Aviation Week and Space Technology

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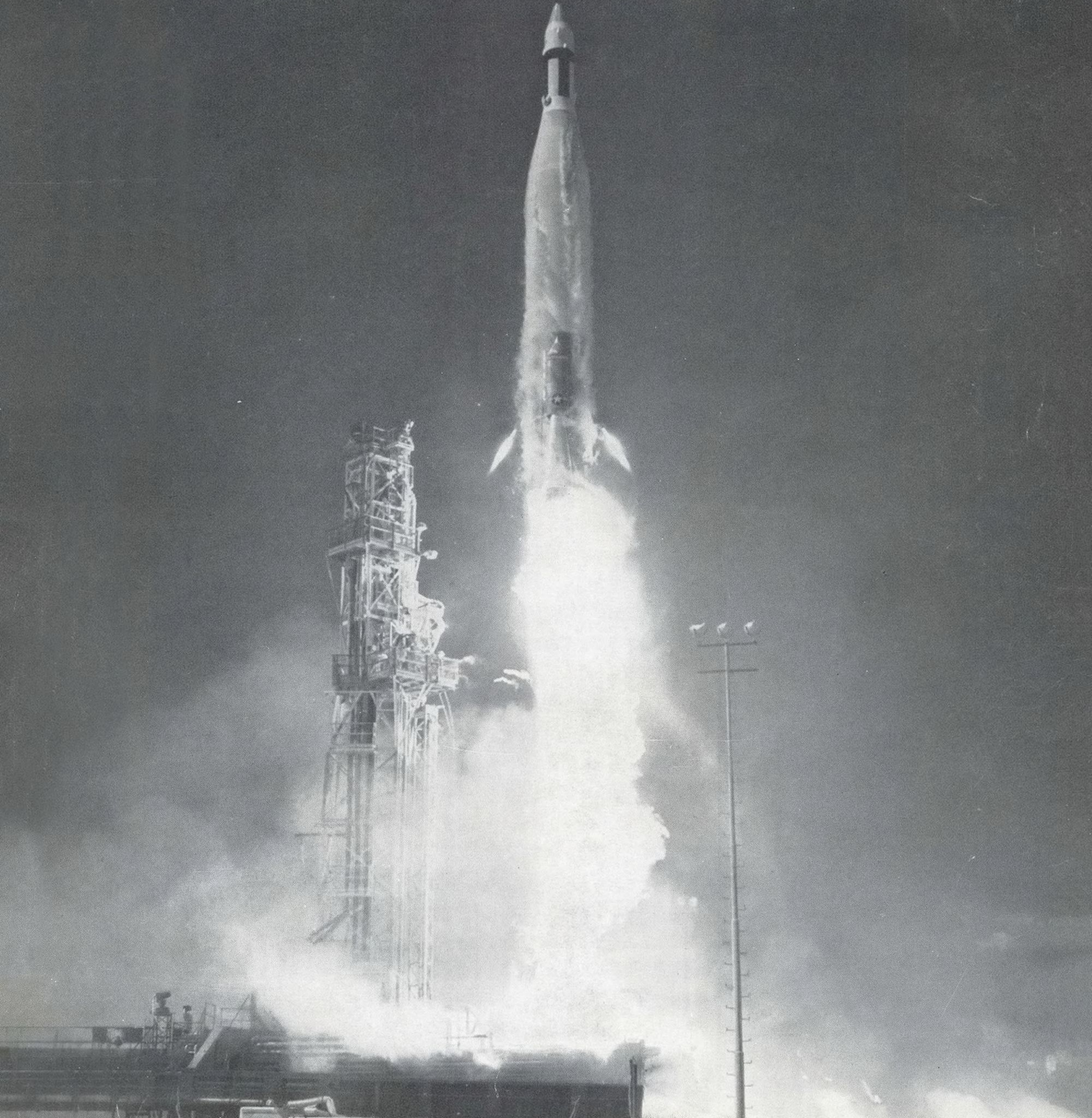
March 28, 1960

SPECIAL REPORT:

