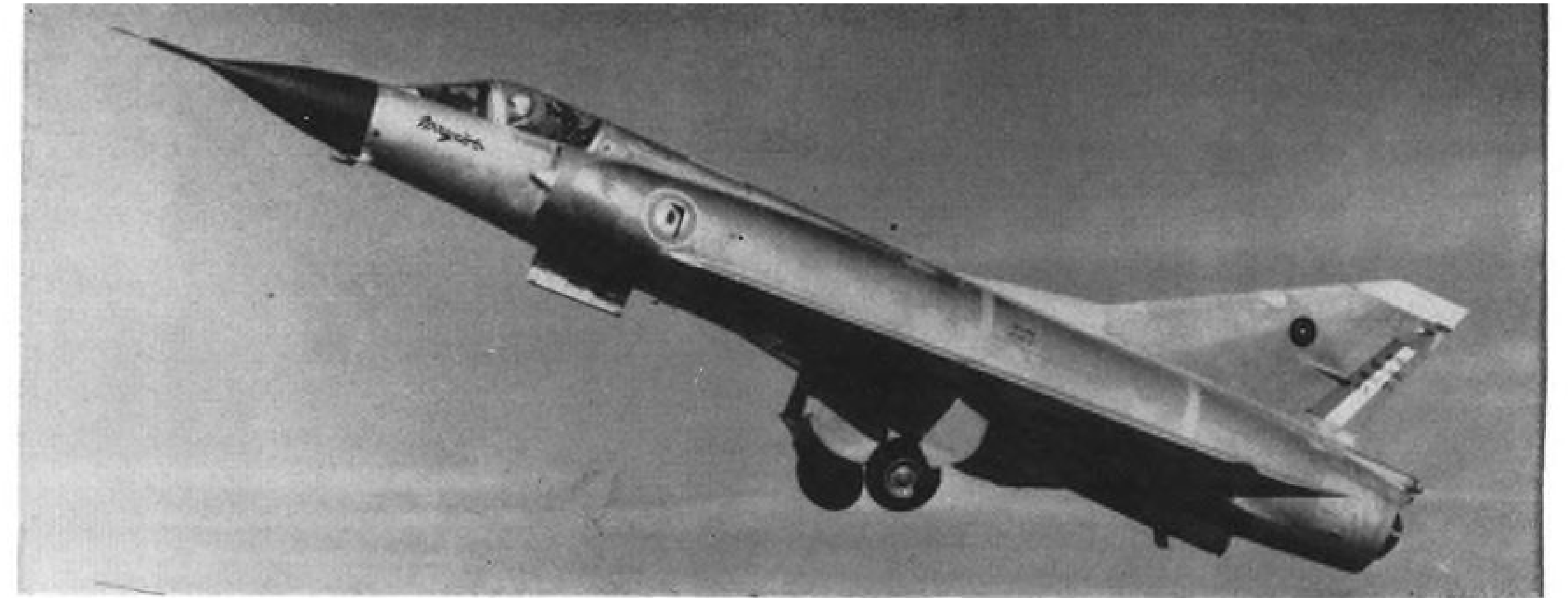
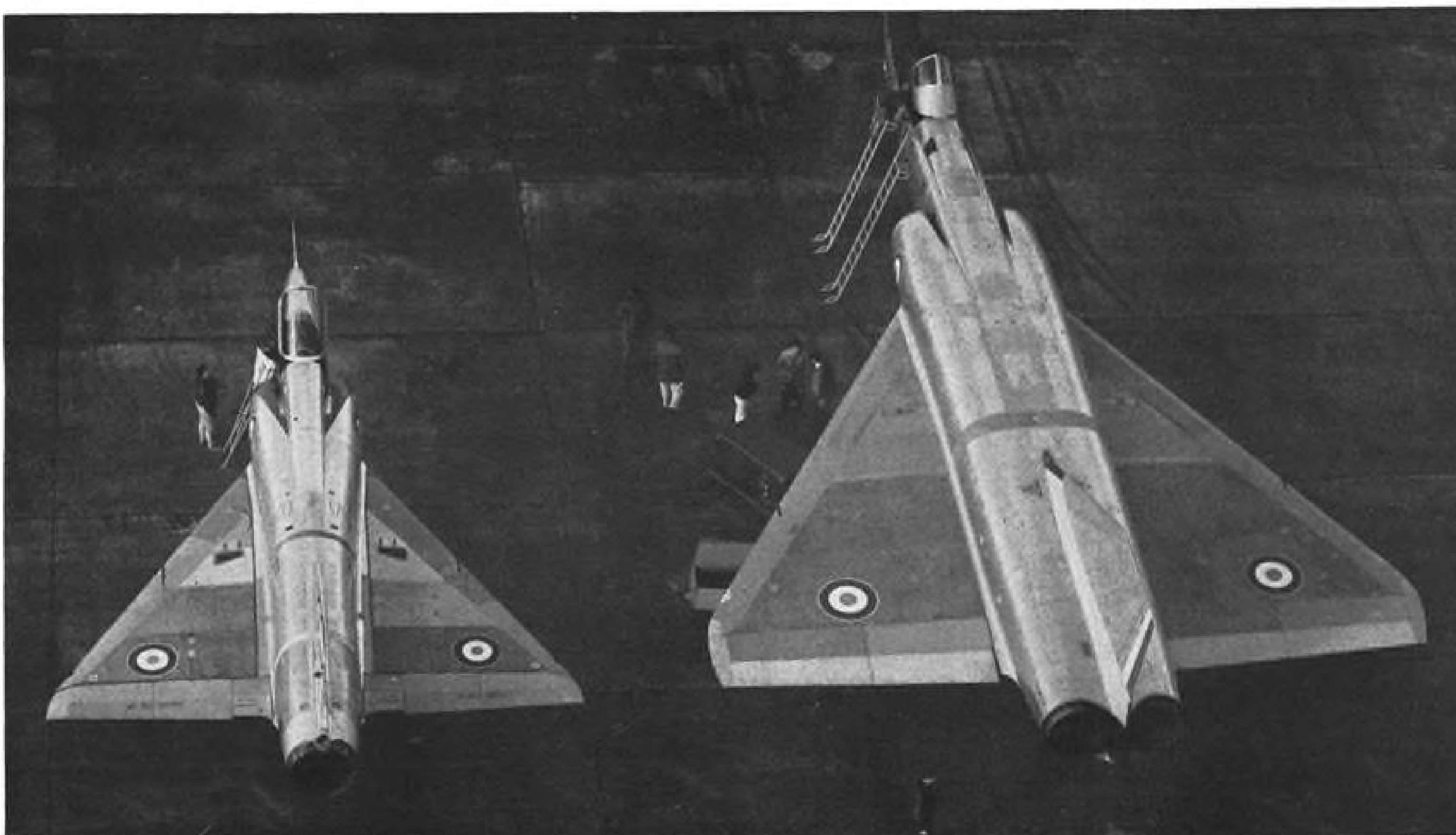
French air force Dassault Mirage 4A twin-jet bomber takes off with wing fuel tanks.



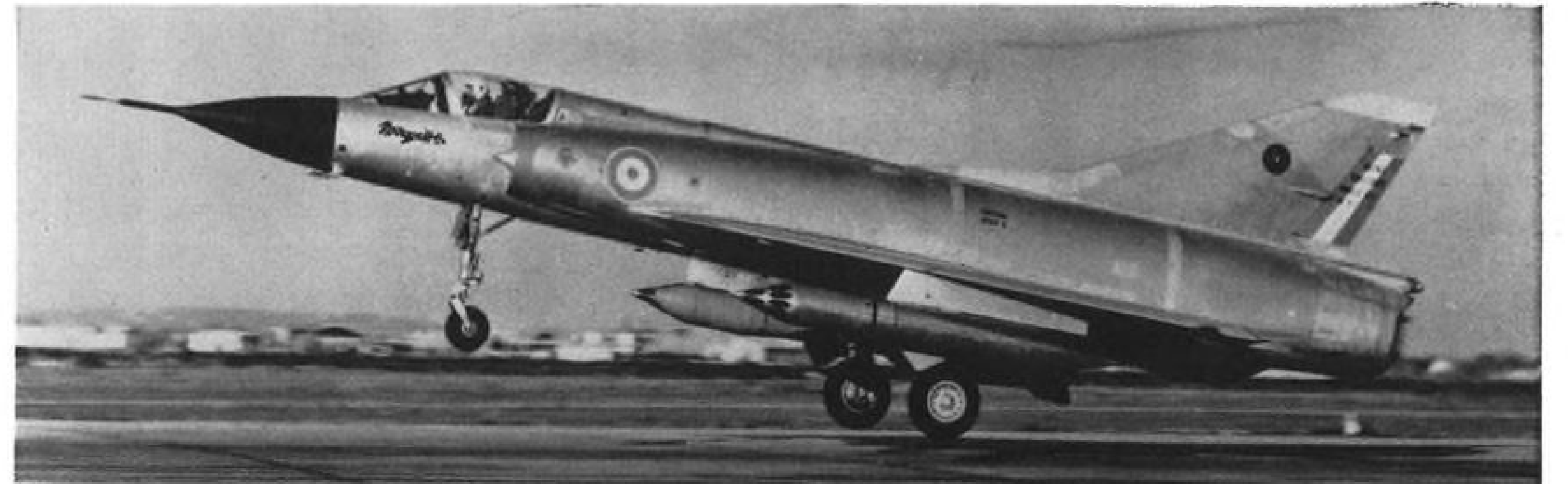
Mirage 4A is powered by two Snecma Atar 9 turbojets, can be modified to serve as tanker. Photo shows auxiliary fuel tank under fuselage.

Mirage 4A Carries Wing Tanks; USAF Tests Mirage 3C

Photo below shows comparative size and design similarity of Mirage 3R reconnaissance fighter (left) and Mirage 4A bomber.



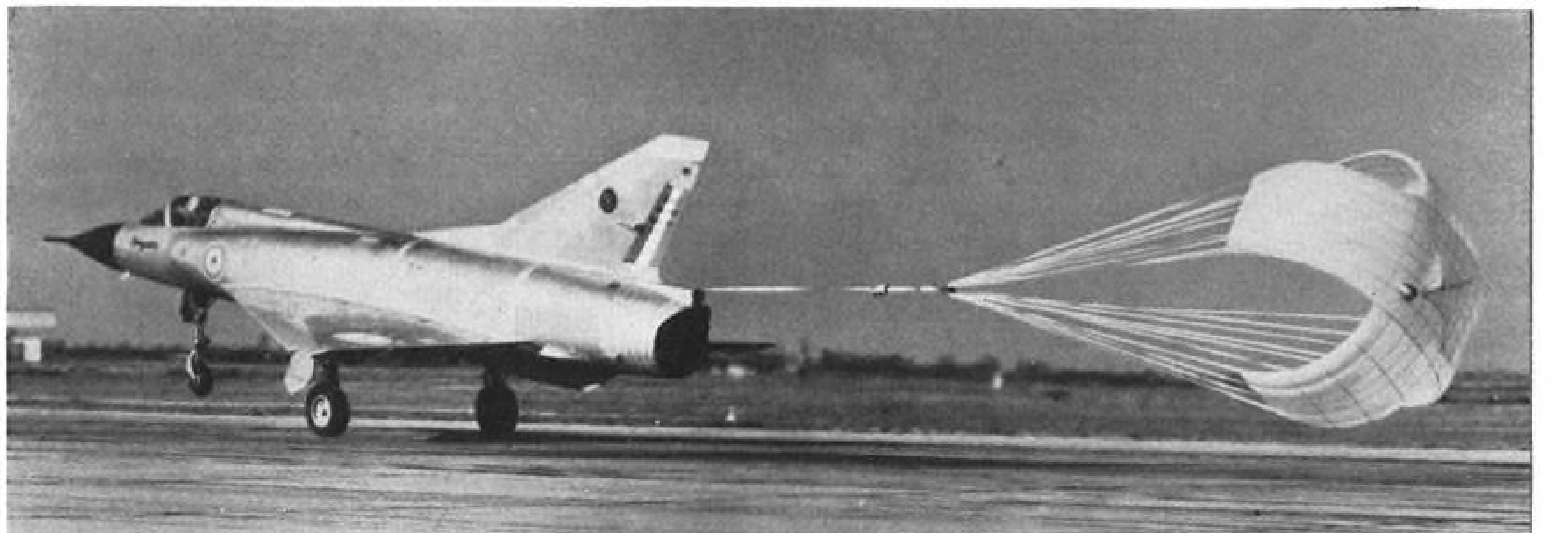
Dassault Mirage 3C fighter interceptor is shown retracting landing gear shortly after takeoff. Aircraft is powered by Snecma Atar 9B turbojet delivering 13,225 lb. thrust with afterburner. Initial deliveries of aircraft to French air force began this year.

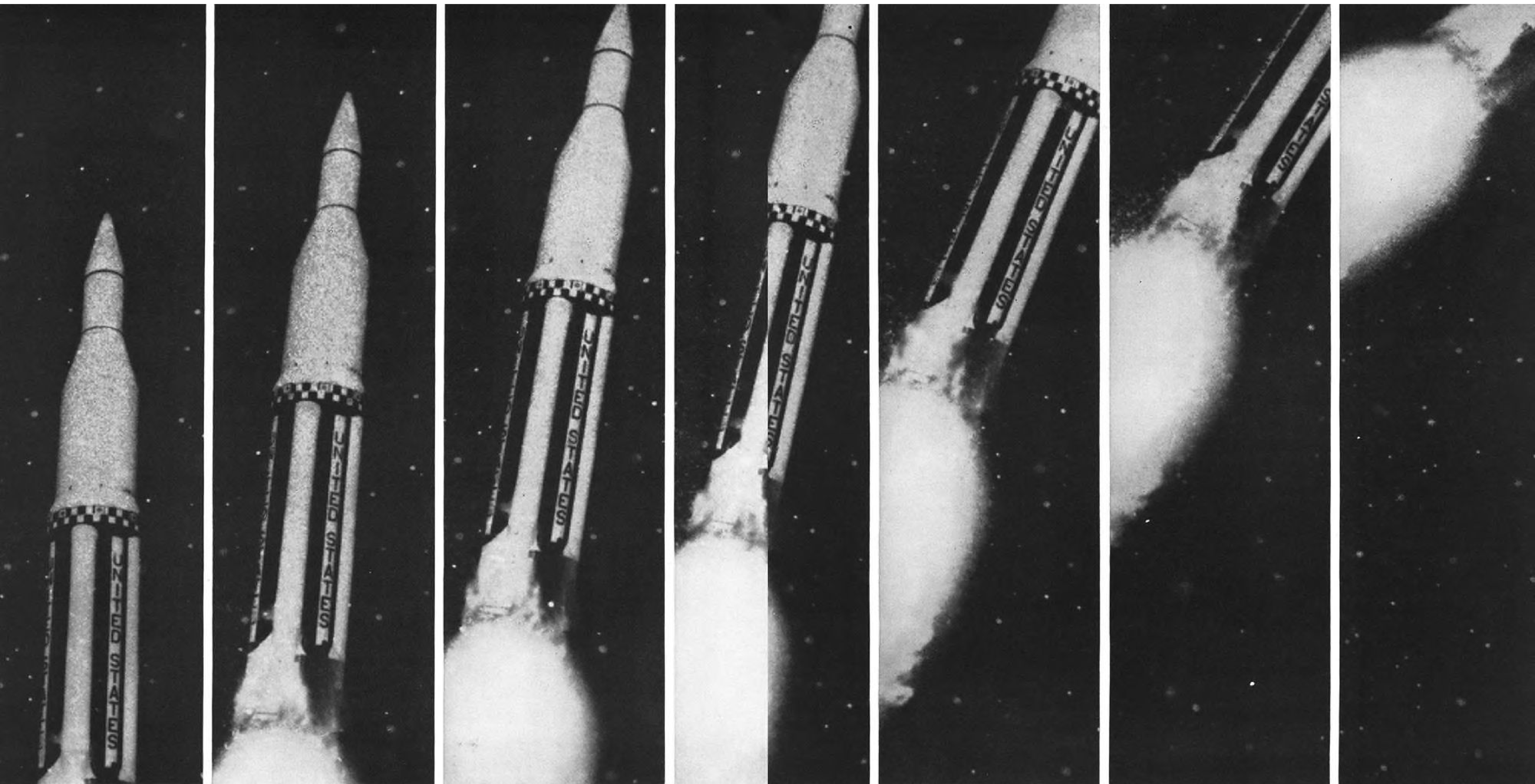


U. S. Air Force pilot takes off in Mirage 3C carrying rocket pods during evaluation flight. Besides French air force, Dassault has sold the plane to Israel, Switzerland, Australia and Republic of South Africa. Ground support fighter and reconnaissance versions have also been developed, the former incorporating Doppler radar for all-weather capability.



Mirage 3C is shown above with auxiliary fuel tanks slung under the wings. Below, USAF test pilot, one of three who evaluated the aircraft and its associated weapons systems deploys a cruciform arresting parachute immediately after touchdown.





TARGET INSTINCT...

Eclipse-Pioneer advanced inertial guidance systems give missiles, boosters and space vehicles unerring "target instinct" whatever the mission. Proof?

Take the Pershing, Army's "shoot and scoot" missile. Flight tests have demonstrated the flawless accuracy of the inertial guidance system—built by E-P—which utilizes our ultra-sensitive air-bearing gyros and accelerometers. Per-

formance has continually exceeded project specifications. And production has been consistently ahead of schedule.

Take the Saturn C-1, NASA's super-rocket earmarked for manned space flight. E-P has been selected to build the highly complex guidance platform because of our knowledge in space age techniques and our proven success on the Pershing missile.

BUILT IN!

Inventiveness, imagination and experience play key roles in Eclipse-Pioneer's ability to solve the difficult and complicated problems associated with the science of inertial guidance. When it comes to state-of-the-art in manufacturing techniques, E-P takes the lead. For example, tolerances of 10 millionths of an inch and one second of arc are constantly maintained in our own Beryllium production machining

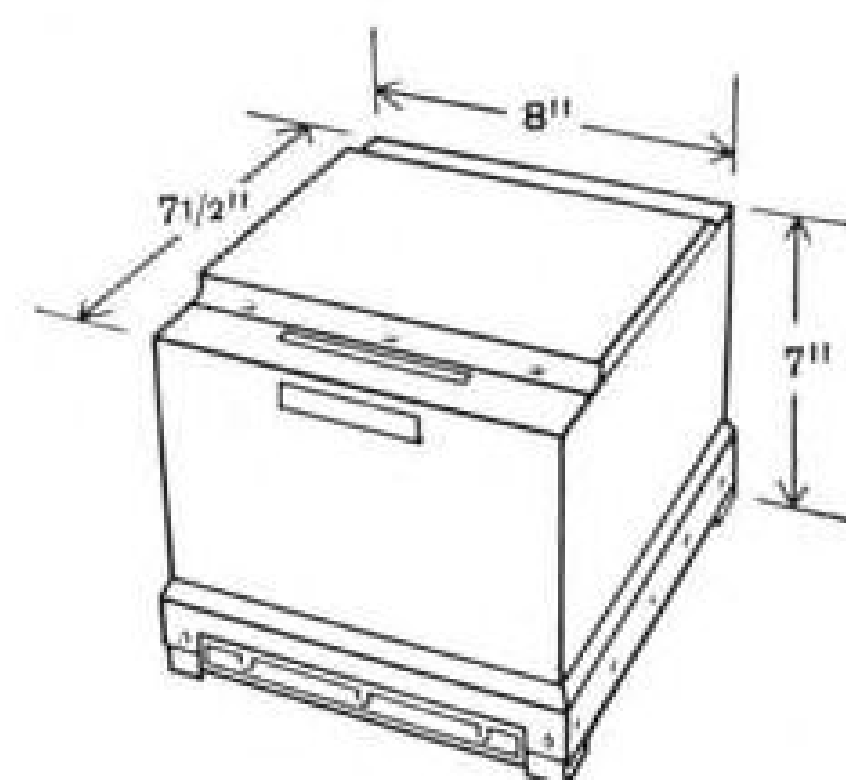
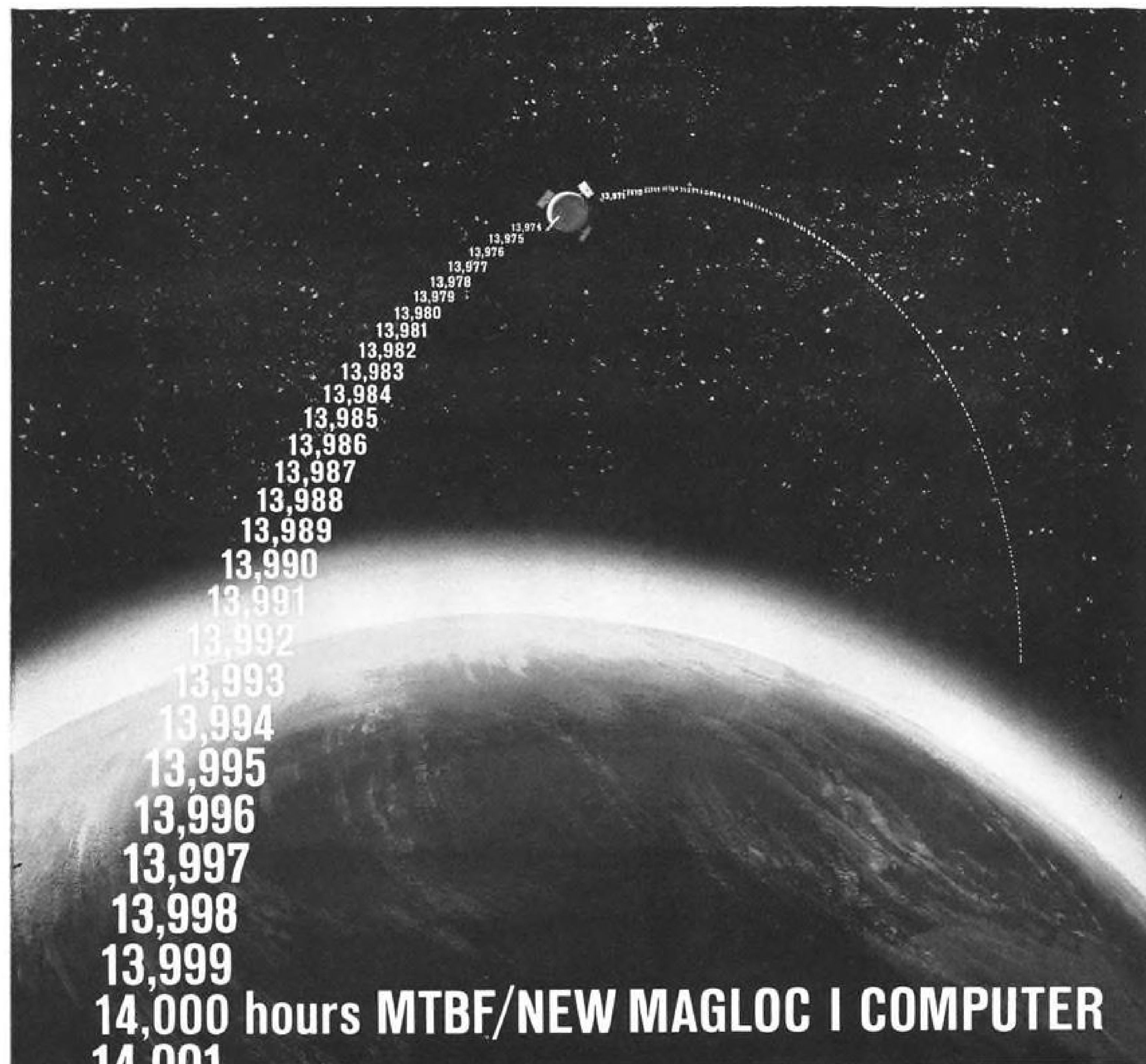
facility. From initial design to complete system manufacture and test, our facilities and capabilities are backed by over forty years' experience in developing and producing the world's most advanced systems for flight control and airborne navigation.

Our technical sales staff invites discussion of your guidance and control requirements. Call us at Teterboro, N. J.

Eclipse-Pioneer Division



**WHERE IDEAS
UNLOCK
THE FUTURE**



SPERRY

An operating model of Magloc I—a new logic computer employing advanced magnetic techniques for maximum aerospace reliability—will soon be delivered to Aeronautical Systems Division, Air Force Systems Command, USAF. Its reliability target is 14,000 hours mean-time-before-failure, under extremes of environment.

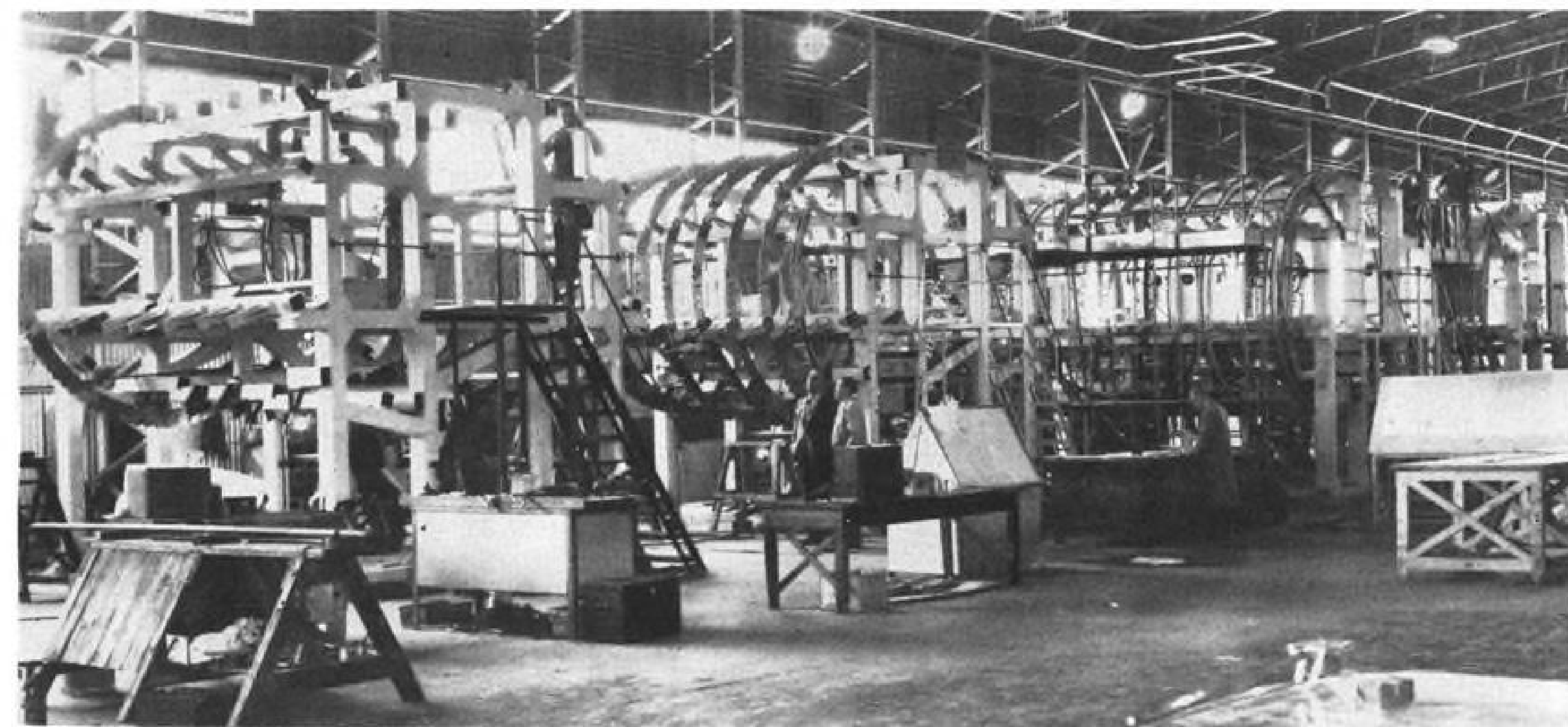
Developed by Sperry under ASD sponsorship, Magloc I uses the high reliability inherent in non-active magnetic components for its logic, drive and memory circuits. Extensive design study and test breadboarding have resulted in a significant reduction in the number of fail-prone semiconductor components such as transistors and diodes . . . in a replacement of these components by magnetic components . . . and in an overall reduc-

tion of total components.

For example, the active components required in a 24-stage shift register was reduced by a ratio of 24-to-1, and the total component count by a ratio of 9-to-1. Unique, high-density, encapsulated welded packaging—using functional building block techniques—further enhances the inherent reliability of the new logic computer.

Magloc I features a biaperture ferrite non-destructive readout, and electrically-alterable program memory operating from -55°C. to 125°C. without compensation. Effective clock rate is 300 kc. Designed for long-duration interplanetary missions, Magloc I offers distinct advantages in cost, size, weight, and radiation resistance. Inquiries are invited.

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



MAIN FUSELAGE JIGS for the British Aircraft Corp. BAC 111 transport are on the production line at Vickers-Armstrongs' Hurn final assembly plant. BAC 111 will be built on the Viscount production line at the factory. Long-range version of the BAC 111 will have a 1,000-gal. fuel tank added to the center fuselage section for British United Airways.

British Push BAC 111 Service Program

By Herbert J. Coleman

London—British Aircraft Corp., now well advanced in logistics of building its BAC 111 twin-jet Viscount successor in four widely separated plants, has turned to concentration on building up a snag-proof sales and services program in strategic world areas.

Metal for the airplane now is being cut at Vickers-Armstrongs' plants at Weybridge and Hurn; Hunting Aircraft, at Luton, and Bristol Aircraft, at Filton. Final assembly will be at Hurn.

Strong sales backup, aimed strongly at the U. S. market for potential sales impetus, is being developed by British Aircraft Corp. in cooperation with its competitor, Hawker Siddeley Aviation, using Society of British Aircraft Constructors standards as a guideline.

System is directed mostly at manufacturers of components in Britain, long a sore spot with airframe and engine manufacturers because of lack of an over-all quality control plan. Airlines, in particular, have been critical of after-sales service inadequacies involving groundings to wait for replacement parts.

Rules for standardization currently are being formulated by a SBAC technical subcommittee. As part of the long-range servicing plan which will result, BAC has decided to offer a year's warranty on the BAC 111 instead of the six-months warranty offered on previous transports, such as the Vickers Vanguard.

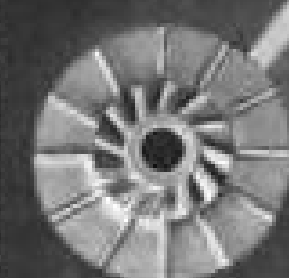
Corporation expects that the BAC 111 will be certified by the summer of



COCKPIT MOCKUP of BAC 111 at Hurn is based on Braniff Airways specifications for two pilot operation. Engine instruments are centered, with flight gages in left and right T outlines. White lighting is used.

Major advance in cryogenic cooling

Miniature turboexpander increases closed cycle system reliability



Actual size turbine wheel for 250,000 rpm, gas lubricated turboexpander in AiResearch closed cycle systems

Garrett-AiResearch is completing development work on closed cycle nitrogen, helium and neon systems using a tiny turboexpander in place of a piston expander.

This promises to dramatically increase system reliability and service life because all wearing surfaces, valves and troublesome reciprocating loads have been eliminated.

These compact, lightweight systems for masers, parametric amplifiers, IR cell cooling and computer components are ideally suited to commercial applications as well as military ground and aerospace uses.

AiResearch was first in production with an open cycle IR cooling system, and has already produced a closed cycle nitrogen system. The company is now working on military programs for 30°K and 4.2°K closed cycle systems.

Utilizing its experience as a world leader in lightweight turbomachinery and cryogenic cooling, AiResearch is also developing an all-turbomachinery closed cycle system incorporating a turbocompressor as well as turboexpander.

Your inquiries are invited.

AIRESEARCH MANUFACTURING DIVISIONS • Los Angeles 45, California • Phoenix, Arizona

Systems and Components for:

Aircraft, Missile, Spacecraft, Electronic, Nuclear and Industrial Applications



1964, with first flight pegged at next April.

Development cycle thus would be about three and one-half years from conception to delivery to customers in late 1964.

Project team consists of 2,000 persons, and is under the over-all direction of W. Arthur Summers, managing director of Hunting Aircraft.

Hunting's Luton plant is responsible for the BAC 111's wing design and construction.

Production Doubled

Summers said a production batch of 20 aircraft was the original intent, but that that figure has been doubled as a corporate gesture of confidence in future sales. Then BAC 111s have been ordered by British United Airways, Braniff International has ordered six and eight are for an operator who does not wish to be identified, but reportedly is buying the eight aircraft as a broker.

Summers said that about 50% of the manufacturing drawings have been issued to production teams; about 20,000 will be needed for the entire project. All major tools and jigs are completed and test rigs are under construction. Eleven models for wind tunnel testing have been built, at a cost of about \$500,000 and company is nearing 1,000 hr. of tunnel testing, producing 50,000 data points.

Main airframe stress tests will start at the end of this year, with 1,500 gages indicating stress levels. Fatigue testing is planned for equivalent of 100,000 flights of average flight time of 40 min. Summers predicts a fatigue life of 30,000 hr. per aircraft and added the entire fatigue program will take about two years to complete.

Landing gear will be tested separately, primarily due to a history of gear cracking troubles associated with jets now in service.

Ground Time Cut

Major portion of design time has been spent on reducing ground times to a minimum, according to A. J. K. Carline, Hunting chief designer who was involved in design of the Hunting 107, predecessor of the BAC 111.

For instance, Carline pointed out the following:

- Hydraulic airstairs for both front and rear loading can be provided to customer requirement.

- AiResearch auxiliary power unit is mounted in the tail cone for self-contained main engine starting, ground electrical power and ground cooling of cockpit and passenger cabin. AiResearch APU was selected because the Garrett division could guarantee service backup. Carline said integrated APU also improves payload capability by eliminating

Too high!

Too low!

Coming in just right!

Glide Angle doubt is permanently out...

with Sylvania's Visual Glide Slope Indicator

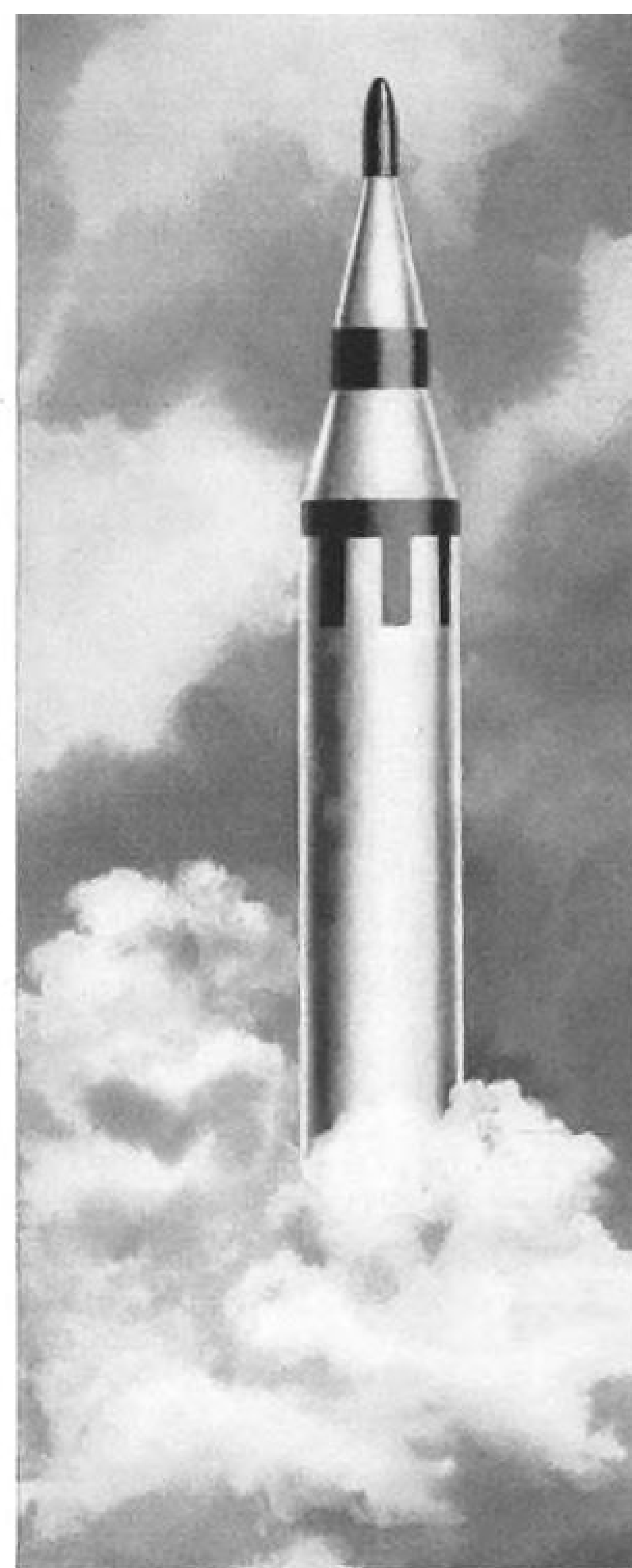
Here's the remarkable new lighting system that makes landings safer and easier than ever before. It's the Sylvania Visual Glide Slope Indicator. Now being installed at major metropolitan airports. Veteran pilots praise it. Here's how it works.

When a pilot comes in too high, he sees a double bank of white lights on either side of the runway. When he comes in too low, he sees a double bank of red lights. When he comes in just right, *on the correct glide slope*, he sees one bank of red and one bank of white. It's a major advance in airport safety, and it's ready to work for you now. Conforms to applicable FAA and military specifications.

Whatever your airport lighting problems, Sylvania has the lighting system and technical assistance to solve it. For information write to Special Products Division, Sylvania Electric Products Inc., Estes Street, Ipswich, Mass.

SYLVANIA
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS





COMMAND AND CONTROL

The nation's deterrent posture is based on a tightly controlled retaliatory force capable of immediate action through the proper commands. The survivability of the command and control structure and the security of its communications are vital elements in overall national defense.

The design of such a command and control system demands consideration of the politico-military structure, and of the deployment and use of a wide variety of weapon systems of overwhelming power. To this must be added a proven capability in modern electronic technology.

Raytheon's Missile and Space Division has developed truly unique concepts by applying an integrated "weapon system" approach to the command and control problem. Raytheon is applying these concepts to the problems of survivable national communications, as well as control of strategic aircraft and missiles, mobile ballistic missile systems, and field army weapons.

Engineers or scientists interested in these vital and challenging areas are invited to contact Mr. W. F. O'Melia, Raytheon Company, Missile and Space Division, Bedford, Massachusetts.

RAYTHEON COMPANY

MISSILE AND SPACE DIVISION

RAYTHEON

need for bleed takeoffs from the two Rolls-Royce Spey engines.

- Single-point refueling at 300 gpm. rate takes 7½ min. to complete. Automatic cutoff for filled tanks will be installed.
- Single servicing point for domestic water supply and external servicing of toilets.
- Low-loading of baggage compartments, both fore and aft. Sliding freight doors form a ledge to assist baggage loading.
- Large capacity wheel brakes designed for 15 min. turnarounds without overheating. Carline said brakes have twice the kinetic energy absorption as those utilized on the Viscount turboprop aircraft.

Duplicate Systems

BAC 111 has duplicated systems to essential controls, such as flaps and spoilers, tailplane trim and rudder and feel units, along with duplication of sources of power. Two hydraulic systems are independent of each other and both include an electrically powered backup to the engine-driven hydraulic pump.

In case of complete power failure, the BAC 111 can be flown safely on manual elevators and ailerons, with sufficient freedom to operate the rudder manually for landing. Gear may be lowered by gravity after manually releasing the up-locks.

Electrical system also is duplicated; in the event of complete loss of main electrical power, two 25-amp. batteries provide power for at least 45 min. for essential services.

Three Spars

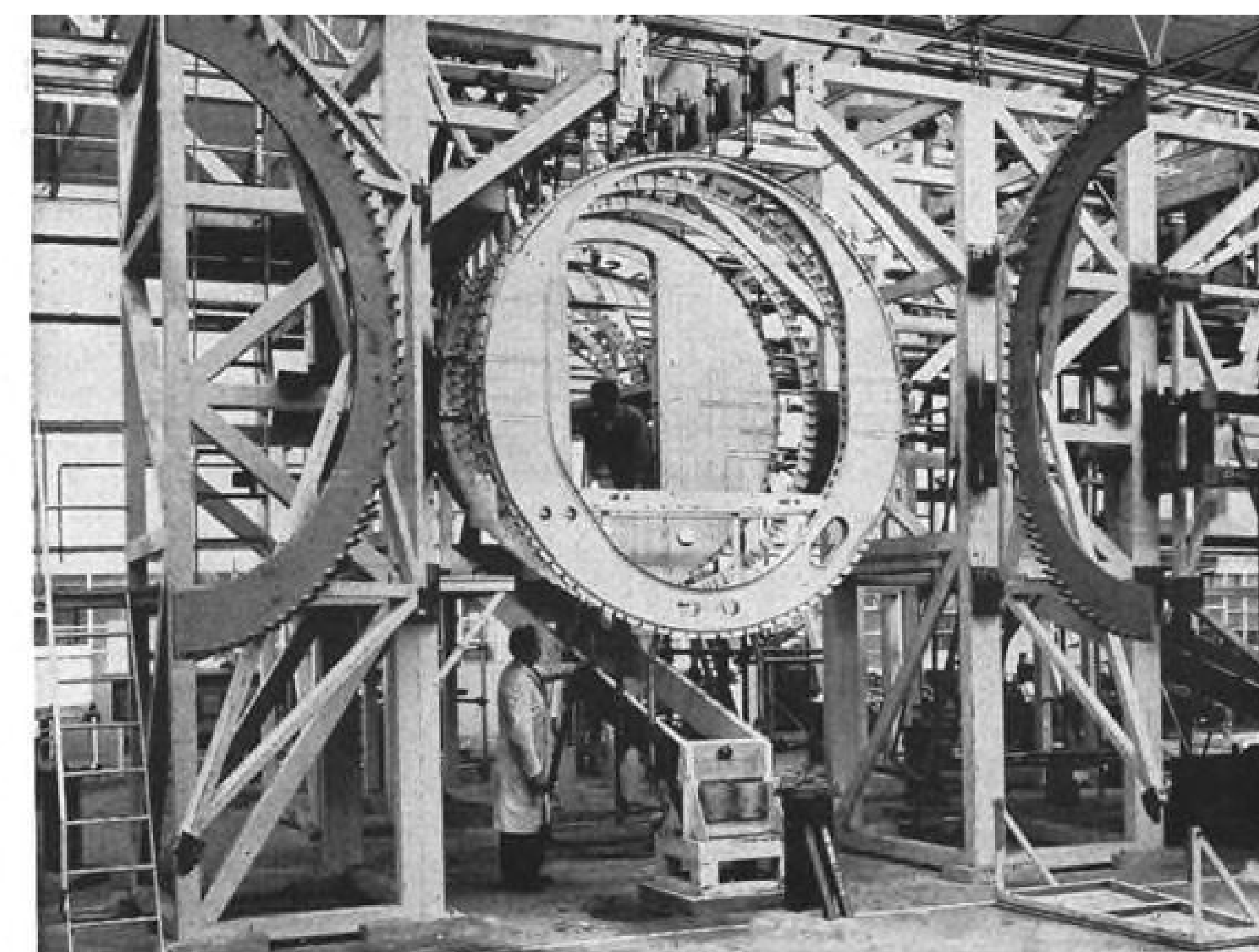
Carline emphasized that, on fail-safe philosophy, wing has three spars and the fuselage has continuous frames and stringers, with frames cleated directly to the skin. This provides a stress level of 9,800 lb./in. Primary structure utilizes only copper-based aluminum alloys in order to attain high fatigue-resistant properties.

There are no zinc-based alloys used in BAC 111 construction. In addition, Carline said there will be no high grade steels used in landing gear design, because of difficulties experienced with the larger jet transports.

To facilitate maintenance, Spey engine pods have large doors for engine removal.

Thus, it is not necessary to dismantle the pod-mounted fire detection system during a change. All fluid lines to the engines also have self-sealing couplings.

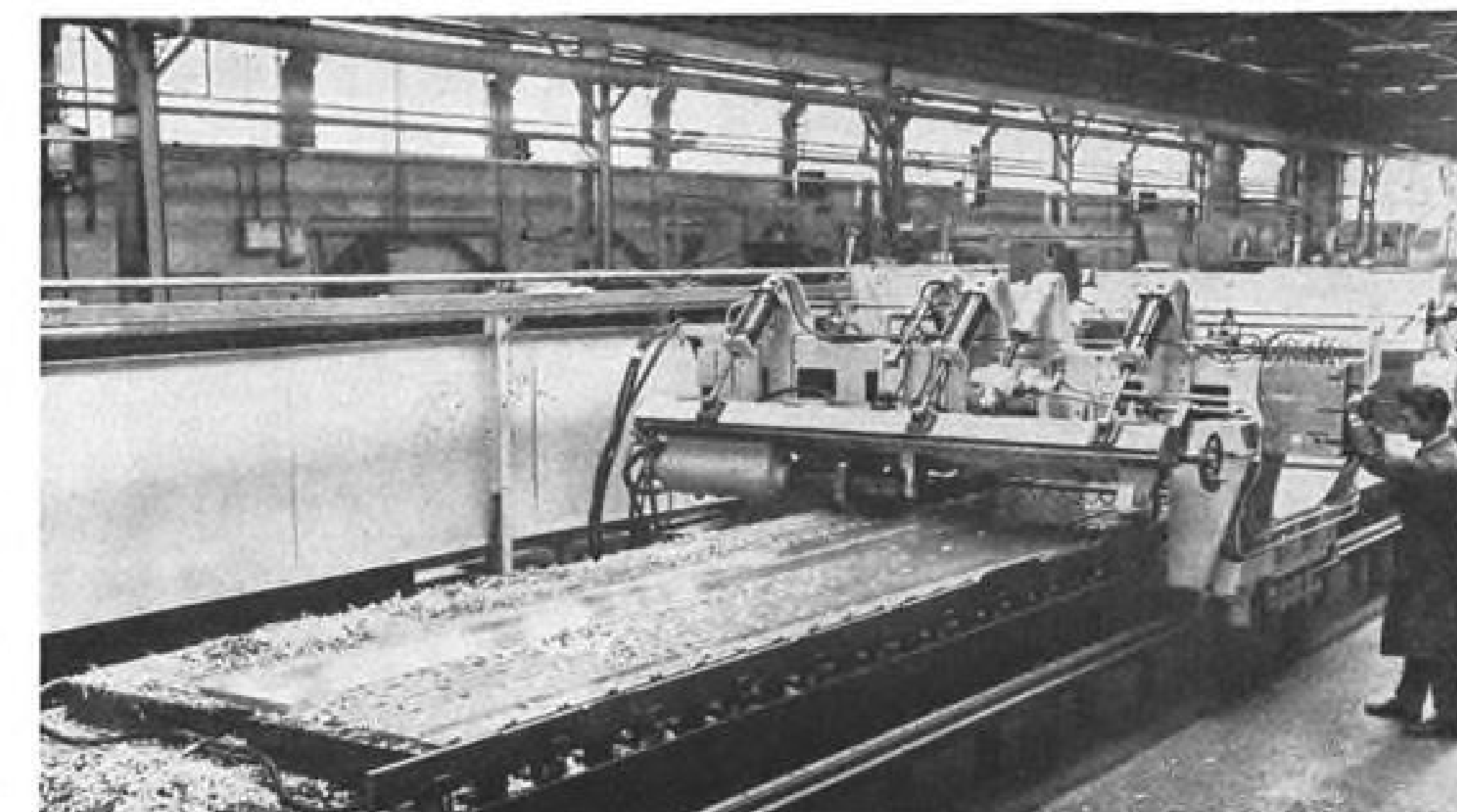
At Vickers-Armstrongs' Weybridge plant, work is concentrated on machined wing skins and fuselage panels, the wing center section and landing gear. Customer mockup, which has been in-



REAR FUSELAGE of BAC 111 is built in this jig at Bristol Aircraft plant at Filton.



ROLLS-ROYCE SPEY bypass jet engine for BAC 111, de Havilland Trident and Blackburn Buccaneer naval strike fighter is built at the Derby factory.



STRUCTURAL MILLING MACHINE at Weybridge cuts billet to form fuselage side panel with integral stringers. Window openings are routed out later.



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Avco // **ELECTRONICS AND ORDNANCE DIVISION**

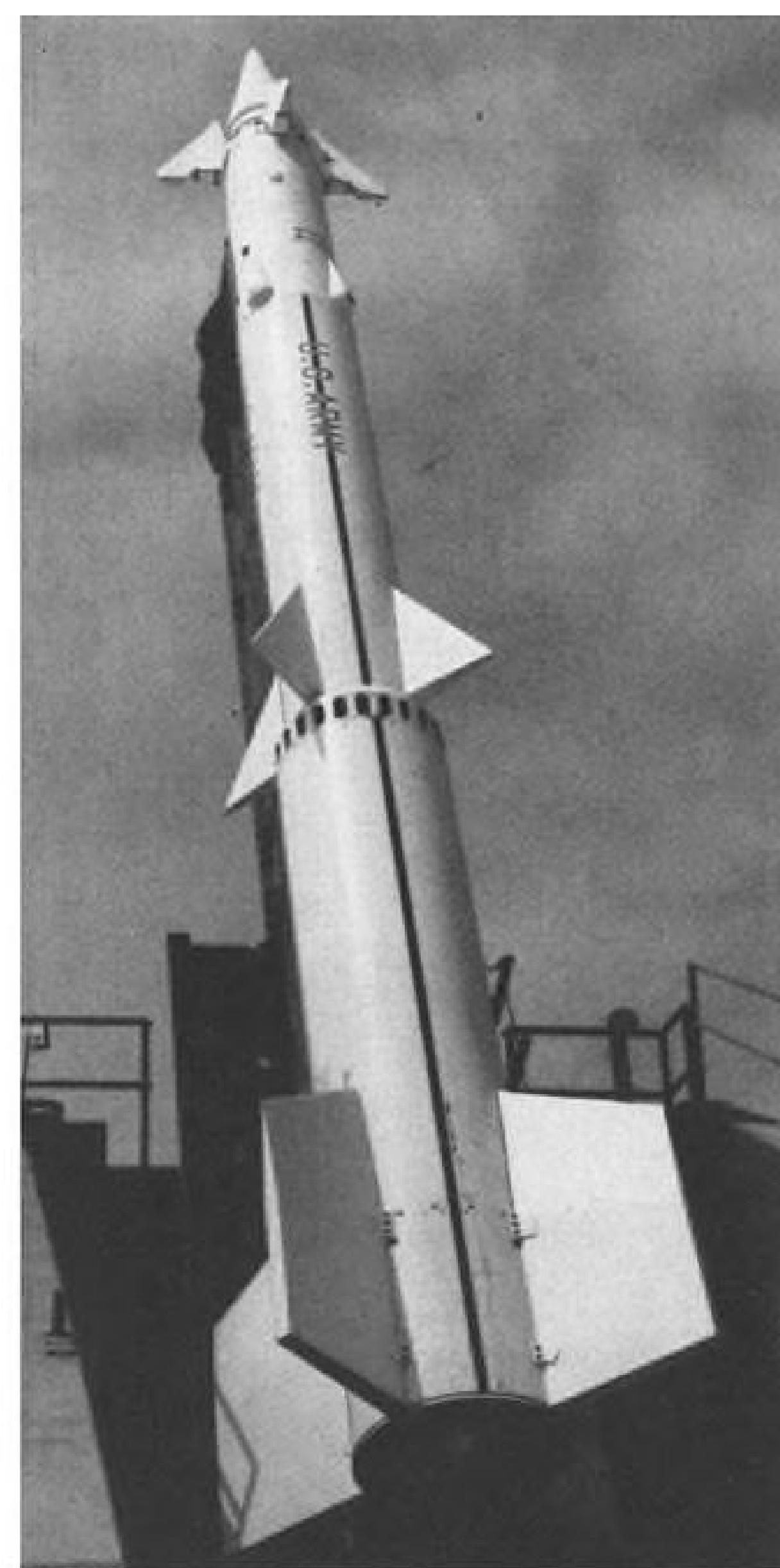
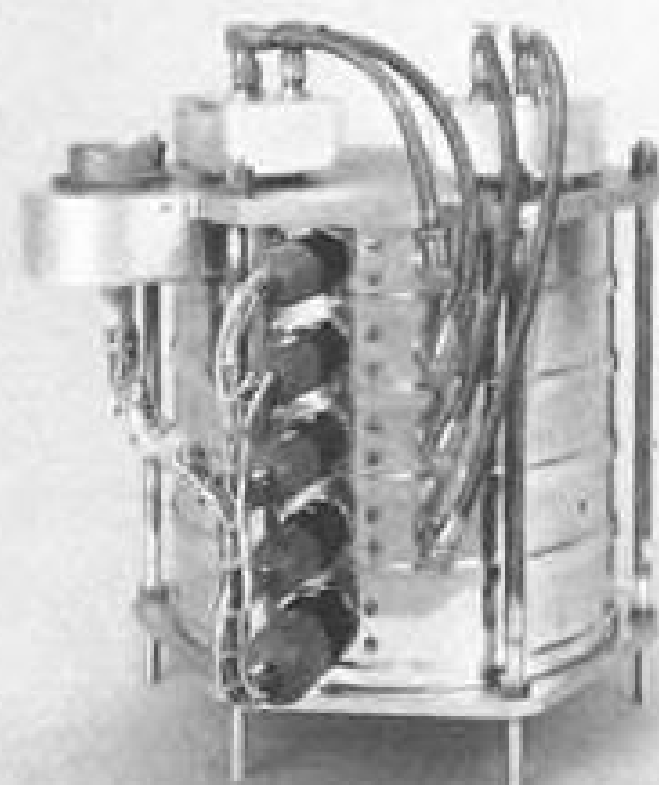
"Keeping in touch": communications for space

Space communications gear by Avco's Electronics and Ordnance Division today meets a wide range of military and nonmilitary needs . . . on the ground, in missiles and launch vehicles, and in space vehicles. For example:

- 1. Explorer XI.** Between April 27 and December 6, 1961, Avco's Satellite Receiver and Decoder functioned reliably more than 1,000 times before ordered to "turn off" satellite.
- 2. Orbiting Astronomical Observatory.** The OAO, being built for NASA by Grumman, will carry four Avco Satellite Receivers and an Avco Video Detector.
- 3. Saturn.** Avco's Solid State Decommutator, ground-based at Canaveral, can process simultaneously all data telemetered from the Saturn booster engines.
- 4. Orbiting Solar Observatory.** The OSO, developed for NASA by Ball Bros., took into orbit a combination of Avco's Satellite Receivers and Decoders on March 7, 1962.
- 5. Ionosphere Research.** Avco Phase Lock Receiving Systems, at six locations in the U.S., will measure phase differences between signals from a series of ionosphere satellites, one of which is up—four more to go.
- 6. Range Safety.** Hundreds of Avco Missile Command-Destruct Receivers have served in space-launch vehicles, missiles, and drones since 1953 without a single failure.