Cryogenic Avionics

Atlas-Agena Launches First Lockheed Midas




MK3031


MF1400


H41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MK2031


MF6000


MK4400


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K7000

H14

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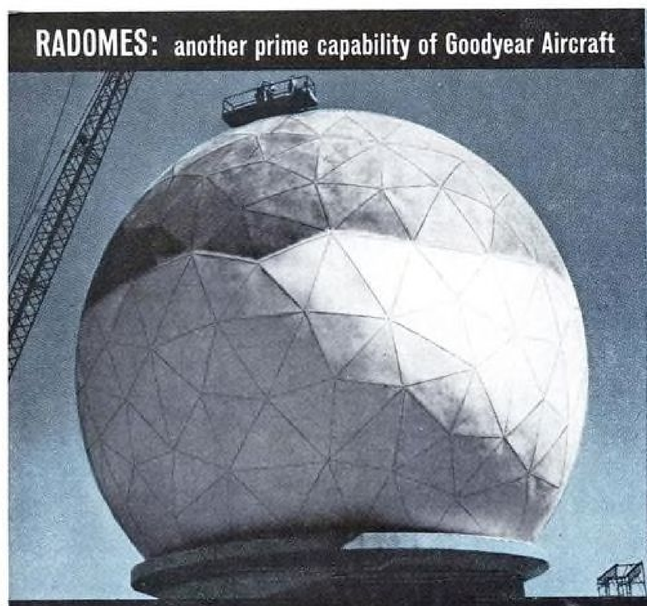
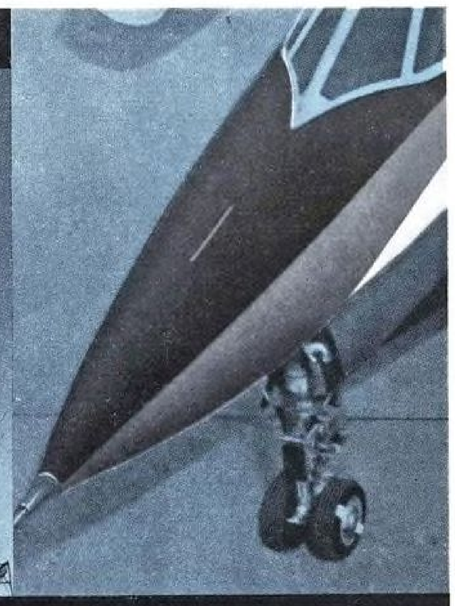
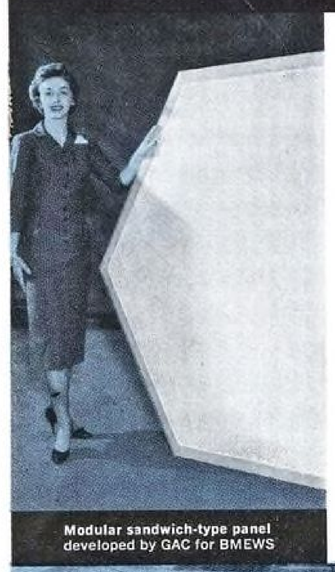
RADOMES: another prime capability of Goodyear Aircraft


110-foot rigid radome, pioneered by GAC


Solid laminate radome for Mach 2 airplane


Modular sandwich-type panel developed by GAC for BMEWS

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Whatever your radome requirements, *chances are Goodyear Aircraft Corporation (GAC) has built one like it. For GAC has pioneered radome development — from the smallest aircraft and missile radomes to giant ground radomes for BMEWS and Nike-Zeus. Whether you need a "foamed in place" or honeycomb-sandwich construction, a ducted radome design or a solid laminate model — Goodyear Aircraft has the answers to the problem — electrical and mechanical design, fabrication, testing, erection and service. Your inquiry is invited. Write: Goodyear Aircraft Corporation, Dept. 916AO, Akron 15, Ohio.*

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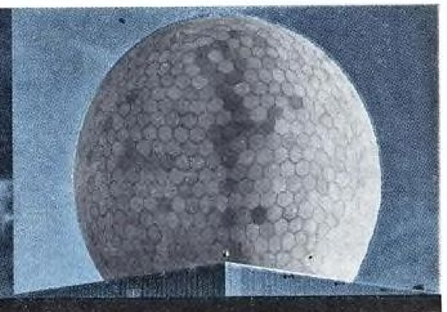
Cored deicing radome, built by GAC for C-130


140-foot honeycomb sandwich radome

AVIATION CALENDAR

Apr. 5-8—1960 National Aeronautic Meeting and Missiles and Aircraft Engineering Display, Society of Automotive Engineers, Commodore Hotel, New York.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 11-13—Electrical Engineering in Space Technology, Hotel Baker, Dallas, Tex. Sponsor: American Institute of Electrical Engineers.