For complete information on Avco's space communications capabilities, write: Director of Marketing, Electronics and Ordnance Division, Avco Corporation, Cincinnati 41, Ohio.

This Avco Satellite Command Receiver and Video Detector package will activate and control all equipment aboard NASA's Orbiting Astronomical Observatory.



Zeus Shot Success

Twelfth Nike Zeus anti-ICBM missile firing at Pt. Mugu was considered a partial success, although it failed to hit tape-created target fed to intercept computer. Missile was intentionally destroyed before third-stage motor ignited.

spected by representatives of 40 airlines, is also located at Weybridge.

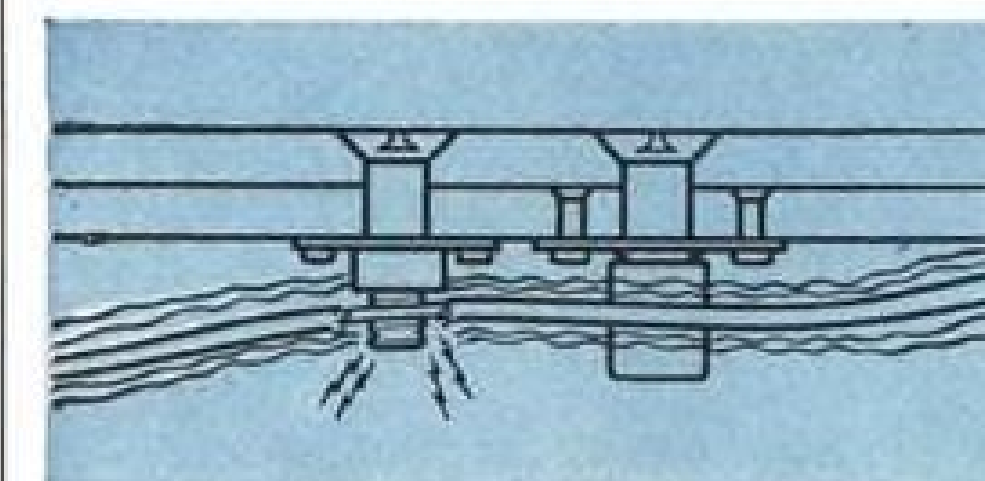
Largest section for shipment to Hurn final assembly line is the rear fuselage and tail fin, now being built at Bristol Aircraft, Filton. First unit is on the jigs and will be shipped by road to Hurn after completion.

At Hurn, the BAC 111 will be built on the Viscount production line, where work is under way on Viscounts for All-Nippon Airways and Red China. Long-range version of the BAC 111 will be built for British United on its initial order, with a center section tank added with 1,000-gal. capacity.

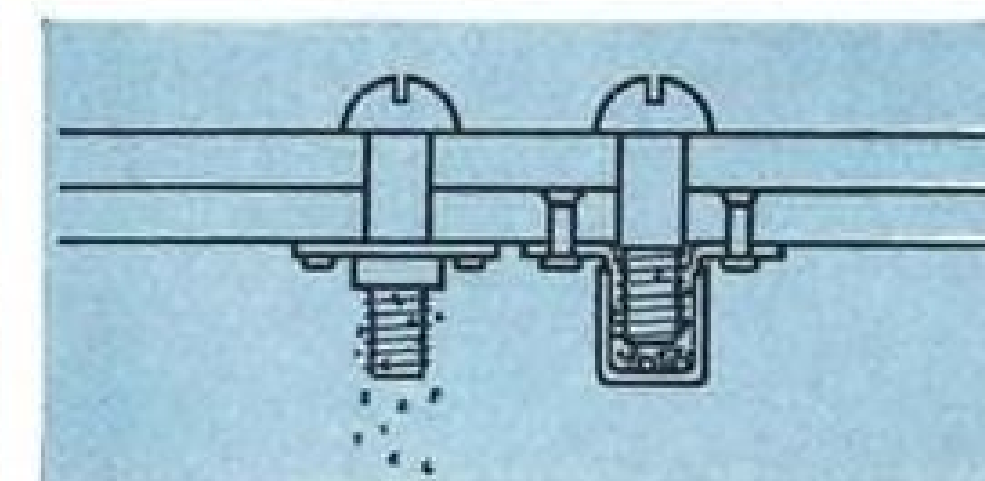
Rolls-Royce Spey engine is gaining flight time in an Avro Vulcan testbed and in the de Havilland Trident three-jet transport. Program of 2,000 hr. engine endurance testing, using the Vulcan, will start in June; individual engines will be taken up to 750 hr. time between overhauls. So far, the Spey has accumulated more than 2,500 hr. of bench testing.

BOOTS CAPPED LOCKNUTS

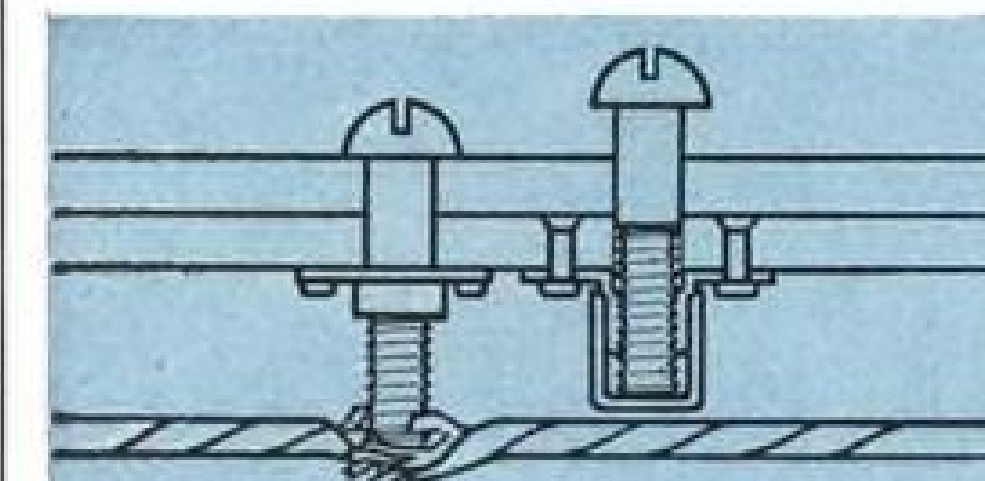
Protect Vital Assemblies, Assure Safe, Trouble-Free Operation



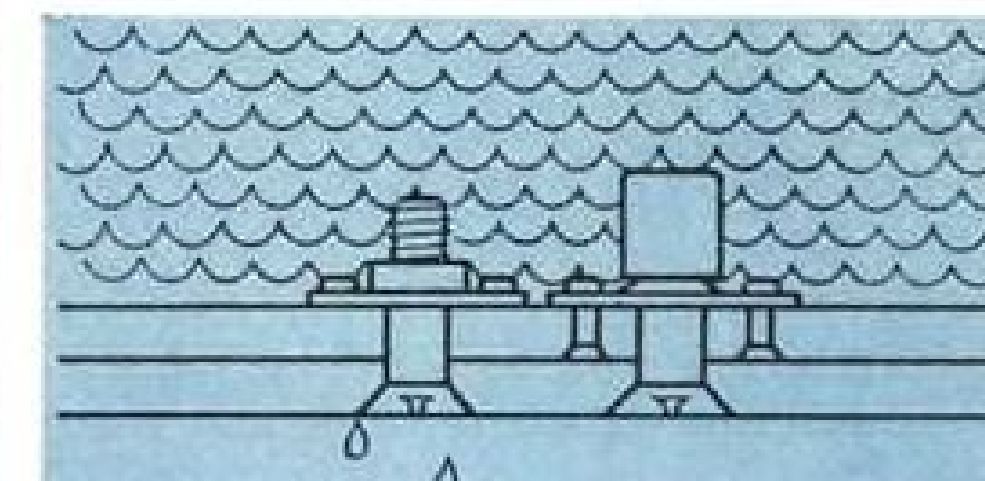
Under conditions of vibration, capped locknuts increase assembly reliability by preventing the abrasive removal of insulation from wires near protruding bolt threads.



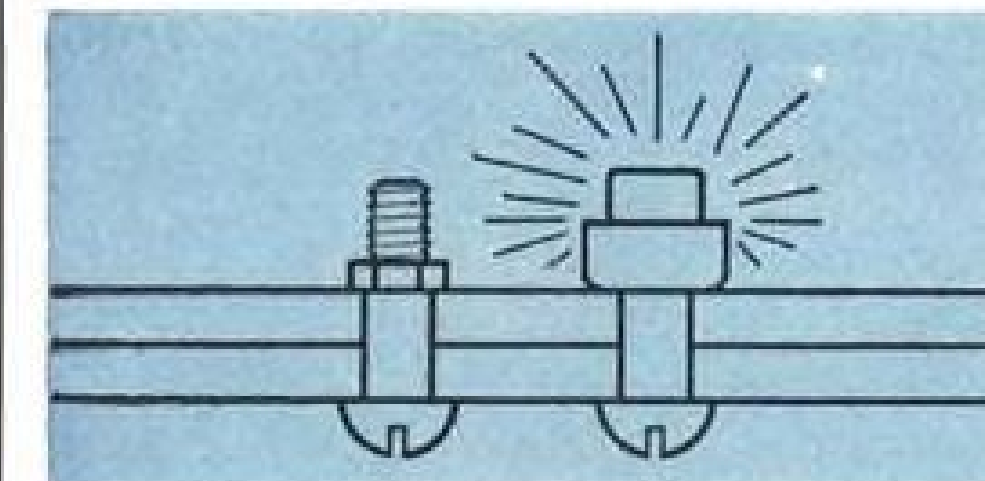
Increased reliability and protection for delicate exposed circuits—cap effectively traps metallic flakes or other fallout resulting from assembly of screw and nut.



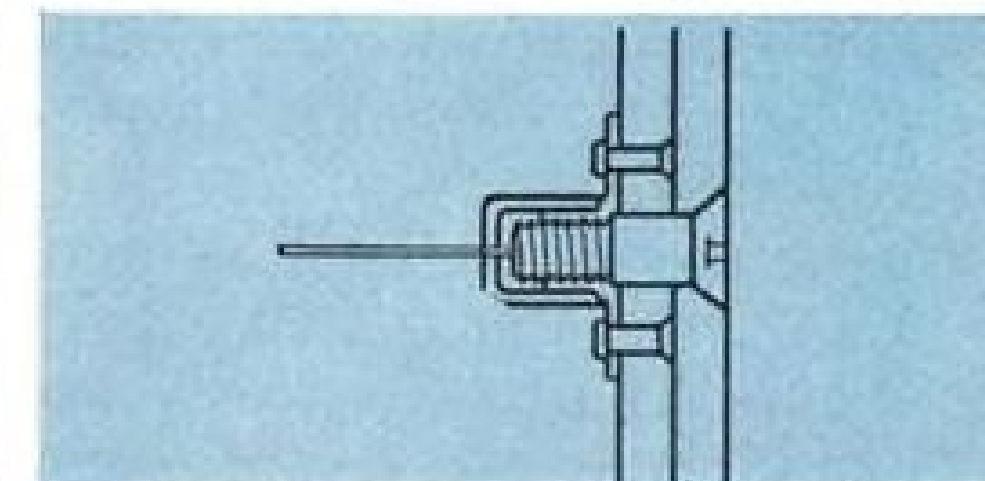
Automatic quality control—capped locknut prevents damage to internal and hidden assembly from screw that is too long. Important wire bundle circuits are safe.



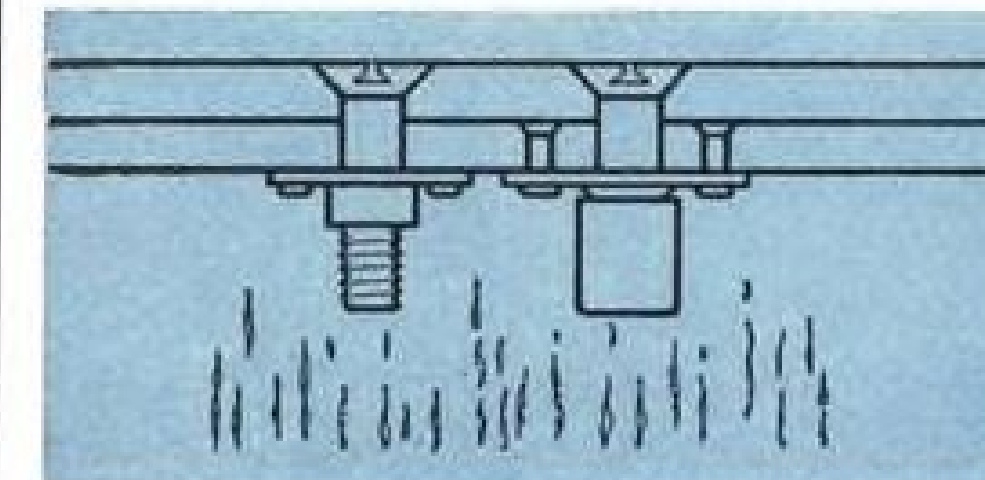
Used in conjunction with liquid sealing "gunk," capped locknuts provide one of the tightest weight integral seals possible for fastening integral tanks or other liquid reservoirs.



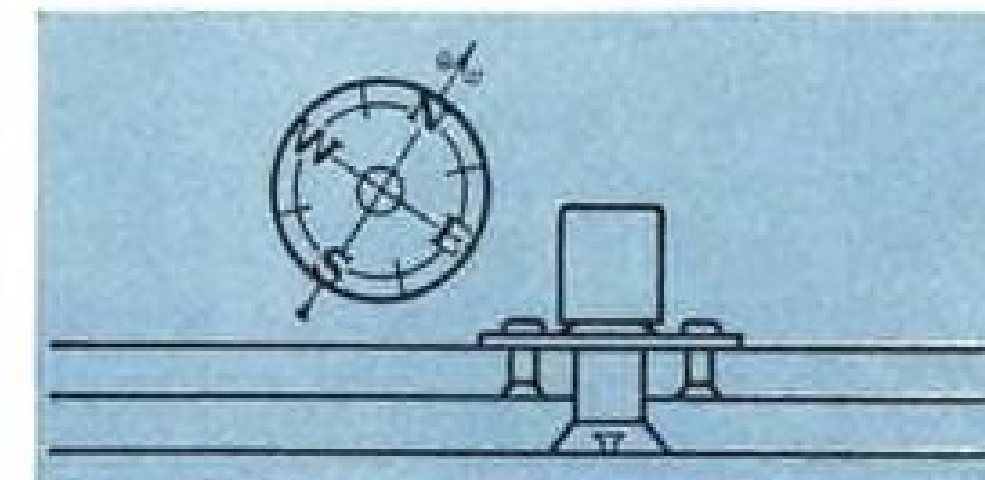
Neat, workmanlike appearance is always a product plus—capped locknuts show extra care in design and manufacturing—experienced buyers look for these extras.



For maximum reliability, caps can be provided with a probe hole so inspectors can check penetration of screw in nut locking element.

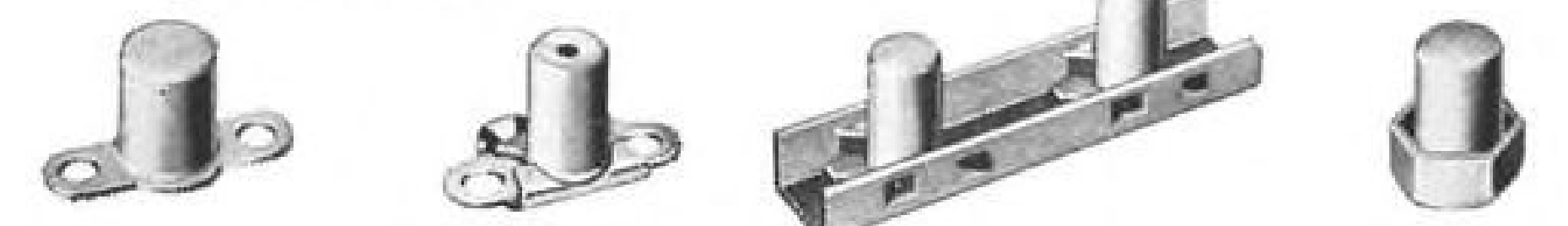


Protection from galling of screw threads in high temperature and corrosive atmospheres. Capped nut protects threads and permits easy subsequent removal of screw—fast replacement of sub-assemblies.



Available in A-286 stainless steel which has extremely low magnetic permeability—ideal for navigation instrument applications, ASW devices, as well as certain corrosive atmospheres.

Boots all-metal, one piece self-locking nuts are simple in design, compact, lightweight and exceed government specifications for tensile strength. Torque and loading is uniform. Re-usability factor is high. Available in a wide range of regular and miniature sizes. Write for descriptive literature.



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Norwalk, Conn.



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Mallory imagination in metals puts new life in rocket nozzles

The next generation of rockets with higher energy fuels will fly further and more accurately because of a new idea from Mallory in space age materials . . . the use of unique Mallory powder alloys for rocket nozzles.

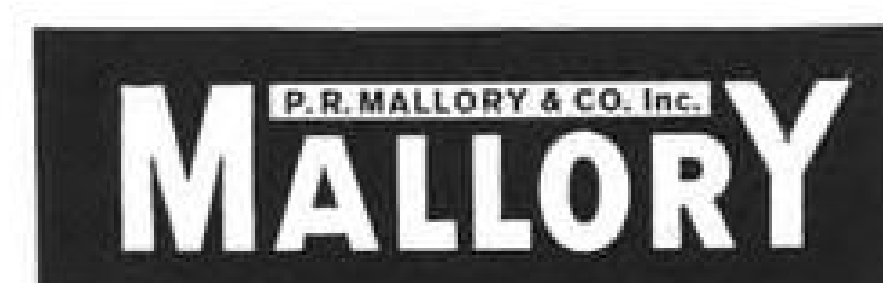
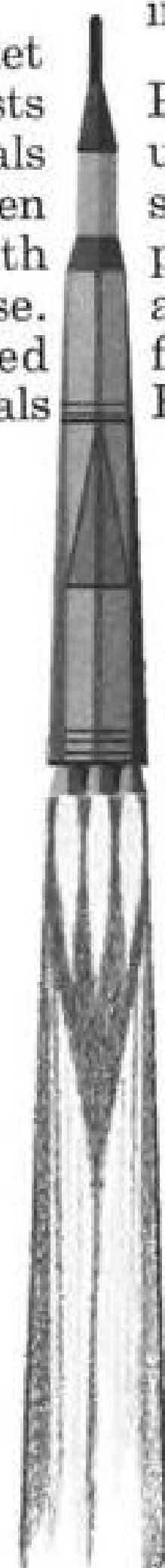
No ordinary material can withstand the terrific heat and flame velocities to which the nozzles of a rocket are subjected. Yet to provide optimum flame velocity and guidance characteristics, the nozzle should maintain its geometry accurately, without excessive erosion, during the critical fuel-burning phase of flight.

In their search for better nozzle materials, rocket engine researchers asked Mallory metallurgists for recommendations. Our Elkonite® materials . . . powder metallurgy products having tungsten or other refractory materials infiltrated with copper or silver . . . seemed to offer promise. Elkonite was developed and has been used successfully for many years, as contact materials

which withstand the searing heat and mechanical stress of interrupting heavy electric currents in high power switchgear. Their refractory capabilities, plus good machinability, looked right for nozzles.

We made up some test nozzles, using techniques which we have developed over 34 years' experience, to form these materials to accurate dimensions. On static test firings, the Elkonite nozzles showed exceptional performance. Results look so promising that we are now pursuing further investigations under a development contract.

Perhaps our long experience in working with unusual metals can prove valuable in your own space age projects. Write to us about your problem. We're full of ideas, ready to share them, and well equipped to apply brain power and facilities. Mallory Metallurgical Company, P. O. Box 1582, Indianapolis 6, Indiana.



High density metals • refractory materials • special alloys

MANAGEMENT

Computer Simulates Executives' Problems

By Russell Hawkes

Sunnyvale, Calif.—Use of computer simulation to train business executives and develop management techniques in a compressed time scale and without attendant losses due to learning errors has been developed and is being used by Lockheed Missiles & Space Co.

Aerospace business environment simulator (ABES) has been developed during the past two years by the LMSC information processing staff headed by Roger K. Summit to subject competing teams of managers to many of the same factors which real aerospace firms encountered in doing business with the government.

Four Lockheed competitors, Philco

Corp., Aerojet-General Corp., Boeing Co., and Douglas Aircraft Co. have taken part in ABES exercises by mail and all have expressed interest in using the simulator under license in their own organizations. Douglas used ABES to give the people in its new top management structure experience in working together as a decision team. Boeing used its ABES exercise to test operations research techniques the company has been developing.

IBM Computer

ABES is a mathematical and logical model programmed for the IBM 7090 computer which was developed in a program during the past two years to apply quantitative techniques and elec-

tronic data processing to management problems.

To conduct an exercise, separate teams of managers are assembled to represent aerospace companies in competition with each other for business. The computer reacts to decisions by printing out the results that presumably would occur in the real world. Teams compare the results of each round of decision-making to the objectives of their simulated companies and adjust their decisions during the next round to get improved results. The game lasts about two weeks, though the length is arbitrary. This period of time represents a number of years.

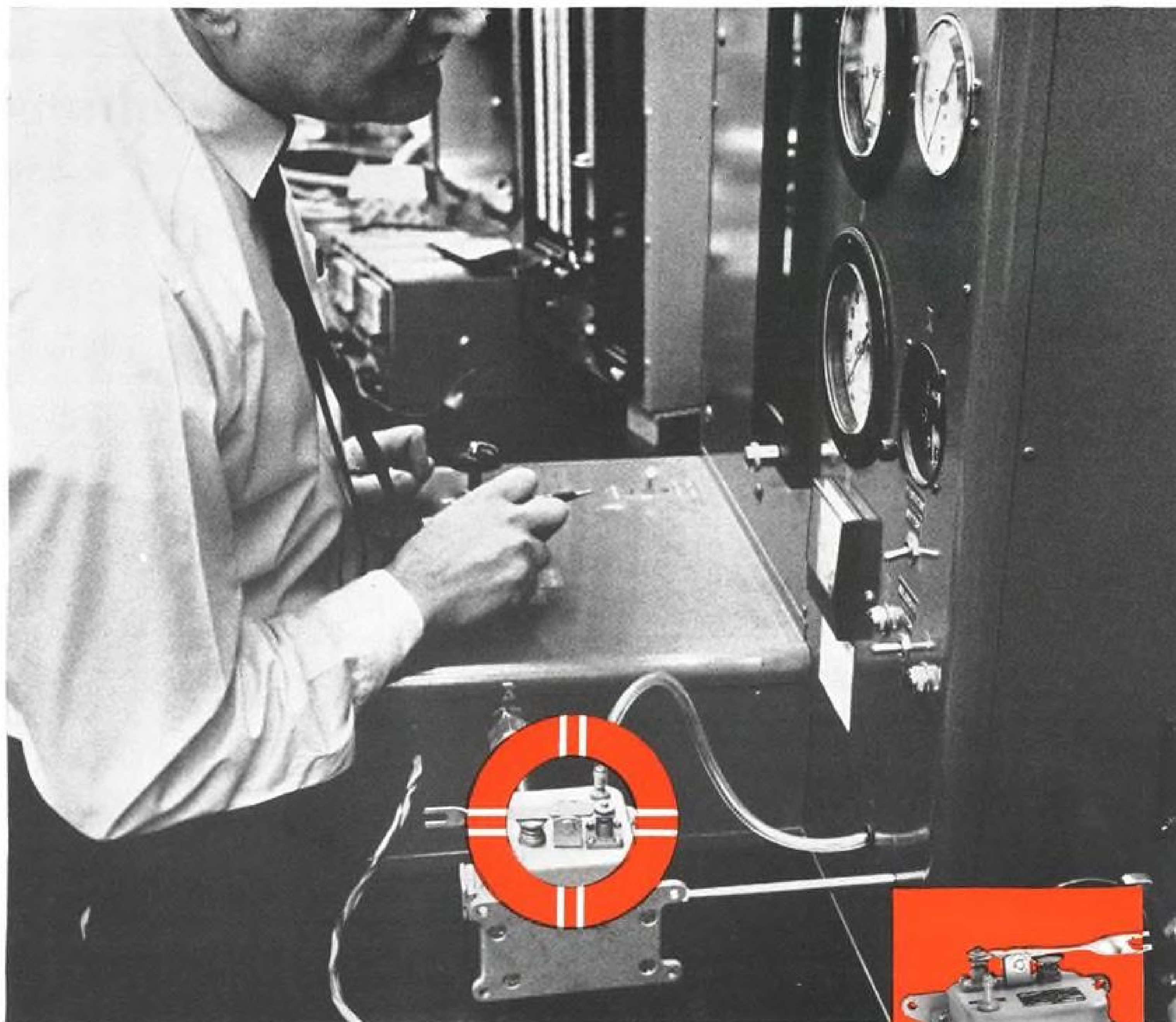
The teams begin with identical companies and the decisions each makes

Rolls-Royce Specification Table Corrected

Some engine power ratings and fuel consumption figures for Rolls-Royce turbine engines listed in the specification tables on p. 203 in the Mar. 12 issue of Aviation Week & Space Technology were reported inconsistently, confusing maximum continuous ratings with takeoff power. For the convenience of those using the table

as a reference, the following corrected version is published in the same dimensions so that it can be pasted over the original and used instead. Generally, the engine power ratings are Rolls' minimum guaranteed takeoff thrust figures, but nominal ratings are indicated by an asterisk and noted in the remarks column.

Manufacturer and Address	Designation	Type	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at maximum power	Compression ratio at max. rpm.	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, est. allips. lb.	Remarks
Rolls-Royce, Ltd. Derby	Avon RA.24R	AFJ	NA	NA	8	14,430 lb. t.*	NA	NA	41.5	126	NA	*Nominal performance
	Avon RA.29/1 Mk.522.526	AFJ	16	3	8	10,500 lb. t.	0.770	9.1	39	126	3,328	
	522A, 526A											
	Avon RA.29/1 Mk.524B & 525B	AFJ	16	3	8	10,250 lb. t.	0.759	9.08	39	126	3,343	*Nominal performance
	Avon RA.29/3 Mk. 527	AFJ	16	3	8	11,400 lb. t.	0.805	9.35	39	126	3,347	
	Avon RA.29/6 Mk. 531	AFJ	17	3	8	12,200 lb. t.	0.782	10.1	39	134	3,491	
	Avon RA.29/6 Mk. 532R	AFJ	17	3	8	12,080 lb. t.	0.770	10.1	39	134	3,491	
	Avon RA.29/6 Mk. 533R	AFJ	17	3	8	12,600 lb. t.	0.787	10.3	39	134	3,491	
	Avon RB.146R	AFJ	NA	NA	8	16,000 lb. t.*	NA	NA	41.5	145	NA	
	Conway R. Co 11	AFP	NA	NA	10	17,250 lb. t.	NA	NA	66	136	NA	
	Conway R. Co 12 Mk. 508 & 509	AFP	7x9	2x1	10	17,500 lb. t.	0.725	14.1	42	136	4,542	
	Conway R. Co 17	AFP	NA	NA	10	20,600 lb. t.	NA	NA	67.5	136	NA	
	Conway R. Co 42	AFP	7x9	2x1	10	20,370 lb. t.	0.636	14.8	51	154	5,009	
	Conway R. Co. 43	AFP	7x9	2x1	10	21,825 lb. t.	0.654	15.2	51	154	5,101	
	Dart R. Da. 3 Mk. 506	CFP	2	2	7	1,345 shp.	0.727	5.4	38	98	1,026	*Water methanol boost
	Dart R. Da. 6 Mk. 510	CFP	2	2	7	1,535 shp.	0.690	5.4	38	98	1,106	
	Dart R. Da.6 Mk.511&511-7E	CFP	2	2	7	1,535 shp.	0.690	5.4	38	98	1,106	
	Dart R. Da. 6 Mk. 514	CFP	2	2	7	1,710 shp.*	NA	5.4+	38	98	1,114	
	Dart R. Da. 7 Mk. 520	CFP	2	3	7	1,630 shp.	0.700	5.6	38	98	1,207	
	Dart R. Da. 7/1 Mk. 525	CFP	2	3	7	1,730 shp.	0.680	5.6	38	98	1,227	
	Dart R. Da. 7/2Mk.526&527	CFP	2	3	7	1,835 shp.	0.665	5.6	38	98	1,227	
	Dart R. Da. 7/2Mk.528-7 & 528-7E	CFP	2	3	7	1,835 shp.	0.665	5.6	38	98	1,223	
	Dart R. Da. 7/2Mk.529-7 & 529-7E	CFP	2	3	7	1,910 shp.	0.656	5.6	38	98	1,223	
	Dart R. Da. 7/2.Mk.529-8 &529-8E	CFP	2	3	7	1,910 shp.	0.656	5.6	38	98	1,227	
	Dart R. Da. 7/2Mk.530& 531	CFP	2	3	7	1,835 shp.	0.665	5.6	38	98	1,227	*Water methanol boost
	Dart R. Da.10/1Mk. 542-10	CFP	2	3	7	2,750 shp.*	NA	6.35+	38	98	1,377	
	Dart R. Da.7-77Mk.21	CFP	2	3	7	1,870 shp.	0.610	5.9	38	98	1,268	
	Dart R. Da. 8 Mk. 101	CFP	2	3	7	2,470 shp.*	NA	5.8	38	98	1,207	*Water methanol boost
	RB. 108	AFJ	8	2	2,200 lb. t.*	1.060	5.25	20.8	45.6	269	
	RB. 145	AFJ	NA	NA	2,750 lb. t.*	NA	NA	22.6	59.6	NA	*Nominal performance
	RB. 162	AFJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	RB. 168	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Nominal performance
	Spey R Sp 1 Mk. 505-5/10 & Mk. 505-14	AFP	4x12	2x2	10	9,850 lb. t.	0.56	14.1	37	110	2,200	
	Tyne R. Ty. 12 Mk. 101	AFP	6x9	3x1	10	5,095 shp.	0.449	13.5	43.2	108.7	2,219	*Nominal performance
	Tyne R. Ty. 20 Mk. 21	AFP	6x9	3x1	10	5,440 shp.	0.439	13.5	43.2	108.7	2,203	
	Tyne R. Ty. 20 Mk. 22	AFP	6x9	3x1	10	5,440 shp.	0.439	13.5	43.2	108.7	2,218	*Nominal performance



The **LIFEGUARD** of the future on schedule today at SCOTT

Passenger safety is a never-ending challenge at Scott. This Automatic Passenger Oxygen Flow Control Unit (Composite Regulator), undergoing exhaustive tests at Scott research laboratories, has been selected as standard equipment on the Boeing 727 jet. It automatically activates and controls oxygen flow to the passenger emergency oxygen system, replacing as many as seven previously required components including: pressure reduction, automatic turn-on and altitude flow control, activation surge, and turn-off.

The new Scott Composite Regulator is automatically actuated at cabin altitudes of approximately 14,000 feet, and turns off again automatically at cabin altitudes of between 8,000 and 10,000 feet. The unit can be manually reset to "off" position at any altitude in between, while still retaining the auto-

matic features. As an added safety feature, the Regulator supplies a momentary surge immediately after activation of approximately 80 psi, lasting about 10 seconds. This assures immediate filling and pressurization of the distribution system and positive actuation of mask presentation devices. After this initial surge, pressure is maintained at required levels, automatically controlled in response to system flow requirements and changing cabin pressure.

In addition to its many versatile features, the Scott Composite Regulator offers significant advantages in reduced weight, better efficiency, lower maintenance costs, and increased configuration flexibility.

For more information on the Scott Composite Regulator and how it can help you solve aerospace design and engineering problems write, phone, or wire:



SCOTT AVIATION CORPORATION DEPT. B-62, LANCASTER, NEW YORK

Export: Southern Oxygen Company, 3 West 57th Street, New York 19, New York. West Coast Office: Fulton-Ventura Bldg., 13273 Ventura Blvd., Studio City, California. Great Britain Affiliate: The Walter Kidde Company, Ltd.

affect its standing in the simulated industry. Decisions involve procurement of resources, including labor, operations and contract bidding. Results are in the form of financial and operating reports, contract awards and new proposals to be bid. Research and development contracts are funded on a cost-plus-fixed-fee basis and production is done on a fixed price. Space systems and missile systems are treated as separate product lines.

During a game team members have the opportunity to evaluate the factors and the sometimes contradictory interrelationships that must be manipulated to produce success. For example, improved facilities, internal research, and employee training tend to improve productivity of the company but can be obtained only at a certain increase in the cost of operation. As team members learn how contract awards are influenced by other factors such as bid price, past performance, etc., they can decide whether to accept the increased cost of additional productivity or save the money so as to make a correspondingly lower bid.

Some Factors Revised

The inventors of ABES in the LMSC information processing staff have revised some factors in the simulator model on the basis of participant reaction. Among the revisions were reduction of the weighting assigned to availability of resources and the inclusion of company financial condition as factors in determining contract awards.

Past games show that experienced teams make individual decisions within a framework of basic policies that express the degree of risk the team is willing to assume and the alternatives of short-range payout versus long-range payout.

Typical risk considerations are the amount of backlog to be maintained and the degree of diversification to be sought. High backlog is security against running out of work but requires that the company bid more daringly because it is government policy to maintain some sort of balance in the award of contracts to keep competitors in the field.

The game divides operations on a functional basis between R&D work which is funded by cost-plus-fixed-fee contracts and production which is funded by fixed-price contracts. Operations are also divided along product lines into missile systems and space systems. If a company specializes in one function or product area, it can become more efficient in that area but runs the risk that a contract in the area might not be available when the company needs business. Each team must also weigh the desirability of high current profits against the gain in efficiency and

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PROBLEMATICAL RECREATIONS 123




Find a five digit number whose first two digits, central digit, and last two digits are perfect squares and whose square root is a prime palindrome.

— Contributed

Did you know that Litton Divisions include such exotic organizations as the Eureka Specialty Printing Company and the Simon Adhesive Company? We mention same to give you some indication of our diverse operations. Other Litton members are A. Kimball Company, Cole Steel Equipment Company, Aero Service, and the Ingalls Shipbuilding Corporation. We're sure you already know about our Monroe Calculating Machine Company so we won't push our point: Litton activities and products cover the industrial-electronic-military scene.

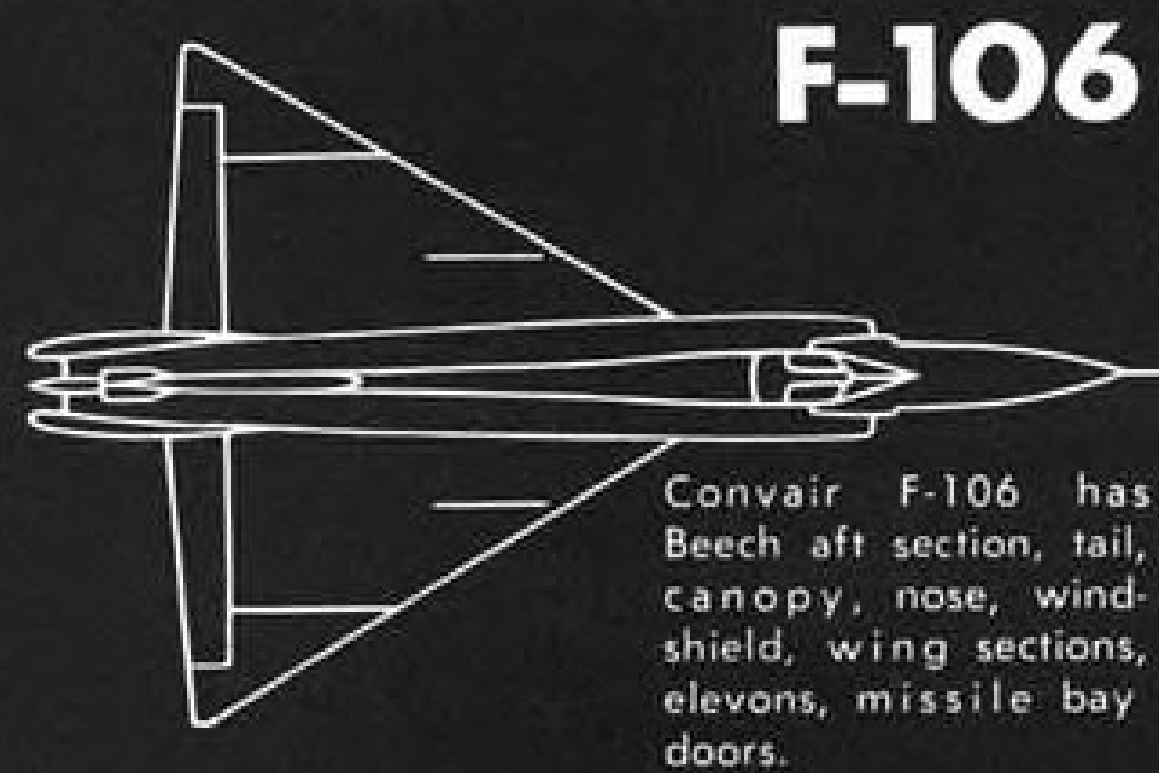
ANSWER TO LAST WEEK'S PROBLEM: The equation $\frac{2}{3} \cdot 2M/3 + 5 = \frac{1}{2}M$ gives the solution $M = 90$. In other words, Mary is as old as the Hills.

LITTON INDUSTRIES, INC.
Beverly Hills, California



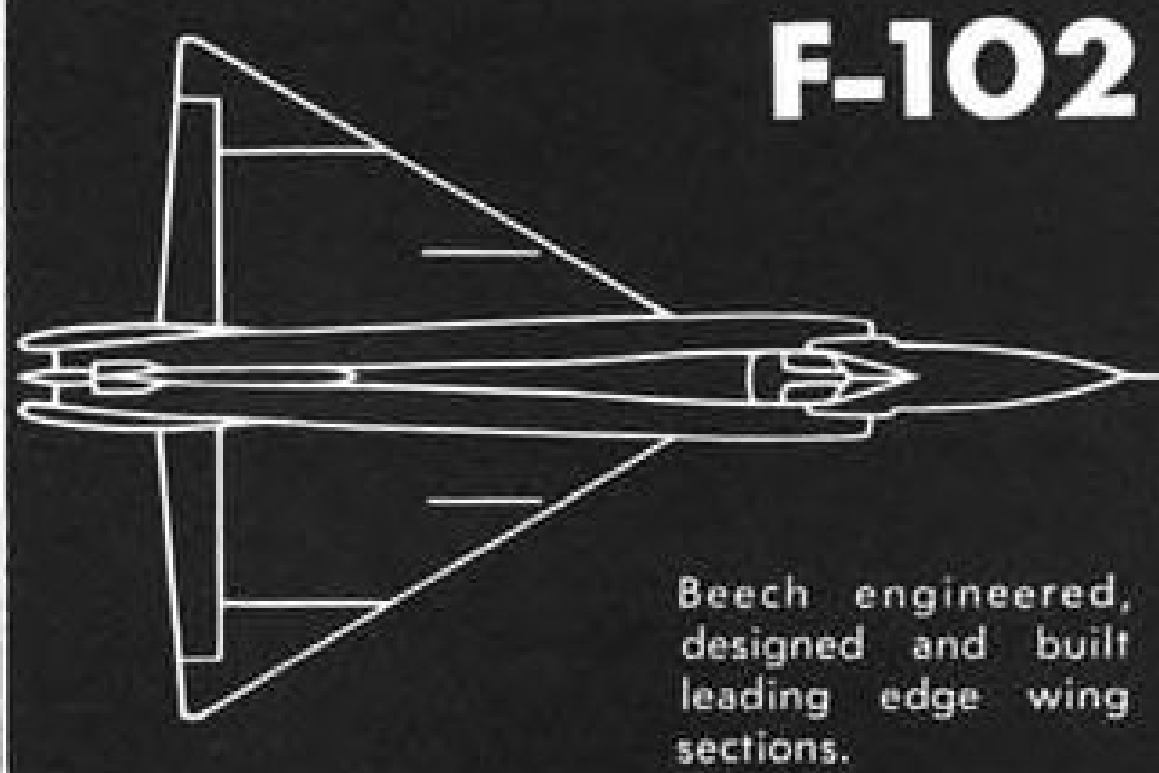
F-101

McDonnell F-101 has Beech nose, canopy, stabilator, windshield, rudder.



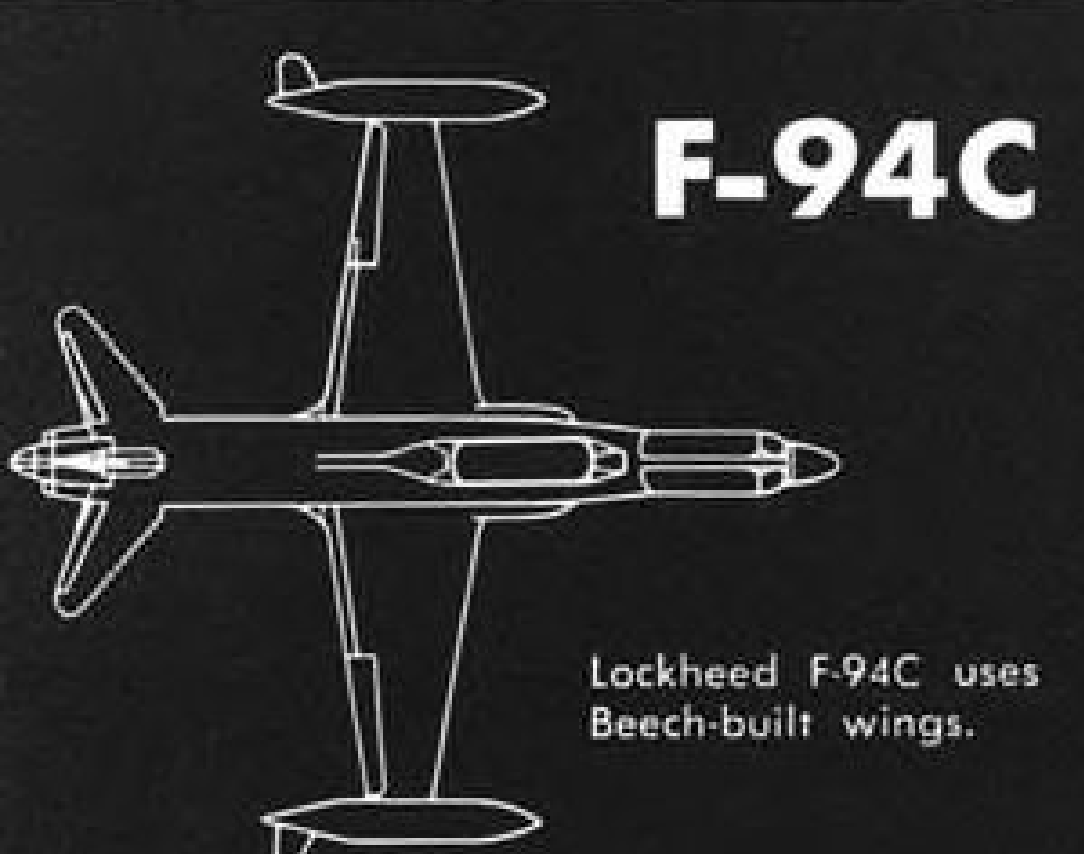
F-106

Convair F-106 has Beech aft section, tail, canopy, nose, windshield, wing sections, elevons, missile bay doors.




F-102

Beech engineered, designed and built leading edge wing sections.



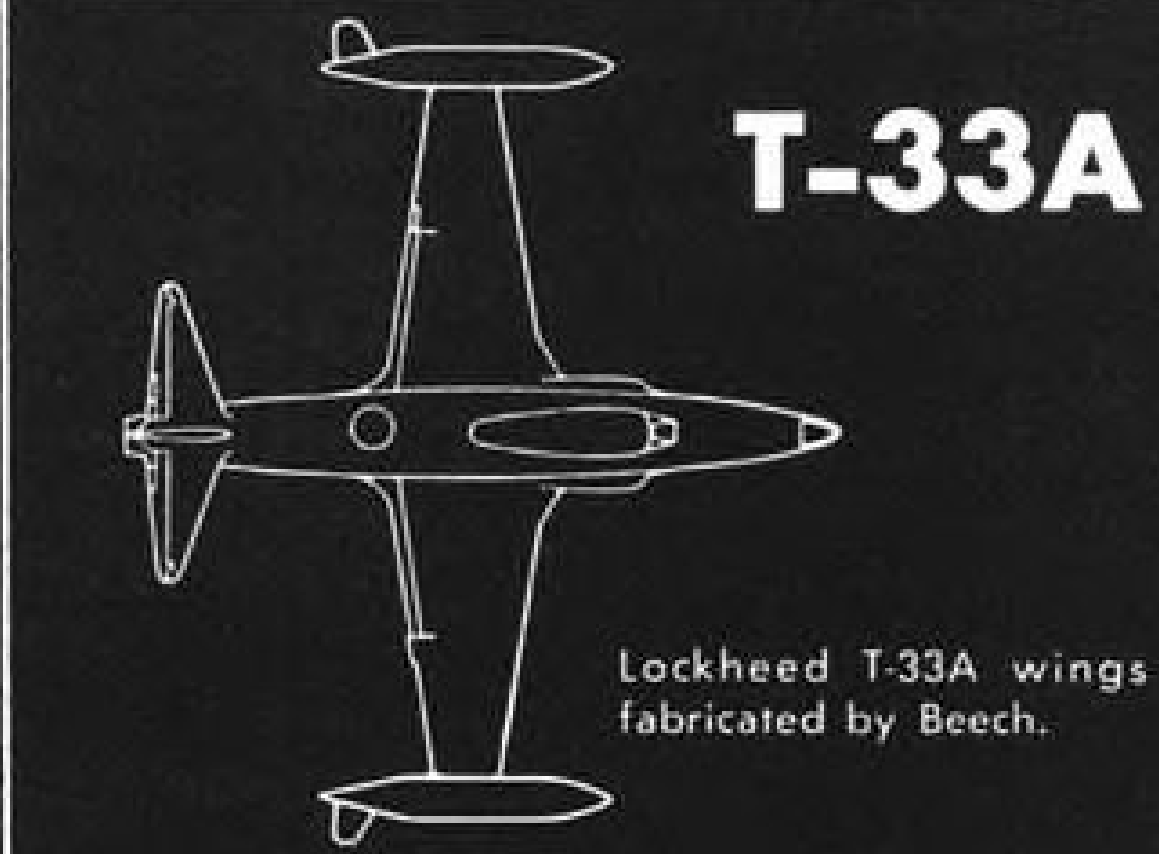
F-94C

Lockheed F-94C uses Beech-built wings.



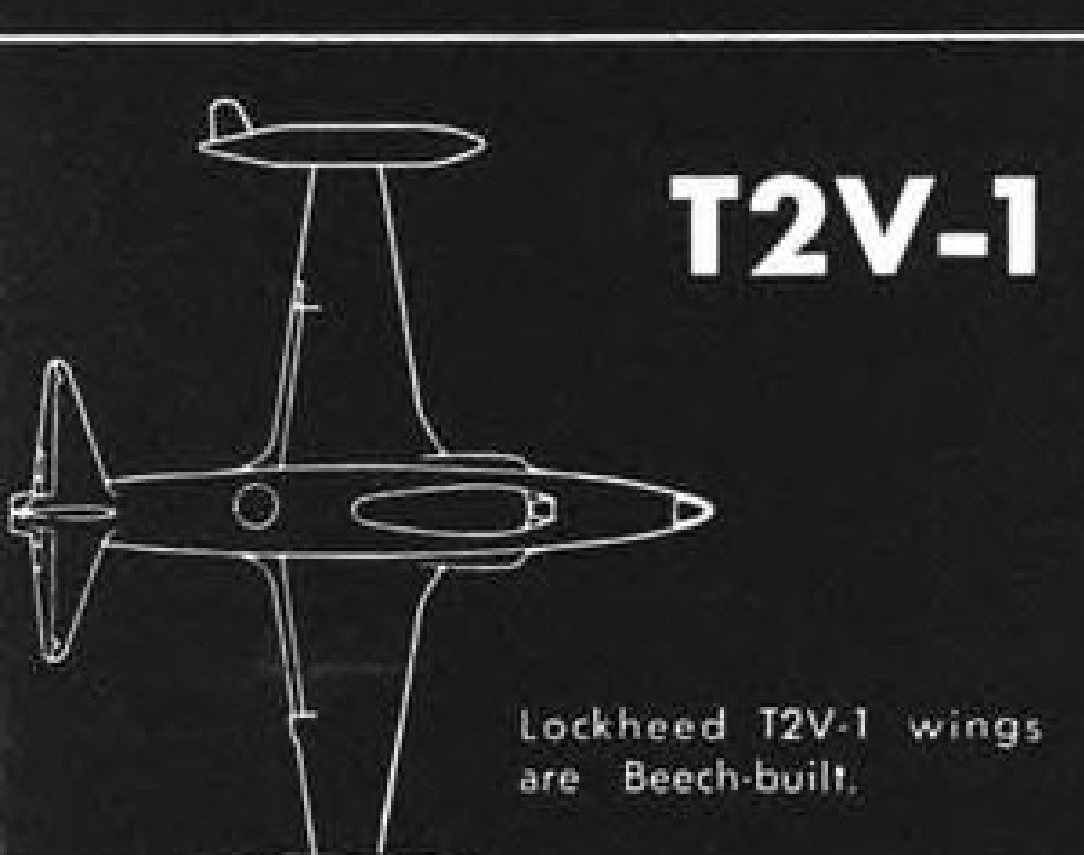
MISSILES

Beech contributions include fuel tankage and fuel management and component testing for ATLAS, TITAN, SATURN, and CENTAUR.




T-33A

Lockheed T-33A wings fabricated by Beech.



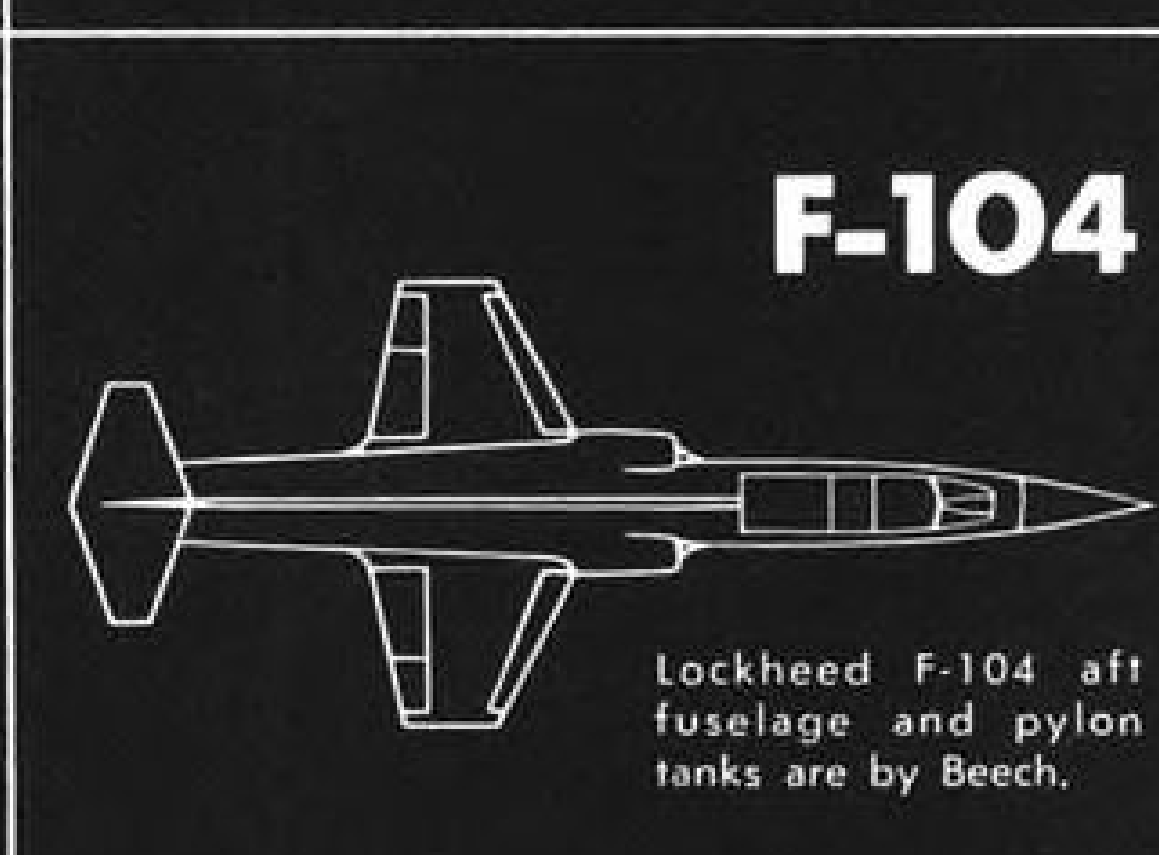
T2V-1

Lockheed T2V-1 wings are Beech-built.