Apr. 12-13—14th Annual Spring Technical Conference, Institute of Radio Engineers in conjunction with the American Rocket Society, Hotel Alms, Cincinnati, Ohio.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 19-21—10th Annual Convention, International Airline Navigators Council, Hotel Manhattan, New York, N. Y.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA; the Rand Corp.

Apr. 21—Annual Eastern Regional Meeting, Institute of Navigation, Key Bridge Marriott Motor Hotel, Washington, D. C.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Apr. 21-22—Seventh Annual Heat Transfer Conference, "A Survey of Radiation Phe-

(*Continued on page 6*)

AVIATION WEEK and Space Technology
March 28, 1960
Vol. 72, No. 13

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AVIATION CALENDAR

(Continued from page 5)

nomena and Heat Transfer Equipment for Space Flight Application," Oklahoma State University, Stillwater, Okla.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

Apr. 28-29—Symposium on "Closed Circuit Respiratory Systems," Wright Air Development Division, Wright Patterson AFB.

May 2-4—National Aeronautical Electronics Conference, Biltmore and Miami-Pick Hotels, Dayton, Ohio. Sponsor: Institute of Radio Engineers.

May 2-5—Sixth National Flight Test Symposium, Instrument Society of America, San Diego, Calif.

May 3-5—Fourth Signal Maintenance Symposium, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego.

May 9-12—Semi-Annual Meeting and Astronautical Exposition, American Rocket Society, Ambassador Hotel, Los Angeles.

May 9-13—Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, Tex.

May 9-13—Annual Conference, Society of Photographic Scientists and Engineers, Miramar Hotel, Los Angeles, Calif.

May 10-12—1960 Electronic Components Conference, Willard Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts; American Institute of Electrical Engineers; Electronic Industries Assn.; Western Electronic Manufacturers Assn.

May 11-14—16th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 13-14—1960 National Intercollegiate Flying Meet, Ohio State University Airport, Columbus, Ohio.

May 15-18—Annual Convention and Business Meeting, American Assn. of Airport Executives, Waldorf-Astoria, New York.

May 16-20—Aviation Fire Safety Seminar, National Fire Protection Assoc., Queen Elizabeth Hotel, Montreal, Canada.

May 18-20—National Meeting, Society for Experimental Stress Analysis, Hotel Severin, Indianapolis, Ind. Theme: Stress Analysis of Propulsion Systems.

May 22-29—Fourth Annual Reserve Navigation Competition, Ellington, AFB.

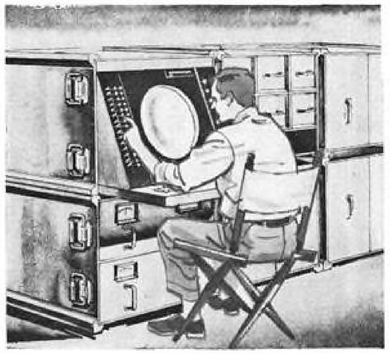
May 23-25—12th Annual Meeting, German Society for Rocket Engineering and Space Flight Research, Heidelberg, West Germany.

May 24-26—1960 Convention, American Society for Quality Control, San Francisco, Calif.

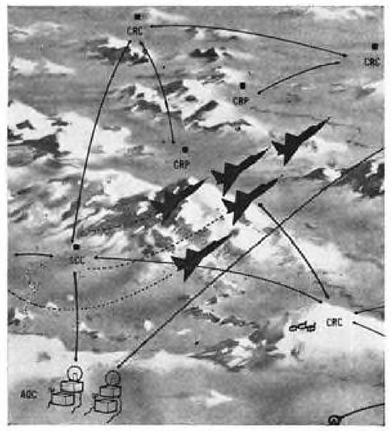
Aug. 15-20—11th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm.

Sept. 5-11—1960 Farnborough Flying Display and Exhibition, Society of British Aircraft Construction, Farnborough, Eng.

Sept. 12-16—16th Annual General Meeting, International Air Transport Assn., Copenhagen, Denmark.



A Tracking Center collects, evaluates and displays pertinent information on all air activities within its area of responsibility. Each tracking site can track while scanning many high speed maneuvering targets. Position information and supplementary intelligence is available for insertion into the system from the communications network which involves all stations in the system.