F-105

Republic F-105 ailerons and aft fuselage are Beech-made.



F-104

Lockheed F-104 aft fuselage and pylon tanks are by Beech.

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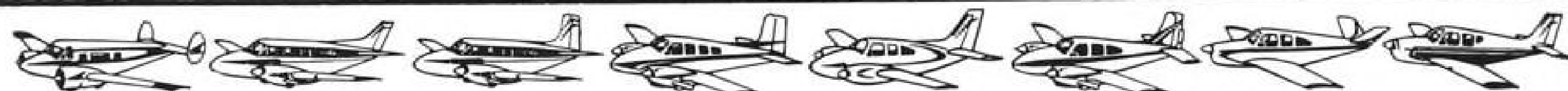
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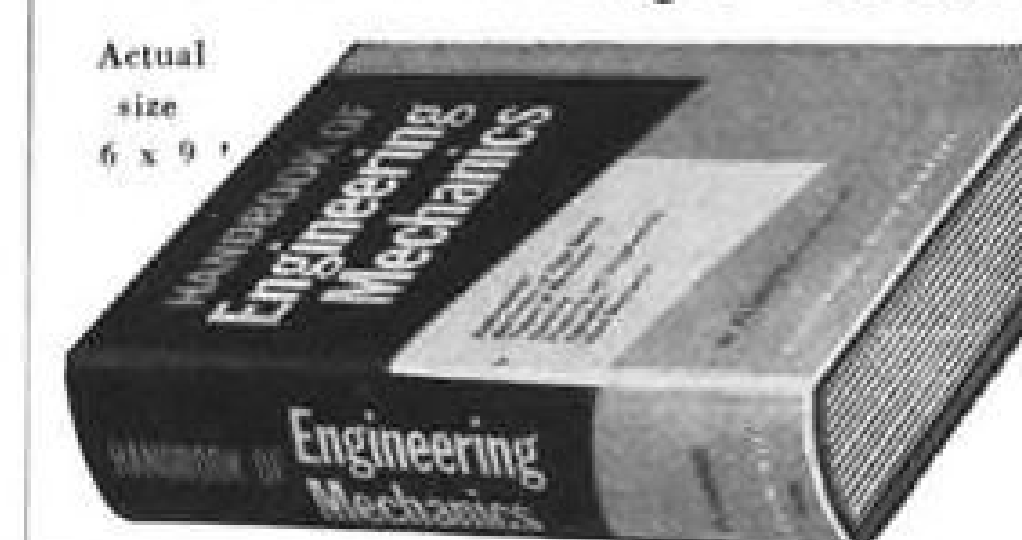
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Results of ABES games often fail to produce clear-cut winners and losers. In an exercise involving five teams and covering a simulated span of three years, one team was the apparent winner by the criterion of total equity at the end of the period. However, it achieved this at least partially by sacrificing some efficiency in research and development which might have caused later procurement difficulties had game been continued indefinitely as in real life. The apparent winner also had bid on only a few contracts which kept indirect administrative costs low but allowed backlog to approach zero frequently which could have necessitated a major lay-off.

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No. of Drums	5	3	3	2	4
Range	0-32,768 (2^{15})	(+)0 to (+)999 (-)999 to (-)0	0 to 359.9	0 to 359	0 to 359.9
Bits per Revolution	16	20	40	40	40
Revolutions for Total Range	2,048	100	90	9	90

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GENERAL PRECISION

FINANCIAL

Four Airlines Report Salaries of Officers

Washington—Following is a list of airline officers' salaries, bonuses and indirect compensation, expenses and stock holdings for the year ending Dec. 31, 1961, as reported to the Civil Aeronautics Board:

Mohawk Airlines, Inc.—R. E. Peach, president and director, \$40,000 salary, 13,400 shares of capital stock, \$25,000 debentures; J. R. Carver, vice president and director, \$26,250 salary, 518 shares of capital stock, \$2,000 debentures; C. A. Benscoter, vice president and director, \$26,260 salary, 500 shares of common stock, \$2,000 debentures; E. V. Underwood, chairman of the board, \$4,500 salary, 3,400 shares of capital stock, \$1,000 debentures; F. R. Chabot, treasurer, \$17,250 salary, 500 shares of capital stock; B. C. McLean, secretary, \$12,750 salary, 300 shares of capital stock, \$500 debentures; R. R. Taylor, vice president, \$17,000 salary, 954 shares of capital stock; E. V. Stephenson, vice president, \$16,000 salary, 560 shares of capital stock; H. P. Barnard, vice president, \$13,750 salary; W. P. Mitchell, vice president, \$14,250 salary, 100 shares of capital stock; T. L. Boyd, assistant vice president (since Aug. 15, 1961), \$6,000 salary; H. R. Thomas, assistant secretary, \$7,500 salary, 15 shares of capital stock; L. P. Hornbrook, assistant secretary, \$5,867 salary, 16 shares of capital stock; A. D. Williams, assistant treasurer, \$10,000 salary; B. R. Miner, director, 633 shares of capital stock; W. J. Fields, director, 1,000 shares of capital stock; E. A. Link, director, 24,111 shares of capital stock, \$90,000 debentures; P. A. Schoellkopf, Jr., director, 200 shares of capital stock; J. C. Corwith, director, 100 shares of capital stock; W. V. Daugherty, director, 3,500 shares of capital stock, \$32,000 debentures; C. W. Sorrell, director, 151 shares of common stock; D. B. Billings, director, 100 shares of capital stock; H. W. Harding, director, 200 shares of capital stock; P. D. Stump, director, 200 shares of capital stock; E. P. Curtis, director, 500 shares of common stock. The following firms were paid \$5,000 or more for services rendered during 1961: Pogue & Neal, legal services, (during 1960-1961), \$21,276; Gilfoil & McNeal, auditing, \$13,373 for services rendered during 1960; Aviation Consultants, Inc., consultation, \$12,451.

North Central Airlines, Inc.—H. N. Carr, president and director, \$40,000 salary, \$700 bonus and indirect compensation, \$4,165 expenses, 216,368 shares of common stock; F. N. Buttomer, vice president-traffic and sales, \$17,700 salary, \$2,584 expenses, 18,332 shares of common stock; A. E. Schwandt, vice president-industrial relations, \$13,800 salary, \$873 expenses, 15,060 shares of common stock; R. H. Bendis, Sr., vice president-maintenance and engineering, \$16,200 salary, \$319 expenses, 30,000 shares of common stock; A. D. Niemeyer, vice president-flight operations, \$12,000 salary, \$524 expenses, 500 shares of common stock; B. Sweet, vice president and treasurer, \$16,800 salary, \$495 expenses, 21,432 shares of common stock; J. P. Dow, secretary, \$8,400 salary, \$283 expenses, 20 shares of common stock.

A. E. A. Mueller, chairman of the board, \$27,500 salary, \$600 bonus and indirect compensation, \$13,561 expenses, 2,521,972 shares of common stock, 1,897,156 shares of common stock in the name of others; W. L. Christensen, accountant-consultant and director, \$3,600 salary, \$700 bonus and indirect compensation, \$241 expenses, 30,266 shares of common stock; G. F. DeCoursey, sales consultant and director, \$2,400 salary, \$700 bonus and indirect compensation, \$238 expenses, 36,750 shares of common stock; K. B. Willett, director, \$500 bonus and indirect compensation, \$315 expenses, 40,296

shares of common stock; A. L. Wheeler, vice president-general counsel and director, \$27,000 salary, \$400 bonus and indirect compensation, \$29,917 expenses, 850 shares of common stock; A. J. Mueller, director (since Apr. 5, 1961), \$300 bonus and indirect compensation, \$381 expenses, 10,980 shares of common stock; D. E. Crooker, director (since Apr. 5, 1961), \$400 bonus and indirect compensation, \$86 expenses, 49,480 shares of common stock.

The following firms were paid \$5,000 or more for services rendered during 1961: Klau-Van Peterson, Dunlap, advertising, \$451,726; Ray & Ray, statistical information, \$8,785; Alexander Grant & Co., auditing, \$7,985; Immell, Herro, Buchner & DeWitt, legal services, \$18,458; Karl Brocken, public relations survey, \$8,457; Liegh Fisher, consultant, \$7,103.

West Coast Airlines, Inc.—N. Bez, president and director, \$21,400 salary, \$4,569 expenses, 54,600 shares of common stock, \$137,500 debentures; E. B. Code, vice president, \$14,200 salary, \$446 expenses, 494 shares of common stock; H. F. Scheurer, Jr., vice president, \$20,166 salary, \$2,104 expenses, 100 shares of common stock; T. R. Croson, \$12,000 salary, \$2,464 expenses, 262 shares of common stock; G. E. Hatch, vice president, \$13,533 salary, \$1,698 expenses, 150 shares of common stock; S. M. Selby, vice president, \$14,000 salary, \$441 expenses; S. R. Servetson, vice president, \$17,333 salary, \$611 expenses, 550 shares of common stock; W. R. Thrall, vice president and director, \$13,000 salary, \$51 expenses; L. J. Hawkinson, secretary-treasurer, \$16,000 salary, \$954 expenses, 455 shares of common stock; K. N. Laurin, assistant treasurer, \$9,720 salary, \$560 expenses; W. Calvert, vice president and director, 3,500 shares of common stock; J. A. Johnston, assistant secretary; F. L. Anderson, director, 45 shares of common stock; E. K. Bishop, director, 1,961 shares of common stock; C. E. Gunderson, director, 6,931 shares of common stock; G. Gunn, Jr., director, 1,500 shares of common stock; P. J. Hillings, director, 100 shares of common stock; D. Hogue, director; D. K. MacDonald, director; T. E. Robinson, director, 2,000 shares of common stock; D. G. Graham, assistant secretary, 1,400 shares of common stock.

The following firms were paid \$5,000 or more for services rendered during 1961: Alexander Grant & Co., auditing services and income tax preparation, \$34,668; C. Edward Leasure, legal services, \$11,573; Washington Employers, Inc., labor consultants, \$6,745; Graham, Green, Dunn, Johnston & Rosenquist, legal services, \$9,905.

Trans-Texas Airways—R. E. McKaughan, president, \$33,600 salary, \$4,439 expenses, 32,060 shares of common stock; H. E. Erdmann, vice president-operations and planning, \$19,800 salary, \$1,145 expenses, 6,344 shares of common stock; W. C. Leatherwood, vice president-purchasing, \$12,900 salary, \$45 expenses, 905 shares of common stock; P. S. Reid, vice president-personnel, \$11,700 salary, \$221 expenses, 190 shares of common stock; J. K. Ayers, assistant secretary (since Dec. 22, 1961), \$11,090 salary, \$1,840 expenses, 395 shares of common stock; J. L. Eichner, vice president-traffic (until Aug. 31, 1961), \$13,177 salary, \$915 expenses, 20 shares of common stock; H. E. Krieger, financial assistant to the president (until Jan. 31, 1962), \$15,900 salary, \$1,131 expenses, 605 shares of common stock; R. E. McKaughan, vice president to the president (since Aug. 31, 1961), \$11,700 salary, \$984 expenses, 5,400 shares of common stock; H. H. Farr, acting treasurer (since Dec. 22, 1961), \$9,450 salary, \$85 expenses; J. M. Brooks, vice president-training (since Sept. 6, 1961), \$12,600 salary, \$298 expenses, 1,150 shares of common stock; R. M. Lawrence, assistant secretary (since Sept. 6, 1961), \$6,300 salary, 6,010 shares of common stock. The following firms were paid \$5,000 or more for services rendered during 1961: Clark, Reed & Clark, legal services, \$16,118; Rogers & Smith, advertising, \$48,023; Erwin Wassey, advertising, \$163,647; Peat, Marwick, Mitchell & Co., auditing, \$8,200; Verner & Bernhard, legal services, \$13,704; Air Transport Assn., various services, \$14,998.



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Part Number	5R980-41	CR9 0980 001 R980-018
Excitation (volts) (max.)	60	26
Frequency (cps)	400	400
Total Null Voltage (mv)	25	10
Max. Error from E.Z. (minutes)	5	5
Operating Temp. Range (°C)	-55 to +125	-55 to +125

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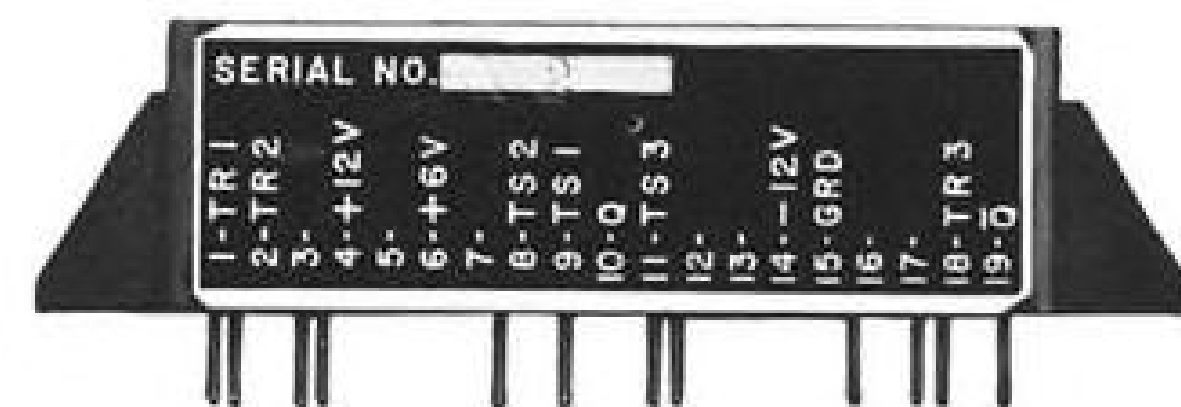
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Part Number	S3100-01
Number of Inputs	4 per channel
Input Impedance (ohms resistive at 25° C)	100,000
Voltage Gain	1±0.0005
Phase Shift (rotor output to input at 25° C)	less than 15 min.
Max. Signal Output Voltage	16 volts
Gain Stability Over Operating Temp. Range	1±0.05%

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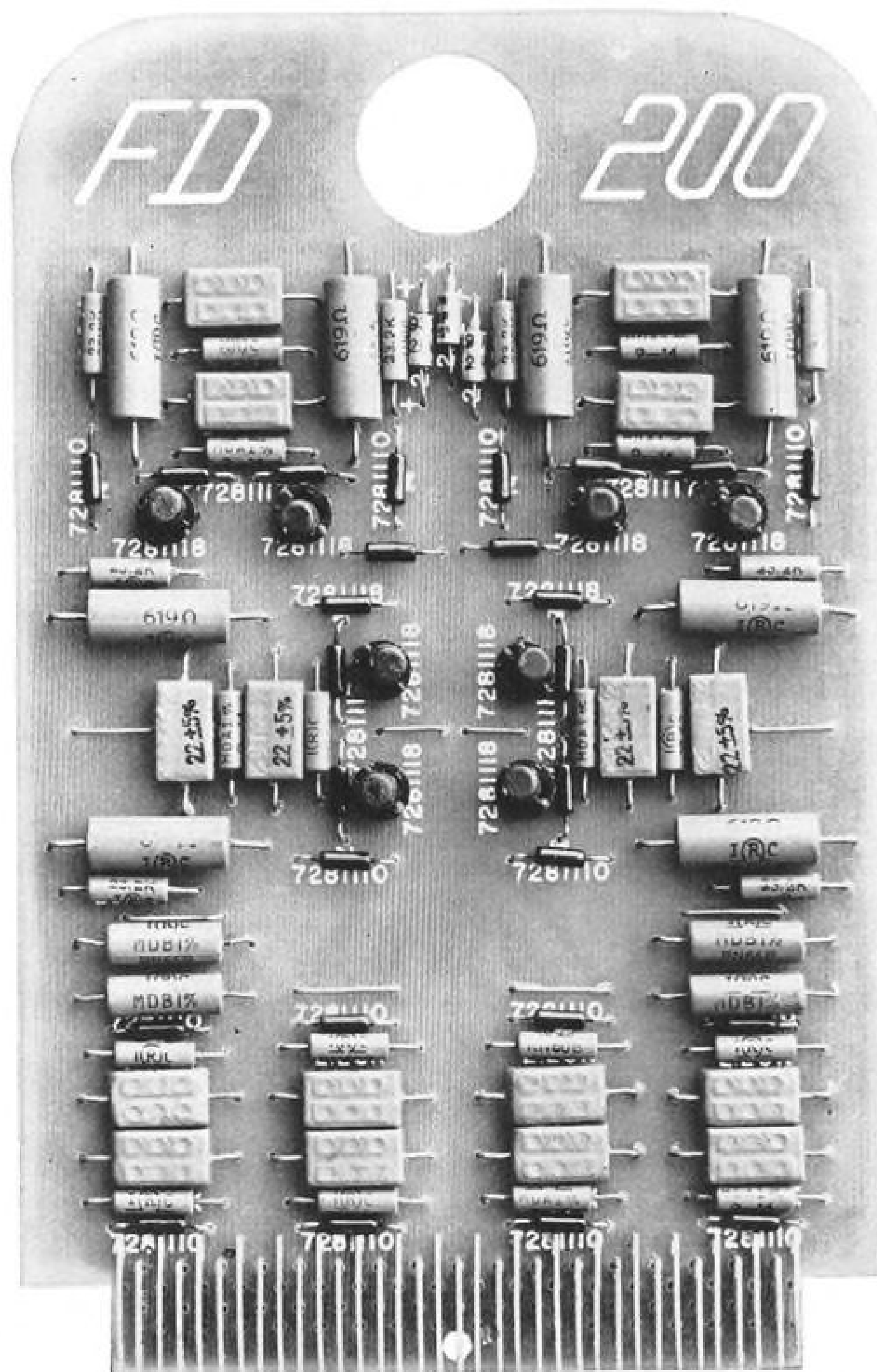
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SAFETY

United Nations Accident Investigation Report—Part I:

UN Issues Report on Hammarskjöld Crash

The following excerpts are from an accident investigation report prepared by the United Nations General Assembly's commission of investigation into the conditions and circumstances resulting in the death of Dag Hammarskjöld, Secretary-General of the United Nations, and members of the party accompanying him on a flight in a DC-6B from Leopoldville, Congo, to Ndola, Northern Rhodesia, on Sept. 17, 1961.

On 18 September 1961, the whole world learned with profound grief of the tragic death of Dag Hammarskjöld, Secretary-General of the United Nations, in the service of the Organization and in the performance of the mission which he had undertaken for peace and the independence of peoples. In this tragedy the following 15 persons accompanying him also met their deaths: Heinrich A. Wieschhoff, Vladimir Fabry, William Ranallo, Miss Alice Lalande, Harold M. Julien, Serge L. Barran, Francis Eivers, Stig Olof Hjelte, Per Edvald Persson, Per Hallonquist, Nils-Eric Ahréus, Lars Litton, Nils Göran Wilhelmsson, Harold Noork, Karl Erik Rosén.

In carrying out the task entrusted to us of investigating the circumstances of the tragic death of Dag Hammarskjöld and his associates, we, the members of the Commission appointed for that purpose, were aware that we were inquiring into the causes of the deaths of men who have laid down their lives in the performance of a mission the purpose of which was to secure a better life for millions. For this reason, we feel it incumbent upon us at the beginning of this report to express our profound respect and high regard for Dag Hammarskjöld and for the other victims engaged in this mission.

The late Secretary-General left New York by air on 12 September and arrived at Leopoldville on 13 September 1961. The purpose of his journey was to discuss with the Central Government the adoption of a program of aid to the Republic of the Congo. Immediately after his arrival, however, he was confronted with a grave crisis in the relations between the United Nations and the provincial authorities of Katanga.

The crisis arose out of the implementation by ONUC—the United Nations Organization in the Congo—of part A, paragraph 2, of the resolution adopted by the Security Council on 21 February 1961. In this paragraph the Council urged that "measures be taken for the immediate withdrawal and evacuation from the Congo of all Belgian and other foreign military and para-military personnel and political advisers not under the United Nations Command, and mercenaries."

By far the largest concentration of such personnel, about 500 men, was to be found in the Katangese armed forces. In the months which followed the adoption of this resolution, ONUC attempted to implement

the provisions of part A, paragraph 2, by agreement with the provincial authorities of Katanga and, in particular, their chief, Mr. Tshombé. This attempt achieved only partial success, and the United Nations military command was compelled to set a time limit for the surrender, for purposes of evacuation, of all mercenaries in the service of the provincial authorities of Katanga. On the expiration of the time limit, however, over 100 mercenaries known to be in Katanga had failed to report to ONUC, and on 13 September the Military Command took precautionary measures to facilitate the task of apprehending and evacuating these men. These measures were met by force, and fighting broke out at Elisabethville and in other Katangese cities.

Hostilities were not limited to ground forces. Whereas the United Nations had no armed aircraft, the Katangese authorities put into action a jet Fouga Magister carrying two machine guns and a small bomb load. This aircraft considerably hampered the movement of United Nations transport planes and in some instances prevented the supply and relief of United Nations units.

In the meantime, several contacts with Katangese officials were arranged for the purpose of bringing about an immediate cease-fire, but no results had been achieved by the evening of 15 September. During 16 September the Secretary-General considered the possibility of a meeting in Rhodesia between himself and Mr. Tshombé. In the course of the night, the United Nations representative at Elisabethville received, through the British Consul, a message informing the United Nations that Mr. Tshombé wished to meet him at Bancroft, Northern Rhodesia, on 17 September at 0930 GMT. The Secretary-General sent a reply in which he recalled the guiding principles of the United Nations action in the Congo and suggested that he should meet Mr. Tshombé personally. He specified, however, that "the proposed meeting obviously requires that orders should be given beforehand for an immediate and effective cease-fire." He proposed therefore that "such a cease-fire should be formally imposed by both sides so as to make a meeting possible." He pointed out, furthermore, that as there were no adequate landing facilities for a large aircraft at Bancroft he would be unable to arrive there by the time suggested by Mr. Tshombé. He accordingly suggested that the projected meeting should take place at a later hour at Ndola, Northern Rhodesia. The Secretary-General concluded his reply to Mr. Tshombé with the following words:

"I shall inform you as early as possible tomorrow morning [17 September] of my time of arrival [at Ndola], allowing for the fact that before I leave I must have your reply to this message, including your decision regarding the cease-fire. The cease-fire will occur automatically on the United Nations side,

in view of the fact, that, according to the instructions given and the rules followed by the Organization, it only opens fire in self-defense. I am awaiting your urgent reply to this proposal for a meeting and for an immediate cease-fire."

In the morning of 17 September, the British Consul at Elisabethville transmitted a message to the United Nations from Mr. Tshombé stating that he agreed to "the principle of an immediate cease-fire" and was prepared to meet the Secretary-General at Ndola. Mr. Tshombé specifically requested, however, "that United Nations troops be confined to their camps" and "that the United Nations stop troop movements and the sending of reinforcements by land and air."

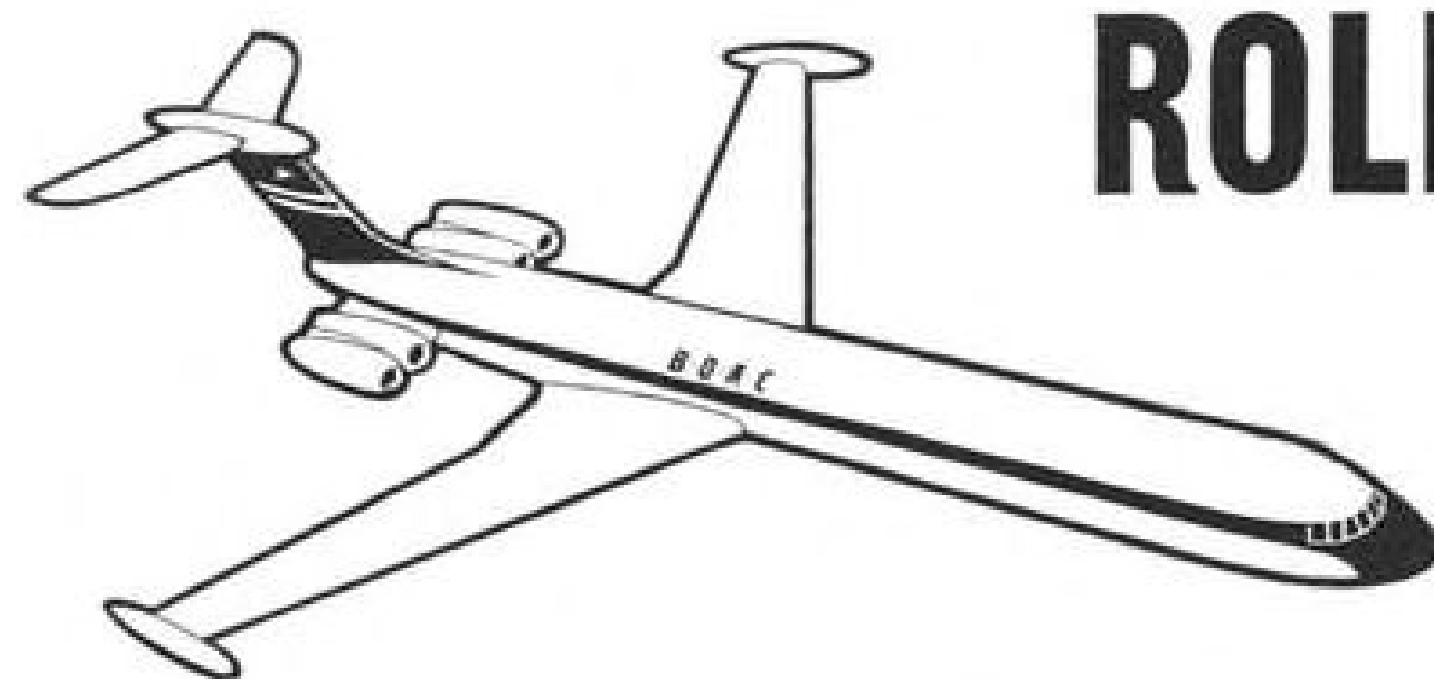
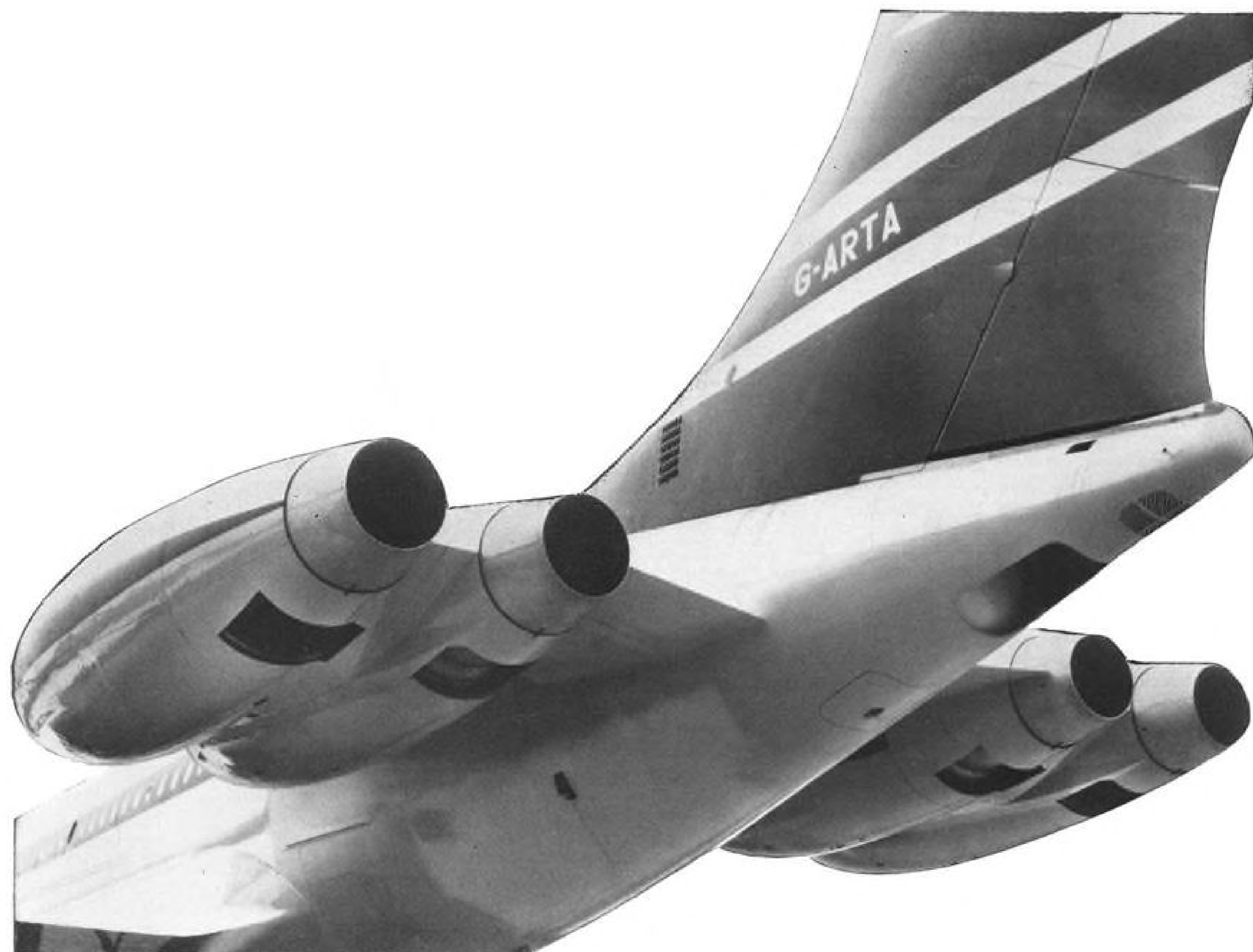
In answer to this message, the Secretary-General instructed the United Nations representative at Elisabethville to inform Mr. Tshombé that he found it "impossible to accept the conditions for a cease-fire and a meeting which have been conveyed to him." He emphasized that "there can be no question of anything but an unconditional cease-fire on both sides and an agreement to meet together, all other modalities obviously to be discussed in the course of the meeting."

When, however, the United Nations representative at Elisabethville asked the British Consul to transmit the Secretary-General's answer to Mr. Tshombé, he was informed that Mr. Tshombé had chartered an aircraft and was expected to leave for Ndola shortly.

In the circumstances, the Secretary-General decided to proceed to Ndola and took off from Leopoldville at 1551 GMT in the plane of the Force Commander, a DC-6B bearing the registration letters SE-BDY. At 2210 GMT, SE-BDY radioed "overhead Ndola" and was seen flying over the airport. A few minutes later it disappeared from sight in a westerly direction, and all efforts to re-establish radio contact failed. On the next day, 18 September, at 1310 GMT, the wreckage of the aircraft was sighted from the air 9.5 miles west of Ndola. When the police arrived at the site of the crash, they found only one survivor—Sergeant Julien—who was in so serious a condition that he died a few days later.

On 29 September Dag Hammarskjöld was buried at Uppsala. Two days before his funeral, several Member States had requested the General Assembly to place on its agenda an item entitled "An international investigation into the conditions and circumstances resulting in the tragic death of Mr. Dag Hammarskjöld and of members of the party accompanying him." By unanimous decision the item was placed on the agenda on 13 October; it was discussed on 26 October, at the 1042nd plenary meeting.

At that meeting the Assembly had before it a draft resolution providing for the estab-



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lishment of a United Nations Commission to conduct an investigation into all the conditions and circumstances surrounding this tragedy. In the course of the discussion the following arguments were advanced in support of the draft resolution: the investigation should be carried out under the auspices of an international body, in order to satisfy public opinion and allay the world-wide concern aroused by the magnitude of the tragedy and by its political and historical importance; the United Nations should conduct this investigation as a tribute to the Secretary-General and the other victims of the disaster; an international investigation should be conducted under the auspices of the United Nations in order that the independence and impartiality of the inquiry should be assured; the investigation should provide answers to the rumors, fears and speculations to which the tragedy gave rise; the investigation should determine any responsibility involved; finally, the investigation should assist in preventing the occurrence of such disasters in the future and in ensuring maximum protection for those performing functions in the service of the United Nations.

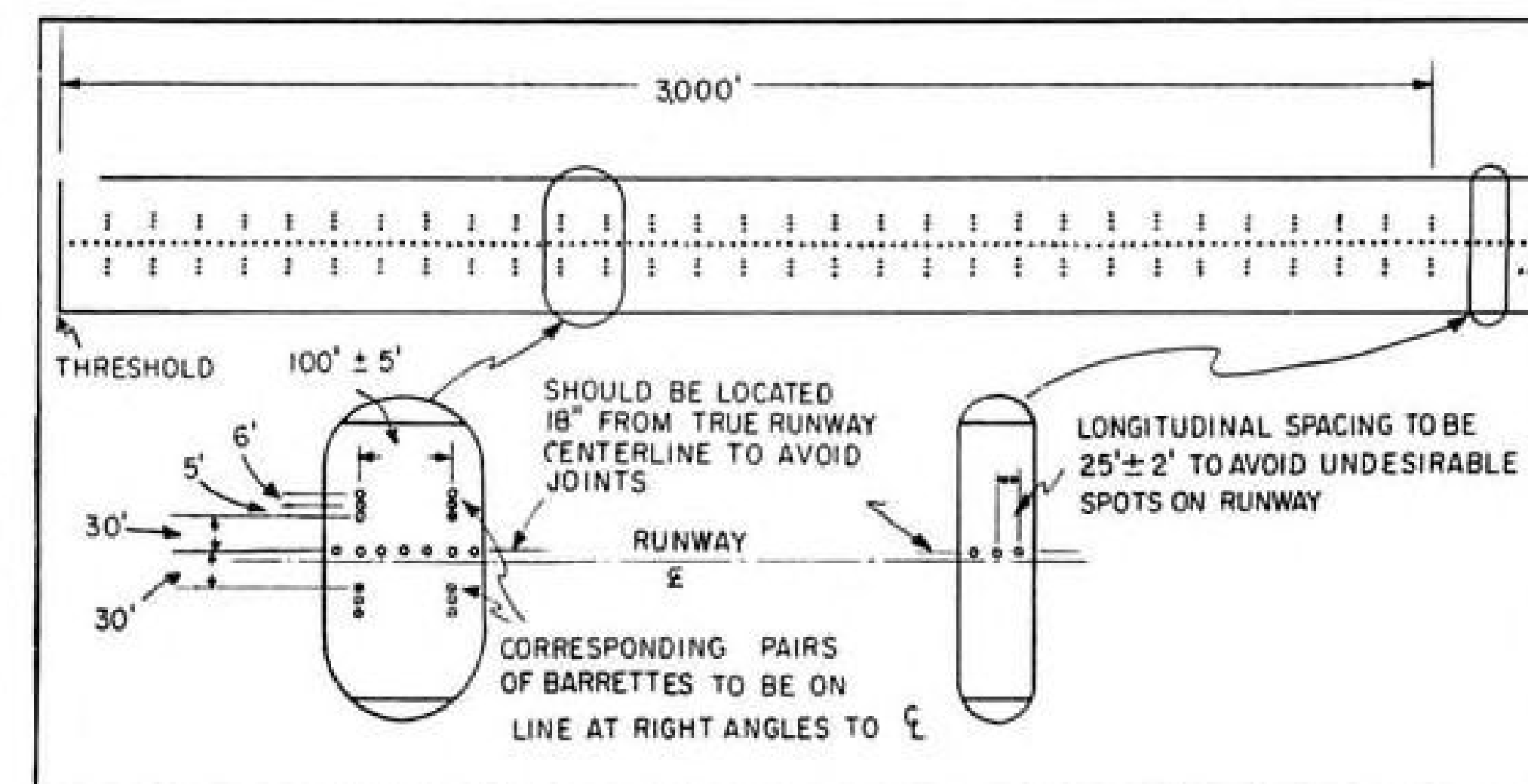
At the end of the discussion, the draft resolution was adopted by the General Assembly by 97 votes to none and became resolution 1628 (XVI). On 8 December, the General Assembly appointed the following persons as members of the Commission:

Justice Samuel Bankolé Jones (Sierra Leone)
Raúl Quijano (Argentina)
Justice Emil Sandström (Sweden)
Rishikesh Shaha (Nepal)
Nikola Srzentic (Yugoslavia)

Flight Preparations

... Originally it had been intended that the Secretary-General should leave for Ndola in OO-RIC [a DC-4] at 1000 Z on 17 September. On 16 September, Air Operations had issued Flight Order No. 673 to that effect. However, it was later decided that the Secretary-General should fly in the aircraft of the Force Commander, SE-BDY, a Douglas DC-6B belonging to the Swedish company Transair, which was a faster and more comfortable aircraft. Flight Order No. 673 was amended accordingly and the estimated time of departure for the Secretary-General's flight was changed from 1000 Z to 1500 Z. ... OO-RIC was assigned to Lord Lansdowne.

SE-BDY had flown the Force Commander to Elisabethville on the night of 16 September and had returned to Leopoldville at approximately 0700 Z on 17 September. The crew on that journey had been composed of Captain Arhéus, First Officer Litton and Flight Engineer Wilhelmsson. On landing at Leopoldville, Wilhelmsson had reported that SE-BDY had been fired on at the take-off from Elisabethville. A thorough inspection of the aircraft was accordingly carried out under the supervision of Chief Mechanic Tryggvason of Transair. In the course of the inspection it was found that number 2 engine (inboard port) had been struck by a bullet, which had penetrated the engine cowl and hit the exhaust pipe. The exhaust pipe was replaced and the plane was refueled to a total amount of 10 tons. Both Tryggvason and Tjernell, a mechanic of Transair, testified



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that this work had been completed and that the plane was ready to take off by 1100 Z.

A thorough examination had also been made of the aircraft to make certain that there was no other damage, and a careful check had been carried out. There was testimony, which the Commission considers reliable, to the effect that this aircraft was in very good condition and, as the special plane of the Force Commander, very well maintained. ...

From the time when work on the aircraft was completed (1100 Z) until approximately 1500 Z the plane remained unattended on the airfield although, except while they were at lunch, Transair mechanics were working in the vicinity of another aircraft. During this period all ladders were removed and the main doors of the aircraft were locked. However, the doors giving access to the hydraulic compartment and to the heating system were unsecured. No special guard was put round it and the regular United Nations guard detachment at the airfield was not asked to provide special security measures for the aircraft.

At about 1530 Z the crew of SE-BDY arrived at the airfield. It was composed of the three men who had flown the aircraft to and from Elisabethville and Captain Hallonquist, who was to act as pilot in command. Captain Hallonquist had not been on the flight to Elisabethville and is reported to have appeared rested and in a cheerful state of mind. ... It is also noted that there was sleeping accommodation for the crew on the aircraft and that apparently Captain Arhéus and First Officer Litton alternated as copilot. First Officer Litton, according to the testimony of Major Ljungkvist, had announced his intention of sleeping during the first part of the flight. In view of these facts, it is believed that there was no violation of international standards and recommended practices, nor of special regulations applicable in this regard.

The crew had been specially trained for

the operation of SE-BDY. ... Captain Hallonquist, in addition to being a skilled pilot, was also his company's navigation officer and instructor. Each of the three pilots held a valid license as a radio telephony operator. The crew was highly competent and experienced and Captain Hallonquist was considered to be a reliable and cautious pilot by all who testified. The Commission is convinced that the aircraft was properly manned with a competent crew licensed in accordance with international standards and recommended practices.

In the course of its investigation the Commission examined the question whether the crew of SE-BDY, having never previously landed at Ndola, could have difficulties in landing there at night. After hearing expert opinion the Commission was satisfied that a night landing at Ndola could not present any difficulties. In this connection the Commission has noted that Captain Hallonquist had flown a total of 7,841 hours, including 2,669 of instrument and night flight; Reserve Captain Arhéus a total of 7,107 hours, including 1,500 hours of instrument and night flight; and Copilot Litton 2,707 hours, including 835 hours of instrument and night flight.

Because of the danger of an attack by the Fouta Magister of the Katangese Armed Forces, it was decided to observe radio silence during the flight to Ndola. In order, however, to enable SE-BDY to receive and send emergency messages, a radio operator, Karl Erik Rosén, was instructed to fly with the crew and another radio operator was assigned to monitor SE-BDY from an ONUC radio station installed at Leopoldville airport.

Both operators were instructed to communicate by Morse code in Swedish so as to render any message sent by or addressed to SE-BDY less intelligible to the Katangese Armed Forces. There is no evidence, however, that any messages were sent or received.

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Tuesday, June 19

- 1** Analysis of the combined influences of the Micrometeoroid and Radiation Environments on Spacecraft Design: Thomas G. Barnes, Space Project Engineer; E. M. Finkelman, Space Sciences Physicist.
- 2** Influence of the Earth's Trapped Radiation on Choice of Flight Path for Spacecraft: A. L. Barazotti, Space Sciences Engineer; C. E. Wenzel, Space Sciences Physicist.
- 3** Laboratory Investigation of "Moon Soils": John D. Halajian, Project Engineer, Lunar Soil Mechanics.

Wednesday, June 20

- 4** Manual Control of Reentries at Superorbital Velocities, Using Simplified Centrifugal Force Rate Equations: F. A. Donnebrink, Flight Control Systems Engineer; J. V. Biggers, Space Scientist; H. Sherman, Human Factors Specialist; K. Spieser, Dynamic Analysts Department.
- 5** Metalastic Wheels for Lunar Locomotion: Edward G. Markow, Project Engineer, Preliminary Design Department.
- 6** Initial Stabilization of the OAO Spacecraft: Jerome M. Cook, Dynamic Analysis Engineer; Rose Fleisig, Assistant to Chief of Dynamic Analysis.

Thursday, June 21

- 7** Supercircular Reentry Flight Path Control Requirements: T. G. Sanial, (deceased). Paper to be presented by: T. J. Kelley, Assistant Chief of Propulsion.



Nonlinear Analysis of Heated, Cambered Wings by the Matrix Force Method: Warner Lansing, Structural Methods Group Leader; Irving W. Jones, Paul Ratner, Structural Engineers, Structures Department.

**Also on
Thursday, June 21**

Appearing on the panel: Weapon System Management after 10 years. William M. Zarkowsky, Program Manager.

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ONUC, Leopoldville, was aware that SE-BDY could be contacted on 11318 kc., which was no longer an aeromobile network frequency in that area, and requested the Ndjili radio station to notify SE-BDY's radio operator that ONUC Headquarters radio station would be standing by for contact with the aircraft after takeoff for Ndola. The Chief Communications Officer, however, was instructed that the ONUC station was not to communicate with SE-BDY during this flight. Nevertheless, ONUC maintained a listening watch on 11318 kc. from the time of SE-BDY's takeoff until the crash was confirmed. During this time no transmission was heard from SE-BDY and no station was heard to call SE-BDY.

Shortly after his arrival at the airport, Captain Hallonquist filed a flight plan for Luluabourg. The aircraft would not have been permitted to take off without a flight plan, and, for security reasons, it was not desired to declare the true destination. Actually, in a conversation with Major Ljungkvist of ONUC Air Operations, who arrived at the airport shortly before the takeoff of SE-BDY, Captain Hallonquist mentioned that he would be flying not to Luluabourg but to Ndola.

As regards the route which Captain Hallonquist intended to follow, Major Ljungkvist testified before the Commission that: "... when I was with Captain Hallonquist and First Officer Arhéus, we discussed the route of the flight, and at that time the last beacon to be used on the way down was Luluabourg. After that, he told me, 'there is no

radio navigation aid for me, so I have to go to Luluabourg, and after that I do not know if I am going to follow the Angolan border or whether I am going to take some other way.' That was all he told me anything about, that he had decided to go to Luluabourg and that after that he did not know. He told me: 'I am going to prepare the rest of flight during the flight, dependent upon the special conditions.' Captain Hallonquist was to be the navigator himself. He was a navigation specialist with the company and was always the teacher at the company. They told me he was doing the navigation himself."

Arrival at Leopoldville

Shortly after 1530 Z, the Secretary-General and his party arrived at the airport and boarded SE-BDY. Mr. Ranallo, the personal aide of the Secretary-General, who together with Mr. Julien, the ONUC Acting Chief of Security, and a team of security officers, was providing close personal security for the Secretary-General, searched the cabin of the aircraft immediately after boarding. In accordance with standing orders issued by the military command after the outbreak of fighting at Elisabethville, two ONUC soldiers—Sgt. S. O. Hjelte and Pvt. P. E. Persson—were placed on board the aircraft. The engines were started and at 1551 Z SE-BDY took off for its last flight.

Before attempting to reply to the specific questions asked by the General Assembly in paragraphs 3 (a) and 3 (d) of resolution 1628 (XVI), the Commission wishes to

comment on two matters dealt with in the preceding sections.

The Commission notes with regret and concern that in the afternoon of 17 September SE-BDY remained for several hours unguarded and unattended on the tarmac of the airport. The evidence before the Commission shows that a person wishing to sabotage the aircraft might have gained access to it without being detected. The Commission considers that its terms of reference do not require it to pass judgment on individual responsibilities for the lack of special security measures with respect to the Secretary-General's plane at the Leopoldville airport, but it must be observed that necessary co-ordination appears to have been lacking. In this connection the evidence showed that while certain ONUC officials who should have been informed of the proposed flight were not so informed, other ONUC personnel not directly concerned had heard it discussed.

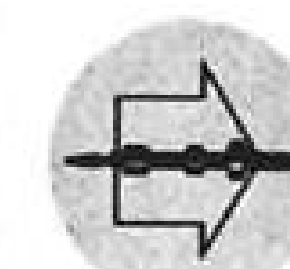
The Commission further notes that no flight plan for SE-BDY was transmitted to Salisbury. The Commission has taken into consideration the conditions existing in the Congo at the time and in particular the danger of an attack from the Fonga Magister which explain this departure from the rules governing commercial aviation. Indeed, the system of aeronautical communications cannot ensure the secrecy of messages.

The Commission believes, however, that a responsible official of ONUC should have been informed in advance of the route which Captain Hallonquist intended to follow, so that the Flight Information Centre

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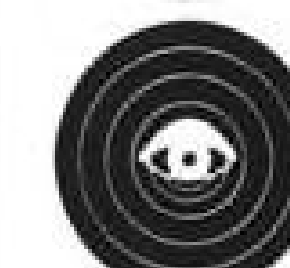
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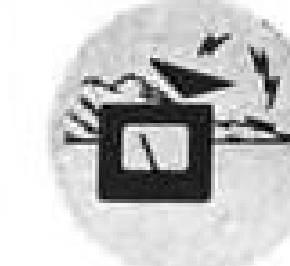
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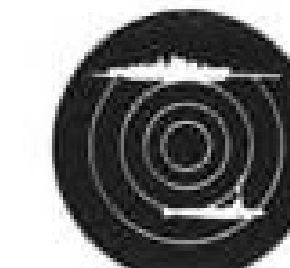
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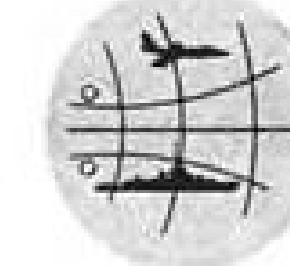
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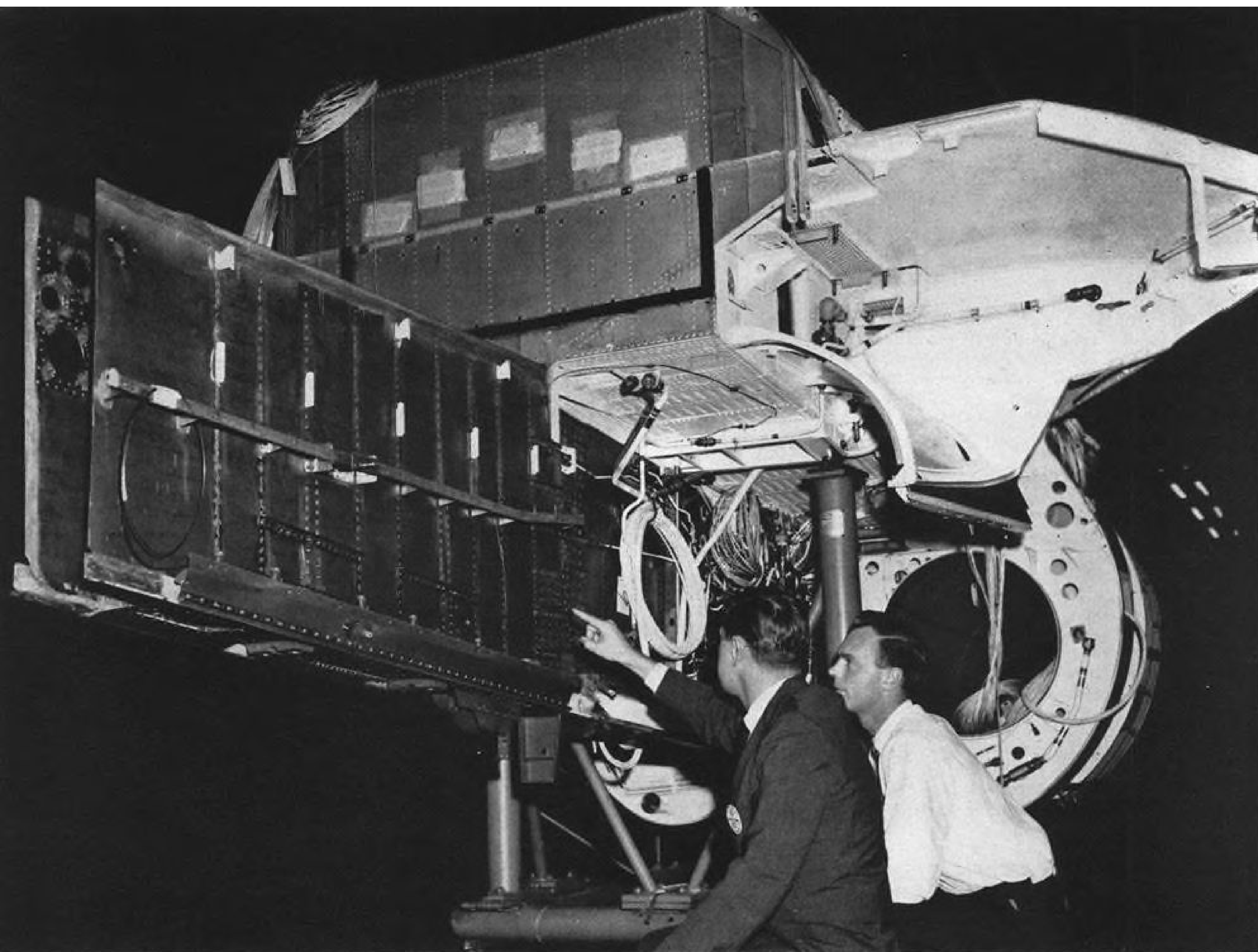
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of Leopoldville could have initiated the necessary search and rescue action if the aircraft had been obliged to make a forced landing before making contact with the Salisbury Flight Information Centre.

Two of the specific questions asked by the General Assembly . . . relate to the subject matter of the present part of the report.

The first question . . . reads: "Why the flight had to be undertaken at night without escort."

As regards the first point—why the flight had to be undertaken at night—the Commission notes that, in his testimony, Mr. Linnér said:

"Two factors were uppermost in Mr. Hammarskjöld's mind with regard to the timing of the meeting. He was anxious, first of all, to arrive at Ndola as soon as possible in order to avoid the possibility of Mr. Tshombé having left before he arrived. In the second place, Mr. Hammarskjöld and Lord Lansdowne had agreed that the latter would also go to Ndola on Sunday, but that he would continue as early as possible for Salisbury and that he would definitely leave before the Secretary-General arrived. Lord Lansdowne's departure from Leopoldville for reasons unknown to me was, however, delayed until 4 p.m. and as a result the departure of the Secretary-General was also delayed until 4.55 p.m."

In another part of his testimony Mr. Linnér said:

"Now, a plane had been put at Lord Lansdowne's disposal and it was ready about lunch time, as far as I know. I remember distinctly we sent a message to the British Embassy, where Lord Lansdowne was having lunch, asking him when he would be prepared to take off, but for reasons unknown to me, he could not make it before 4 o'clock, and, therefore, there was no other thought in the late Secretary-General's mind than that he was anxious to take off as soon as possible and, as things turned out, it happened to become a night flight."

The Commission believes that the evidence before it does not fully support this view. It observes that, even if Lord Lansdowne had driven to the airport immediately after receiving the message referred to by Mr. Linnér, he would not have left Leopoldville in time to allow the Secretary-General to arrive at Ndola before dark. The Commission believes furthermore that the testimony of Lord Lansdowne and Mr. Ponjoulat as well as the estimated times of departure given in Flight Orders Nos. 673 and 685, show that the Secretary-General had decided to take off from Leopoldville not earlier than 1500 Z, or 4 p.m. local time. In these circumstances, as decided by the Secretary-General himself, the major part of his flight to Ndola had to be undertaken at night.

There appear to be several reasons why the Secretary-General's flight did not leave at an earlier hour. During the morning of 17 September, as has been noted, repairs were in progress on the aircraft. Moreover, as noted in the Introduction to this report, discussions concerning the meeting with



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Mr. Tshombé had continued throughout that morning, and the decision concerning the time of departure must have been influenced by the efforts to communicate with Mr. Tshombé through the British Consul at Elisabethville. It is also clear that the Secretary-General wished to arrive at Ndola after Lord Lansdowne had had time to land and depart, and this also conditioned the time of his departure. All these circumstances taken together may have rendered a night flight unavoidable in any event. It is also relevant to observe that, because of the danger of an attack from the Fouga Magister, most of the flights in the Congo at the time were undertaken at night.

As to the second point—why the flight had to be undertaken without escort—the Commission notes that ONUC had no fighter planes in the Congo at the time and that no request for an escort over Rhodesian territory was submitted to the Government of the Federation of Rhodesia and Nyasaland.

The second question . . . of the resolution . . . reads:

"Whether the aircraft, after the damage it was reported to have suffered earlier from firing by aircraft hostile to the United Nations, was in a proper condition for use."

The Commission is satisfied from the evidence before it that the damage to SE-BDY by gunfire at Elisabethville was minor and had been properly repaired before the take-off of the aircraft from Leopoldville on 17 September.

Crash of SE-BDY

The present part of the report deals with the conditions and circumstances of the flight and crash of SE-BDY and contains an analysis of possible causes. In addition a reply is given to the questions asked by the General Assembly . . .

. . . The Secretary-General left Ndjili airport, Leopoldville, at 1551 Z¹ aboard

¹ Z indicates Greenwich Mean Time (GMT).

SE-BDY. For reasons of security it would appear that complete radio silence was maintained while the aircraft was over Congolese territory. So far as is known, SE-BDY first broke radio silence at 2002 Z when it called Salisbury Flight Information Centre (FIC) and asked the estimated time of arrival at Ndola of aircraft OO-RIC carrying Lord Lansdowne. At the request of Salisbury FIC, SE-BDY then identified itself as a DC-6 bound from Leopoldville to Ndola and estimated its time of arrival at Ndola as 2235 Z.

Subsequently at 2035 Z it reported its position at a point over the southern end of Lake Tanganyika.

While the exact flight route of the aircraft up to that point is unknown, it is assumed that it flew from Leopoldville in an easterly direction and on reaching Lake Tanganyika took a southerly course informing Salisbury Flight Information Centre that it was flying on Advisory Route (ADR) 432. It continued to skirt the Congolese border flying for that purpose slightly to the east of ADR 432 and approached Ndola from the east or southeast. The operational team, including a United Nations observer, which was established in connection with the inquiry by the Rhodesian Board of Investigation, reconstructed the probable flight route. . . .

In communications between SE-BDY and Salisbury FIC, SE-BDY was given OO-RIC's estimated time of arrival at Ndola as 2017 Z, and later its actual time of arrival as 2035 Z. SE-BDY was cleared to descend from 17,500 to 16,000 feet and reported reaching the latter flight level at 2115 Z. The aircraft also reported it was keeping outside Congolese territory and proceeding round the border to land at Ndola, that thereafter it was taking off almost immediately, was not returning to Leopoldville and was unable at that time to give its destination after departure from Ndola. The pilot also estimated that he would be abeam Ndola at 2147 Z. At 2132 Z, Salisbury FIC transferred SE-BDY to Ndola Air Traffic Control. . . .

SE-BDY, on instructions from Salisbury Flight Information Centre, called Ndola tower at 2135 Z and informed it of its estimate that it would be abeam Ndola at 2147 Z and would arrive at 2220 Z. The tower transmitted a weather report giving wind at seven knots from an east-south-easterly direction, visibility as 5 to 10 miles with slight smoke haze, and the barometric settings for the altimeter in order to obtain the altitude reading above sea level (QNH) and the altitude reading above the airport (QFE). The aircraft acknowledged the weather report and requested clearance to descend beginning at 2157 Z. Clearance to descend to 6,000 feet was given and the aircraft was requested to report "top of descent." To questions whether the aircraft would be proceeding to Salisbury or remaining overnight in Ndola, SE-BDY replied in the negative. It declared itself unable to give further information concerning its intentions after landing and stated that it would give them on the ground. It also stated that it might require a little refueling at Ndola.

The following conversation is reported to have occurred at 2210 Z:

"SE-BDY: 'Your lights in sight, overhead

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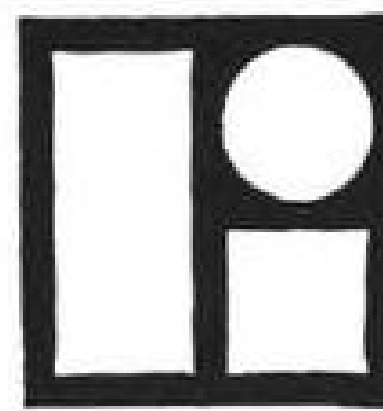
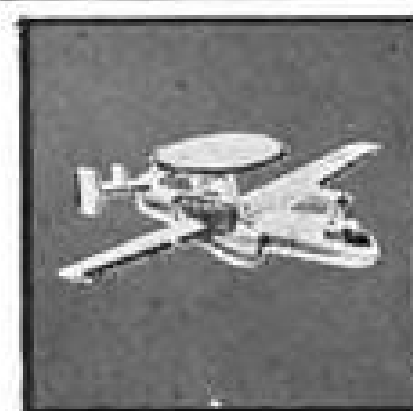
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Ndola, descending, confirm QNH.' (AD 200-317²).

"NDOLA: 'Roger QNH 1021 mb, report reaching 6,000 feet.'

"SE-BDY: 'Roger 1021'."

This was the last communication with the Secretary-General's aircraft.

From the information given by air traffic controller Martin, it appears that SE-BDY never reported reaching 6,000 feet. However, at 2210 Z it did state that it had Ndola lights in sight and was overhead Ndola, descending. At the same time it requested and received confirmation of the altimeter setting (QNH).

It may be of some interest to note the exchange of communications between the Ndola tower and OO-RIC, described as follows by air traffic controller Martin:

"... cleared to descend to 6,000 feet on QNH from FL 75. The aircraft was required to report reaching 6,000 feet. All this was acknowledged, and in due course the aircraft reported 6,000 feet. It was instructed to maintain that height and to report ND or 'lights in sight.' It reported 'lights in sight' and was given the wind direction and strength, and cleared to enter the traffic circuit for runway 10-..."

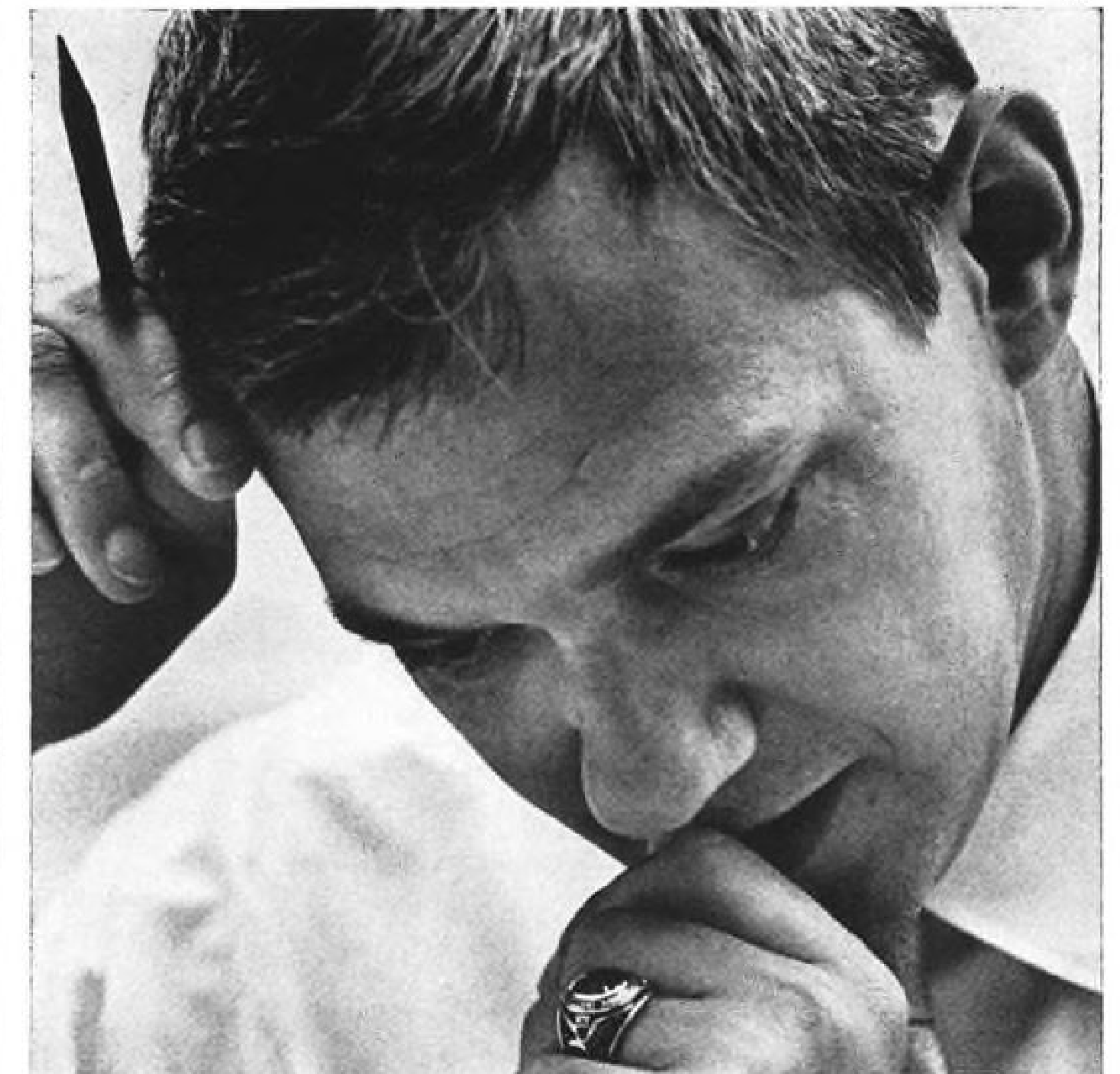
It will be observed that OO-RIC, which was approaching from the west, after reporting reaching 6,000 feet was asked to report its arrival over the radio beacon or "lights in sight." It reported "lights in sight" and was then given clearance to enter the traffic circuit. The possibility was considered whether SE-BDY, in reporting "lights in sight," should have been understood as being at 6,000 feet over the airport. However plausible this interpretation may be, it does not seem to have been so understood by Mr. Martin, who states that his final words to the aircraft at 1210 were "report reaching 6,000 feet."

Aircraft Observed

The aircraft was observed as it flew over Ndola by a number of persons at the airport or in or near Ndola. The navigation lights were on and, while the observations of all witnesses do not agree, it appears that the flashing red anti-collision beacon on top of the tail fin was also operating. With the exception of one of the RRAF personnel stationed at the airport, who thought the plane was approximately 10,000 feet above the airport, all witnesses who actually saw the aircraft pass over the field stated that it flew at normal height or slightly lower. It will be noted that the normal height according to the approved charts is 6,000 feet above sea level, or less than 2,000 feet above the airfield the elevation of which is 4,160 feet. On the other hand, some witnesses living west of the airfield stated their belief that the height of the aircraft was much lower than usual. These witnesses did not actually see the plane but only heard it and their conviction that it was flying at a low altitude was derived from the fact that it

² The entry "AD 200-317" indicates that the magnetic heading of Ndola from the aircraft, as shown on the automatic direction finder (AD 200) in the Ndola tower, was 317° (magnetic). It would appear that the aircraft was not actually over the airfield but was approaching the airfield from the southeast, as would be expected if it had flown round the Katanga pedicle.

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MS, EE, or ME with 8 or more years experience in environmental analysis and testing of missile systems and subsystems. Duties will include the assessment, development, and analysis of criteria for environmental testing of missile systems in the areas of vibration, shock, solar simulation, and extreme temperature variance. Duties will also include the coordination and implementation of standard environmental test procedures for the total Minuteman Weapon System.

PRODUCTION ENGINEERS

BS or MS in ME or EE with 5 to 8 years experience in manufacturing research, production tooling, and production problem solving of sophisticated electronic equipment and precision mechanical equipment. In addition, experience in the design and production of digital equipment is desirable. Duties will include the analysis of production planning and capabilities, specification review, and installation of weapon system equipment.

SENIOR SYSTEMS ENGINEERS

BS or advanced degree in ME or EE with 10 years experience in transportation handling equipment, digital data processing equipment and ground power systems equipment. Duties will include technical direction on design of mechanical ground equipment and ground digital electronic equipment; and systems analysis and integration of the design and development of ground power equipment.

COMMUNICATIONS ENGINEERS

BS or advanced degree in EE with 8 to 10 years experience in design of UHF and VHF communications systems and digital communication systems. Duties will include systems engineering and evaluation of contractors performing design and development of electronic and electromagnetic communications equipment.

CONFIGURATION CONTROL ENGINEERS

Senior and intermediate openings requiring degree in Engineering or Physical Sciences, or equivalent with 2 or more years experience in configuration control activities including technical evaluation and coordination. Requirements include experience in maintaining operational capability of the weapon system.

RELIABILITY ENGINEERS

Senior and intermediate openings requiring BS or advanced degree in EE, ME or Physics with 5 to 10 years experience in missiles or other weapon systems, environmental testing, systems analysis or evaluation, hardware, design, testing, and production engineering. Responsibilities will extend from managing and directing Associate Contractor Reliability Programs, to assisting in evaluating and directing these programs, and overall assistance in the solution of reliability technical problems.

AIRBORNE ELECTRONICS SYSTEMS ENGINEERS

BS or advanced degree in EE or Physics with 5 or more years experience in design/development of airborne electronics systems as applicable to ballistic missiles.

AIRBORNE SYSTEMS PROJECT ENGINEERS

Degree in AE or ME with 5 or more years project experience in analysis, development and test of airborne missile systems.

INSTRUMENTATION ENGINEERS

BS or MS in Physics or EE with 6 to 10 years experience in the actual design and flight test of airborne missile instrumentation systems, including telemetry subsystems, CW or pulse radar tracking systems. Phase lock or digital circuitry experience is required. Duties will include detailed systems analysis in support of Systems Engineering and Technical Direction to Associate Contractors.

FLIGHT TEST ENGINEERS

BS or advanced degree in AE, EE or Physics with 3 or more years experience in systems test planning and analysis in missiles and/or A/C. Responsibilities will include processing, reduction and evaluation of flight test data including FM/FM and PCM/FM telemetry and external tracking data.

SPECIFICATIONS ENGINEERS

BS or equivalent in ME or EE with 5 or more years experience in military equipment specification writing. Opportunities include the review and analysis of model specification for compliance with program requirements.

Resumes and inquiries for the above openings will receive prompt attention. Please write Dr. R. C. Potter at STL's address below. STL is an equal opportunity employer.



SPACE TECHNOLOGY LABORATORIES, INC.

One Space Park, Department A, Redondo Beach, California
a subsidiary of Thompson Ramo Wooldridge Inc.

sounded much louder than aircraft normally landing at Ndola.

However, it would seem that these witnesses were not aware that a DC-6B is a much noisier plane than those normally landing at Ndola.

Ndola Landing Procedures

The Federal Government of Rhodesia and Nyasaland has approved an Instrument Approach Procedure for aircraft landing at Ndola based on the use of a radio beacon (non-directional beacon-NDB) located approximately three miles west of the airport.

This procedure is depicted on an ICAO standard Instrument Approach Chart published by the Rhodesian authorities. It is also shown on a chart in the Jeppesen Manual published by the Jeppesen Company of Denver, Colorado, which is a loose leaf flight information manual approved for use by Transair.

As the name implies, instrument approach charts are primarily intended for use in conditions of reduced visibility when it becomes necessary for the pilot to rely on instruments instead of on visual reference. However, it has been stated that the standing instructions issued by Transair require pilots using an airfield for the first time to make a complete instrument approach even when visibility and cloud height are unlimited.

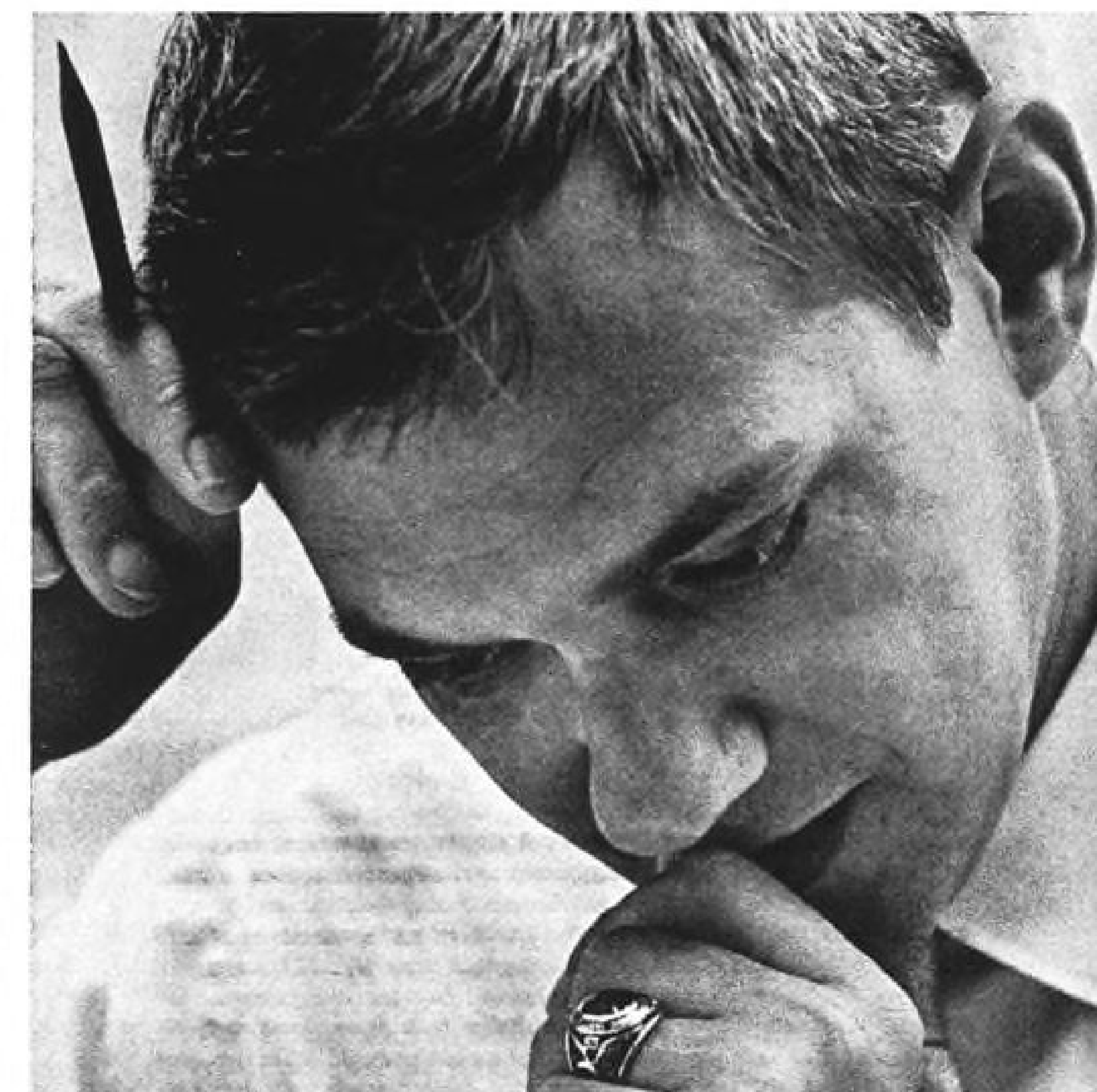
In executing an instrument approach for Ndola the aircraft flies west from Ndola on a heading of 280° to a point 1.25 nautical miles beyond the radio beacon (NDB). It then begins its "procedure turn," altering course first to the right on a northwesterly heading of 325° and then turning gradually to the left until it is aligned with the runway on an easterly heading of 100°. In accordance with the Chart referred to above, the aircraft maintains an altitude of 6,000 feet above sea level (ASL) throughout this procedure turn. On completion of the turn it begins losing height in order to arrive inbound over the radio beacon (NDB) at 5,000 feet (ASL), after which a normal rate of descent ensures an accurate final approach and landing.

Conflicting Charts

It came to the Commission's attention, however, during some of its flights in Rhodesia that there are in use instrument approach charts for Ndola which provide for a descent from 6,000 to 5,000 feet during the procedure turn. A pilot using this descending turn might well reach the level of 5,000 feet while flying over terrain higher than 4,000 feet and thus reduce the safety margin to less than the 1,000 feet recommended in the ICAO Procedures for Air Navigation Services-Aircraft Operations . . . relating to NDB Instrument Approach. There is, however, no evidence before the Commission whether the crew of SE-BDY had available, or in fact knew of, charts authorizing a descending turn, while the chart in the Jeppesen Manual, as well as that published by the Rhodesian Civil Aviation Authorities, provided for maintaining 6,000 feet throughout the procedure turn.

The conclusion of this United Nations accident investigation report will appear in a subsequent issue of AVIATION WEEK.

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Scientists experienced in working with information and sensing systems, platforms, infrared, sensors, flight controls, airborne computing and data handling systems.

Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.

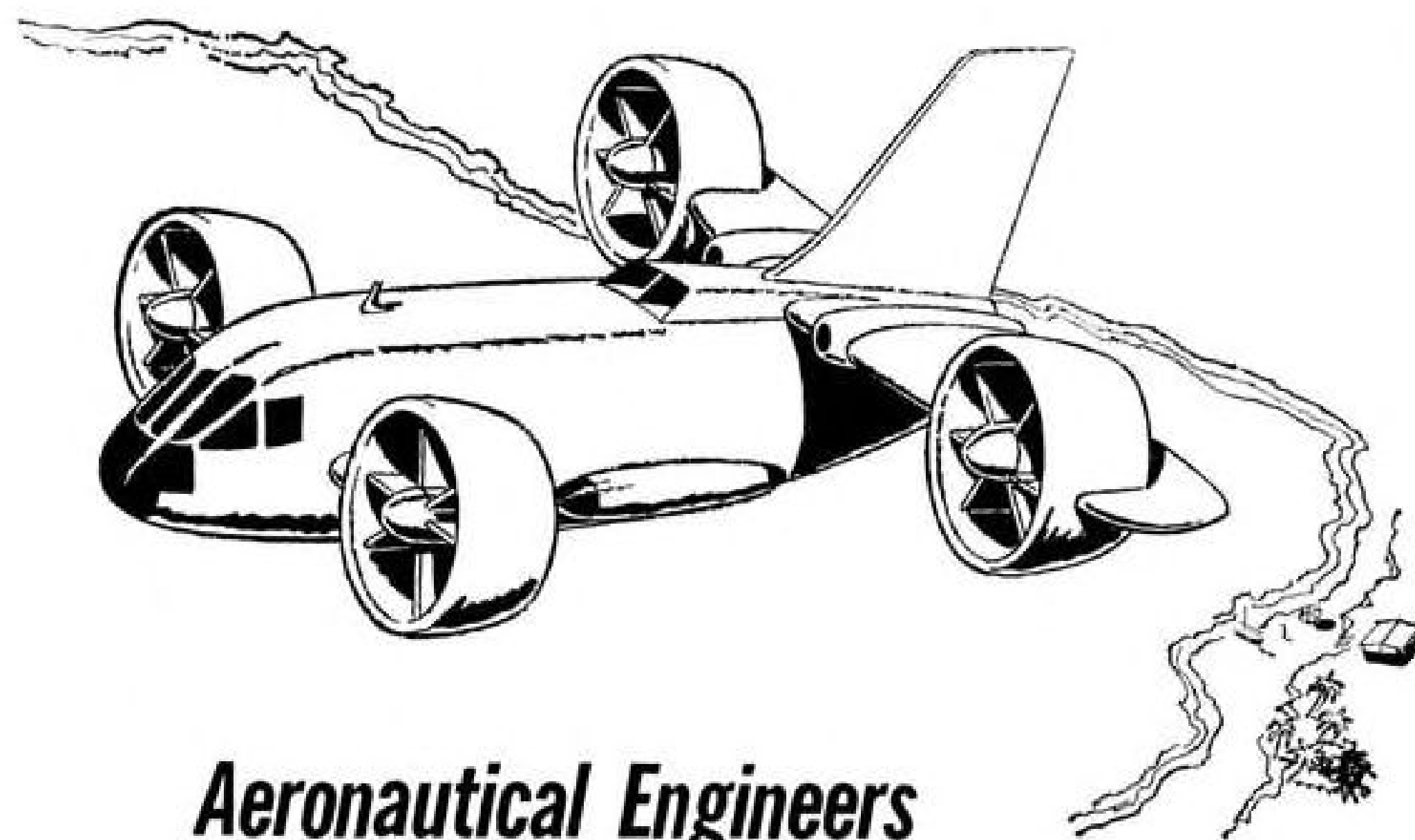
Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.

Chemical Engineers to work on the development and applications of structural adhesives for aerospace vehicles.

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bureau of naval weapons
(DCP-31)

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WHO'S WHERE

(Continued from page 23)

Changes

George V. Butler, director of the newly established Advance Programs Department, Douglas Aircraft Co.'s Missile and Space Systems Division, Santa Monica, Calif., and Ned T. Weiler, deputy director. Named as Advance Programs managers: G. F. Lind, missile offense systems; W. H. Branch, missile defense systems; V. E. Crosley, re-entry systems; C. W. Gaskell, Jr., motor cases; R. J. Gunkel, space launch vehicles; W. W. Reaser, spacecraft; G. C. Goldbaum, space program extensions; P. L. Smith, market analysis; A. C. Robertson, program office; S. J. Colby, program planning; J. W. Shaver, international programs; G. D. Morse, market development (acting); E. L. Sorenson, supervisor, program control data; E. C. Kaliher, advance programs administration.

David R. Israel, head of the newly organized Air Traffic Systems Directorate, The Mitre Corp., Bedford, Mass., and Edwin S. Rich, head of the newly organized System Integration Office. Also: Richard S. Fallows, head of the company's Digital Systems Engineering Department.

David J. Abromowitz, director of contract administration, Ordnance Operation of Avco Corp.'s Electronics and Ordnance Division, Cincinnati, Ohio.

Hooper A. Williams, general manager, Chicago Miniature Lamp Works, Chicago, Ill.

Donald K. Adams, manager, Government Relations Department, Military Products Division, Adler Electronics, Inc., New Rochelle, N. Y.

Richard B. Foster, general manager, Minneapolis-Honeywell's Boston (Mass.) Division, succeeding Melvin P. Fedders, now manager of operations for the company's St. Petersburg (Fla.) facility.

Dr. Malcolm J. Fraser, director of the newly established Superconducting Materials Department, Westinghouse Electric Corp.'s Materials Manufacturing Division, Blairsville, Pa. Also: Raymond E. Wien, manufacturing superintendent; William J. Reichenacker, engineering manager; Thomas J. Holleran, marketing product specialist.

Robert O. Vaughan, director of marketing, General Precision's Librascope Division, Glendale, Calif.

William O. Spink, director of marketing, Electro-Optical Division, Perkin-Elmer Corp., Norwalk, Conn.

Anders Oxehufwud, chief microwave engineer, Aerial Surveys Division of Fairchild Camera and Instrument Corp., Los Angeles, Calif.

Arnold R. Sabel, engineering planning manager, Integrated Electronics Applications, Motorola's Military Electronics Division, Scottsdale, Ariz.

Bernard Epstein, technical service engineer-piezoelectric transducers, Endevco Corp., Pasadena, Calif.

Dr. Donald A. Guthrie, executive assistant to the manager of central research, Lord Manufacturing Co., Erie, Pa.

John W. Smith, manager of engineering, Vitro Electronics, Silver Spring, Md., a division of Vitro Corporation of America.

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Automatic Flight Control Systems Engineers—EE or Physics degree with a minimum of 5 years experience in the design and development of autopilots. Work will consist of the analysis, synthesis and integration of autopilot systems culminating in hardware implementation.

Digital Computer Systems Engineers—BSEE with a minimum of 4 years experience in the analysis, design and development of digital computers. Will participate in the integration of digital computers into a complex weapons system. A significant part of the effort will be devoted to extensive laboratory and flight development programs.

Escape Systems Engineers—BS in ME or AE with 5 years aircraft experience. Capable of major layout, stress analysis and supervision. Requires working knowledge and previous design experience in Escape Systems Concepts, seat design and comfortization programs, recovery systems, survival and personnel equipment.

Systems Engineers—BS or advanced degree, experienced with digital computers and their applications to the mechanization and control of weapons systems. Working knowledge of the components which comprise these systems such as radars, inertial platforms, air data units, star trackers, and displays is desirable. Will be responsible for conceiving, developing, integrating and system engineering complex weapons delivery and reconnaissance systems involving aircraft, missiles and space vehicles.

Statisticians—To apply statistical techniques in a variety of engineering application in aero-space programs including the solution of problems in test design and reliability. Requires degree in statistics or mathematics and minimum of 3 years' experience in design of experiments, analysis of variance and multi-variate analysis in technical fields. Machine programming desirable.



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Airport Operator For Brainard Field, Hartford, Conn. Proposals will be received in the Department of Aeronautics Building, Brainard Field, Hartford, Connecticut, until 2:30 PM DST on July 9, 1962, and then publicly opened for the fixed-base operation, land-leasing and provisions of required services and facilities at Brainard Field, Hartford, Connecticut. Said proposals shall be subject to the conditions and specifications contained in "Instructions to Applicants" and shall be filed on proposal forms, both of which may be procured at the Department of Aeronautics Building, Brainard Field, Hartford, Connecticut. The Connecticut Aeronautics Commission reserves the right to waive any informality in the proposals, to negotiate further with the applicant who most closely meets the objectives of said Commission and to reject any and all proposals.

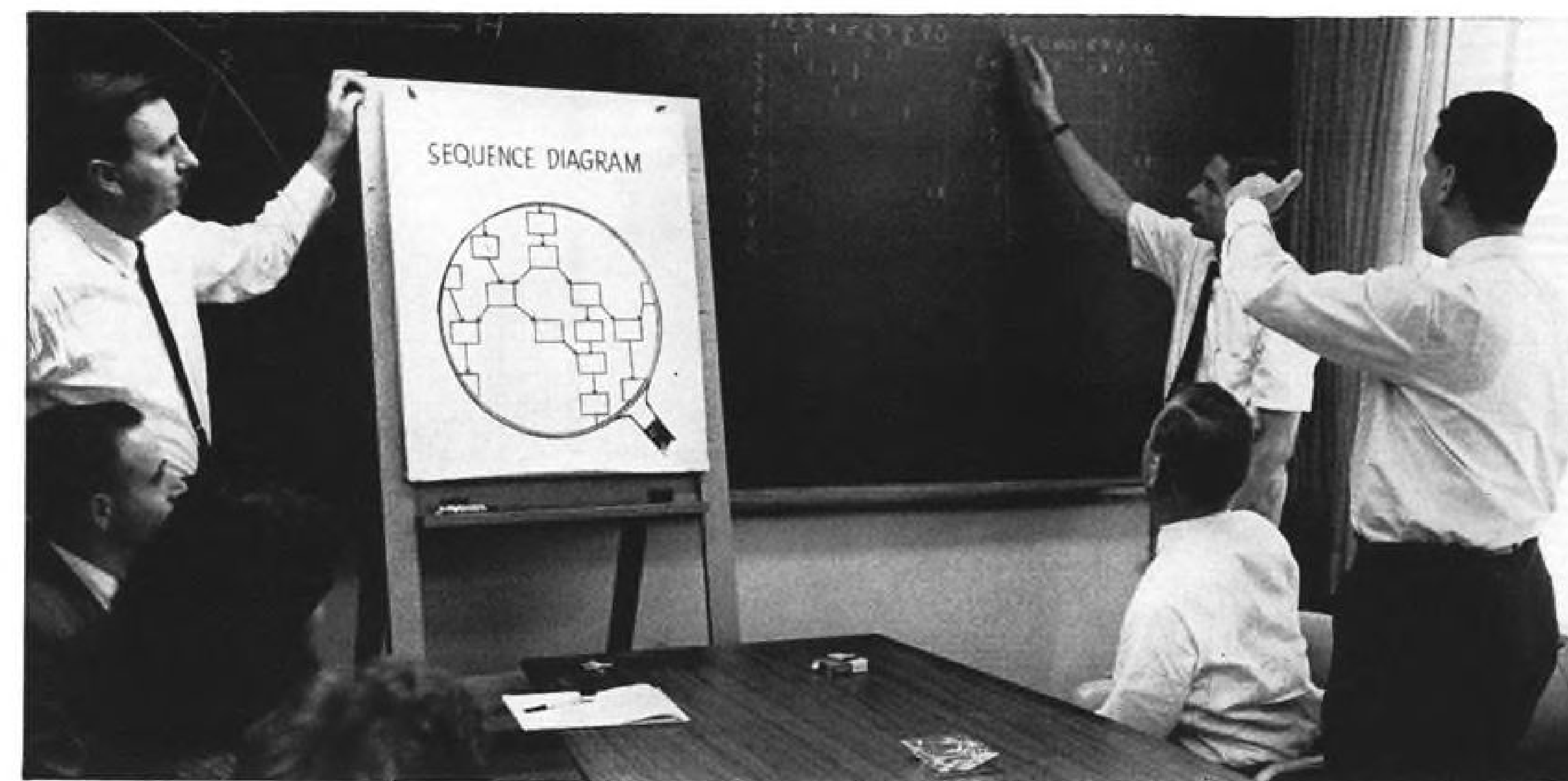
Airport Operator For Danielson Airport, Killingly, Conn. Proposals will be received in the Department of Aeronautics Building, Brainard Field, Hartford, Connecticut, until 2:30 PM DST on July 9, 1962, and then publicly opened for the fixed-base operation, land-leasing and provisions of required services and facilities at Danielson Airport, Killingly, Connecticut. Said proposals shall be subject to the conditions and specifications contained in "Instructions to Applicants" and shall be filed on proposal forms, both of which may be procured at the Department of Aeronautics Building, Brainard Field, Hartford, Connecticut. The Connecticut Aeronautics Commission reserves the right to waive any informality in the proposals, to negotiate further with the applicant who most closely meets the objectives of said Commission and to reject any and all proposals.

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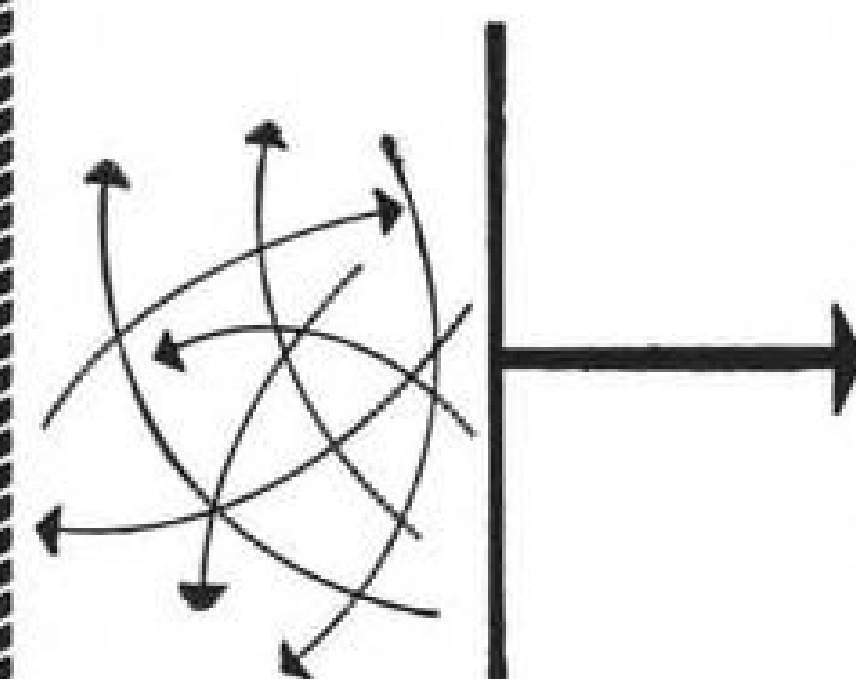
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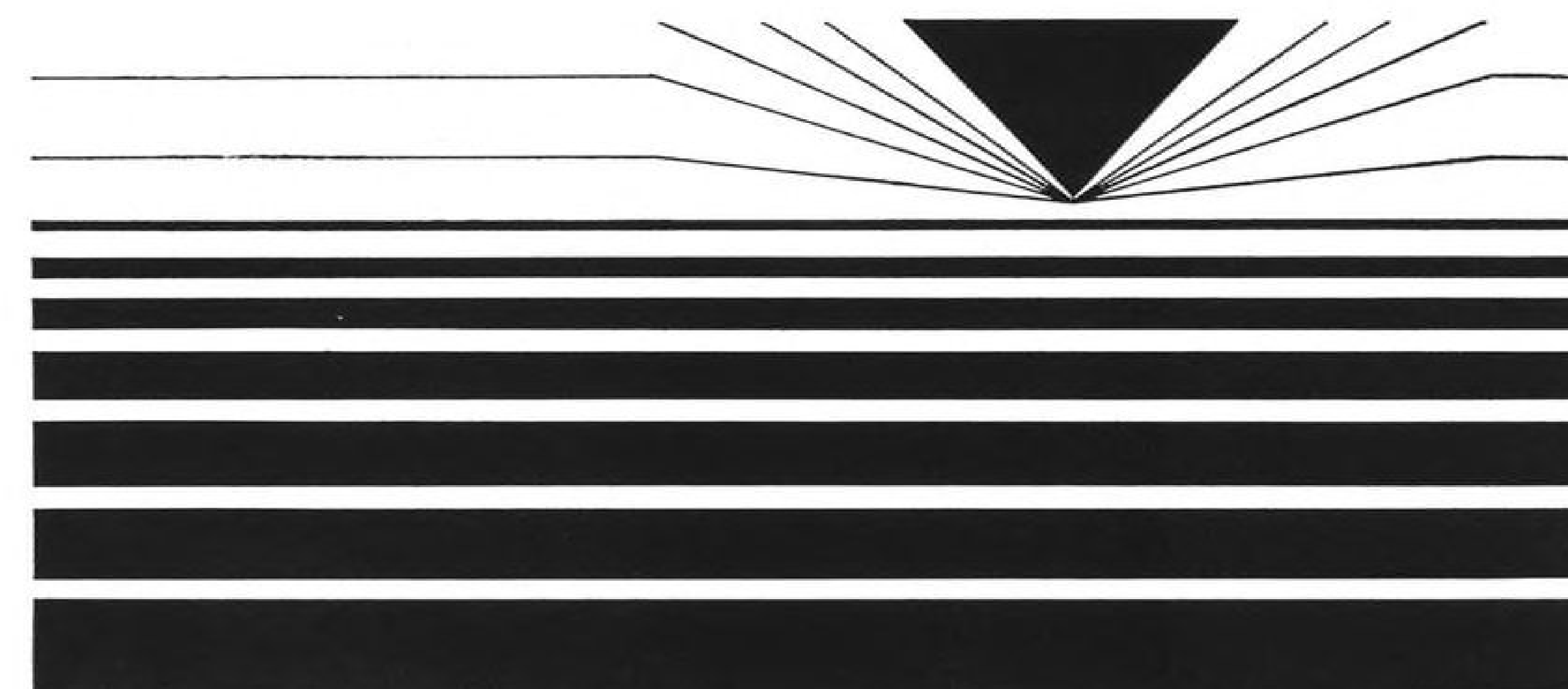
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Super E-18S Executive Beechcraft; One owner aircraft—A-1 condition, fully equipped for instrument flight; total air frame hours 1485; both engines have 585 hrs. SMOH; Hartzell three bladed props—fullfeathering; Ram air scoops—Atkins anti-collision wing-lights; offers invited. FS-9139, Aviation Week.

WANTED

Lockheed 18, Pratt & Whitney powered, airline interior. Americas Trading Company, Box 8536, Lantana, Florida.

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the box number when answering advertisements. It is the only way we can identify the advertiser to whom you are writing.

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4B category license and Swiss import duty paid for European operation if desired. USA registry.

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LETTERS

MA-7 Recognition

Your excellent editorial, "Proof of the Pudding," which appeared in the June 4 issue of AVIATION WEEK showed an intelligent awareness of MA-7 accomplishments. Those of us in the business are always happy to see a realistic appraisal of results.

However, we also appreciate recognition being given. Might I point out the system which threaded the "orbital eye with incredible precision" for MA-7, as for the other three successful Mercury orbital flights, was General Electric's radio-command Atlas guidance system.

GE's Defense Systems Department, a prime contractor just as General Dynamics/Astronautics, would like just a share of credit for our painstaking work to make MA-7 "another startling measure of progress."

E. C. LAMM, Specialist
Information Services
Atlantic Missile Range Operations
General Electric Co.
Defense Electronics Division
Defense Systems Department

Keeping Company

Might I suggest that in future an official of the Port of New York Authority be required to fly on each jet that leaves Idlewild?

CLAY STEFFEE
Kissimmee, Fla.

Tin Goose's Golden Egg

The article "Senators Hear DC-3 Replacement Plans" (AW May 21, p. 42) relates so clearly how our advanced technology leaves small room for the so-called "old fashioned ideas" even when proved to be basically sound.

If smaller cities are destined to enjoy the benefits of unlimited air transportation, it would seem that all the design sophistication being shown in this search for a new work horse is incongruous with feederline philosophy.

Shouldn't the industry be thinking in terms of a lower priced, more ruggedly built, easier to maintain aircraft for "every hour on the hour" type of operation when necessary? Who is demanding retractable landing gears, interiors loaded with plush appointments and high speed, low lift wings? Certainly it's not the short haul passengers, many of whom would ride a broom if it would get them to a long haul terminal. Here is where frequency, regularity and safety—all with a profit—could make a real hit.

While rotary wing and other currently available VTOL do an admirable job, and we can't overlook their future possibilities, the need for our elusive, short-runner heavy-lifter is now—and with economic strings attached.

Where's the group that is willing to take a fresh new look at the old Ford tri-motor concept as a basis from which to start? With certain obvious refinements

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

and possibly two turboprops, does something like the fat winged Model 5-AT suggest an answer to our basic problem?

Good engineering should be able to reflect simplified design when it's called for. In this case, let's resurrect the Tin Goose and make it lay a golden egg.

M. W. MARTIN
Akron, Ohio

Freud and Flying

The hue and cry to fill empty airliner seats has brought about the headline "Airlines Plan More Psychology In Overcoming Fear of Flying" (AW May 21, p. 43). This headline could actually read "Airlines Plan More Psychology In Overcoming Fear of Dying." In the text on p. 45 there is a statement about "... their natural fear of flight." There is no such thing as a natural fear of flying.

Those who have never flown believe that flying is an uncomfortable, unpleasant, and terrifying experience. They conjure up all kinds of fearful images as they are unaware that flying has less sensation than sitting on a comfortable chair in their living rooms.

People are generally afraid of the unknown—and flying, among other things, represents the unknown to them. When the unknown becomes commonplace then people will use air transportation without a second thought.

There are many fatal automobile accidents every day—still this does not stop people from driving or going hell bent for glory on the freeways in heavy traffic. Cars are commonplace, old hat so to speak, and the public shrugs off auto accidents as one of the consequences of driving.

Some time ago I took my mother-in-law (75 at the time) for her first flight. The plane was a Cessna 150, which is a far cry from an Electra or a 707. She enjoyed the flight immensely and asks to be taken all the time. Her only complaint was the apparent lack of speed. As she put it, "You're up there and don't seem to be moving!"

Not long ago a girl working in the operations office of a fixed-base operator at the local airport mentioned to me that she had never flown. I took her for a ride in a Bonanza. Although she had a tendency to shy away from the turns, she enjoyed every minute and now flies at every opportunity.

Less than three years ago my wife had her first flight in a Comanche. She found flying so fascinating that she learned to fly and now has her pilot license.

What is the point of all this? Very simple; the best way to introduce a new product is by giving away samples. Adver-

tising costs money and the airlines would receive more value for their advertising dollar by taking people who have never flown for a short ride. This would give the masses a first hand taste of flying and accomplish more than all advertisements put together. Word of mouth endorsement has more effect to the average person than advertisements in printed form. If the airlines are reluctant to give anything away let them charge a dollar.

WILLIAM MARON
Mountain View, Calif.

Pilots' Pay

An item concerning the internal politics of the Air Line Pilots Assn. (AW May 21, p. 40) states that ALPA's incumbent president conditionally predicts that in the next decade airline pilots may be flying less than 50 hr. per month at \$30,000 per year, with retirement at age 50.

If this becomes fact it will also become some sort of a classic example of poetic justice.

It strikes this independent pilot that the airlines' Air Transport Assn.'s weight and its acknowledged arbitrary thinking on the rule which barred all airline pilots from individual consideration to retain their jobs after age 59 went a long way to encourage the then young FAA to plead to the courts of the land about its incapability in matters pertaining to screening of pilots' competency.

That the pilots should get a little weird in their thinking does not now seem strange to me. Maybe the whole industry should look to the couch.

ROBERT E. TRIMBLE
Washington, D. C.

Service Contrast

Re: Letters, "Fly American," AW May 7, p. 146.

Reader's comments to editor seem to indicate Americans have a duty to use American carriers regardless of factors that weigh heavily in selection of an airline.

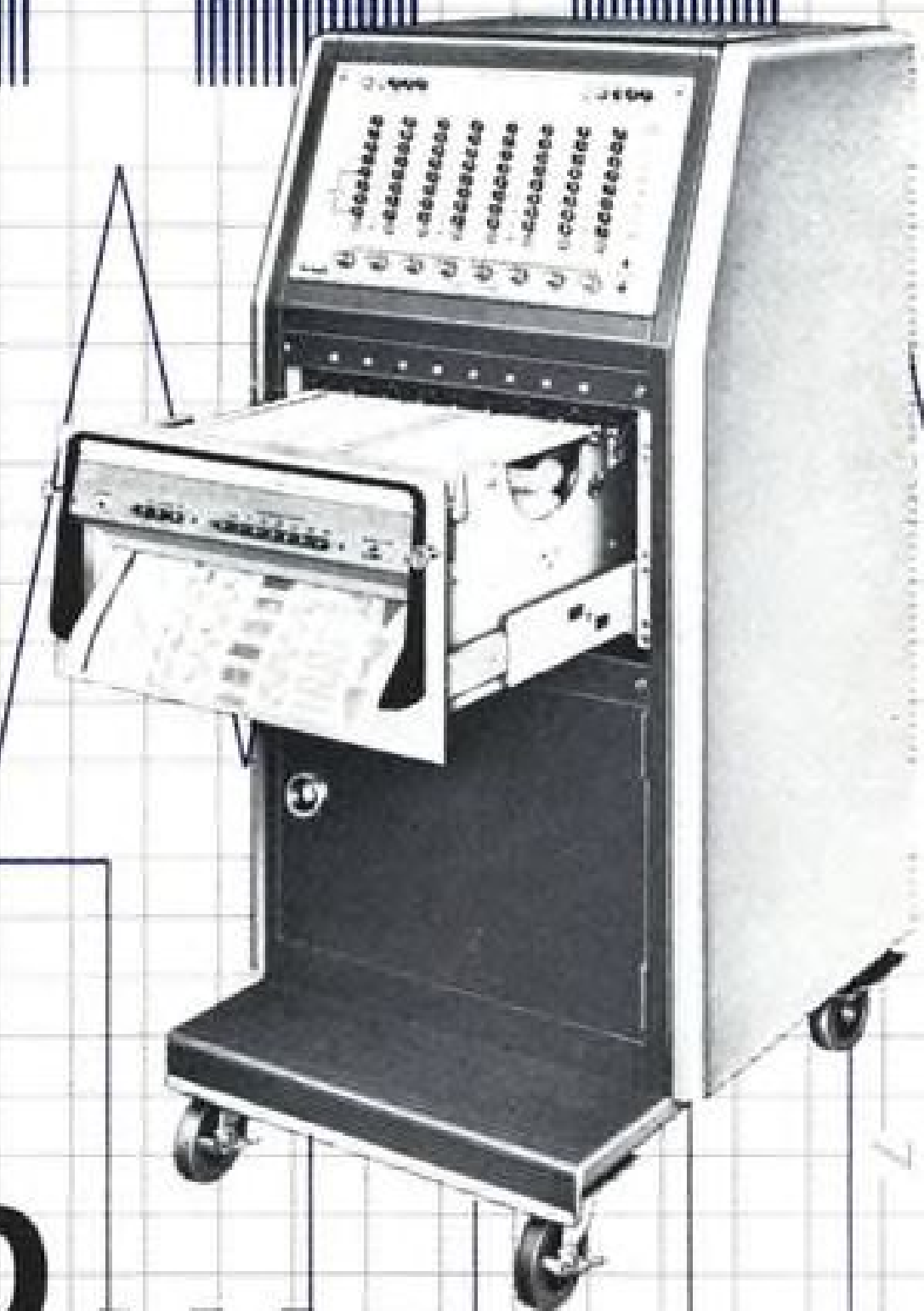
Having traveled extensively by air, including several trips to Europe with both American and foreign carriers, I must say that in my experience American service doesn't compare with European. I would compare tourist service on European airlines very favorably with first class on American. The attention to details, baggage, and schedule are all important considerations which seem to be very minor items with some American airlines.

We are in a competitive age and I certainly want American industry to grow, and particularly airlines—but repeated strike threats, stewardess low pay and resultant indifference, and general personnel attitudes can only lead to the same condition now existent on most railroads where the passenger is almost resented—or at least it appears so.

(Name withheld by request.)

E. A. W.
Los Angeles, Calif.

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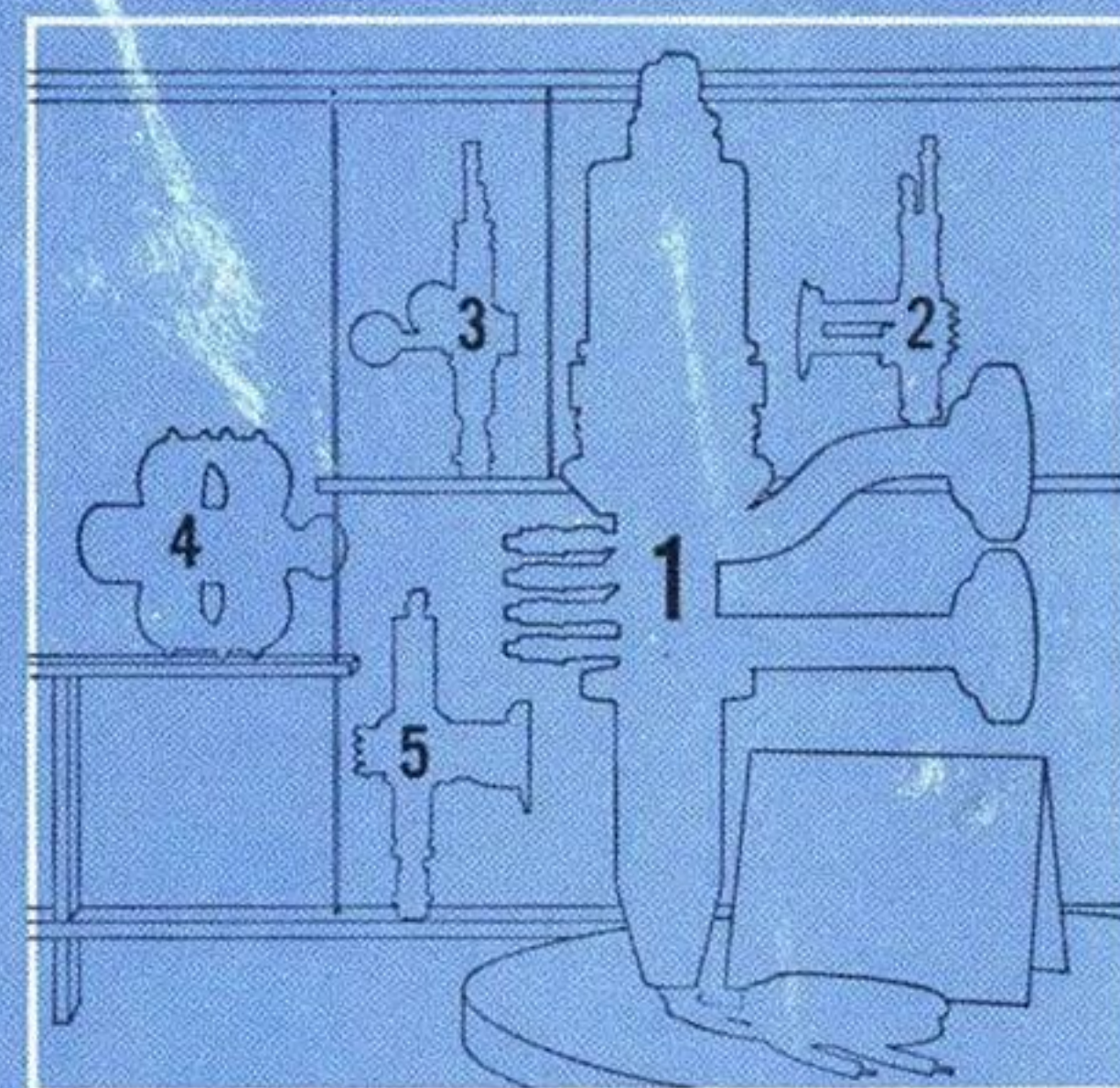
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