The Control Function results in accomplishment of tactical air missions assigned by the command center, including intercepting air targets, air attacks on ground targets, return-to-base missions and response to emergency situations. The vectoring computer group calculates optimum intercept vectors, and guides the assigned aircraft to the target, constantly correcting for target maneuvers and drift. One air controller can monitor many air missions, providing a greatly expanded capacity over manual systems.

Communication is accomplished in ground-to-air messages by automatic voice or digital techniques. Microwaves, tropospheric scatter or land line communication is used between sites. Compact message structure and efficiently programmed time-sharing insures rapid updating of a maximum number of targets. Communication facilities are flexible and can easily be reorganized to accommodate a change in the number of sites.

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TACS—*combining data processing, communications and control functions—demonstrates total systems capabilities.*

A significant example of the capabilities of the Remington Rand Univac Military Division is the AN TSQ-13 Tactical Air Control System. This USAF System automatically performs air surveillance, evaluation and control functions in a 160,000 square mile area, reassessing the air situation every 30 seconds to facilitate command decisions.

The transportability of the System allows Control and Reporting Centers to be quickly moved into far forward positions to give surveillance of tactical territory. A communications network, involving both voice and digital techniques, coordinates these functions with weapon groups and other military activities to successfully meet the fast-changing needs of the tactical air situation.

Designed and built by the Military Division, the Tactical Air Control System fully integrates the computation, communication and control functions. The System represents a solution to a complex problem and exhibits the characteristics which have become identified with Remington Rand Univac achievements in the military area—compact size, high speed of operation and reliability under demanding environmental conditions.

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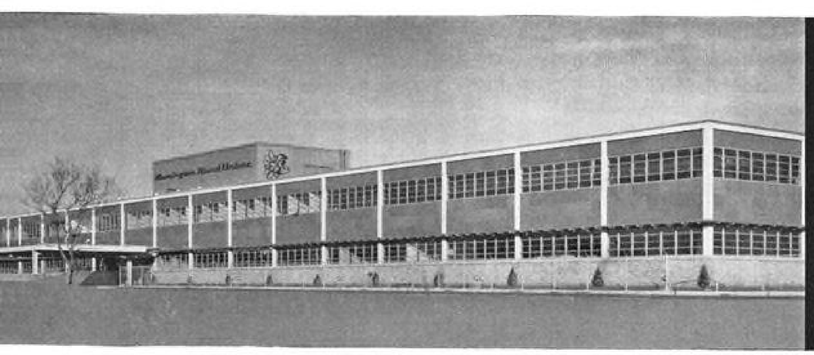

Other control and data systems developed by the Remington Rand Univac Military Division include:
ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY
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"We're Proud of Our Convair 880 Suppliers for Helping Us Meet or Beat Performance Estimates"

Says J. V. NAISH
President, Convair Division of General Dynamics

The sleek new Convair 880, on its maiden cross-country flight from San Diego to Miami, covered the 2,338 miles in the record-shattering time of 3 hours, 31 minutes and 54 seconds. Average groundspeed was 664 mph for the trip.

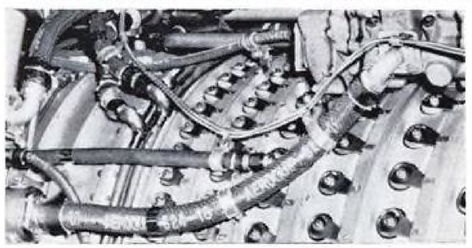
As a supplier of fluid line components for the Convair 880, Aeroquip is proud to have had a part in helping to achieve such outstanding performance.

Aeroquip manufactures a complete range of fluid line products that have earned an enviable reputation for top performance: Hose Lines and Reusable Fittings, Quick-Disconnect Couplings and special tube assemblies, Marman clamps and straps, couplings and joints, and duct assemblies.

Aeroquip's extensive product lines plus engineering experience are available to help you solve fluid system design and development problems.

Write for full information.

AEROQUIP HOSE LINES AND MARMAN TUBE JOINTS ARE USED ON THE CONVAIR 880



Aeroquip 666 Hose of Teflon and 601 Lightweight Engine Hose are used extensively on the Convair 880's four General Electric CJ-805-3 Turbojet engines for top performance, greater dependability.

Shown above are two Marman LJ11 Joints used on the Convair 880's cabin pressure regulator. These dependable, leakproof joints are also used on the anti-icing and air start systems of the Convair 880.

Teflon is Dupont's trade name for its tetrafluoroethylene resin

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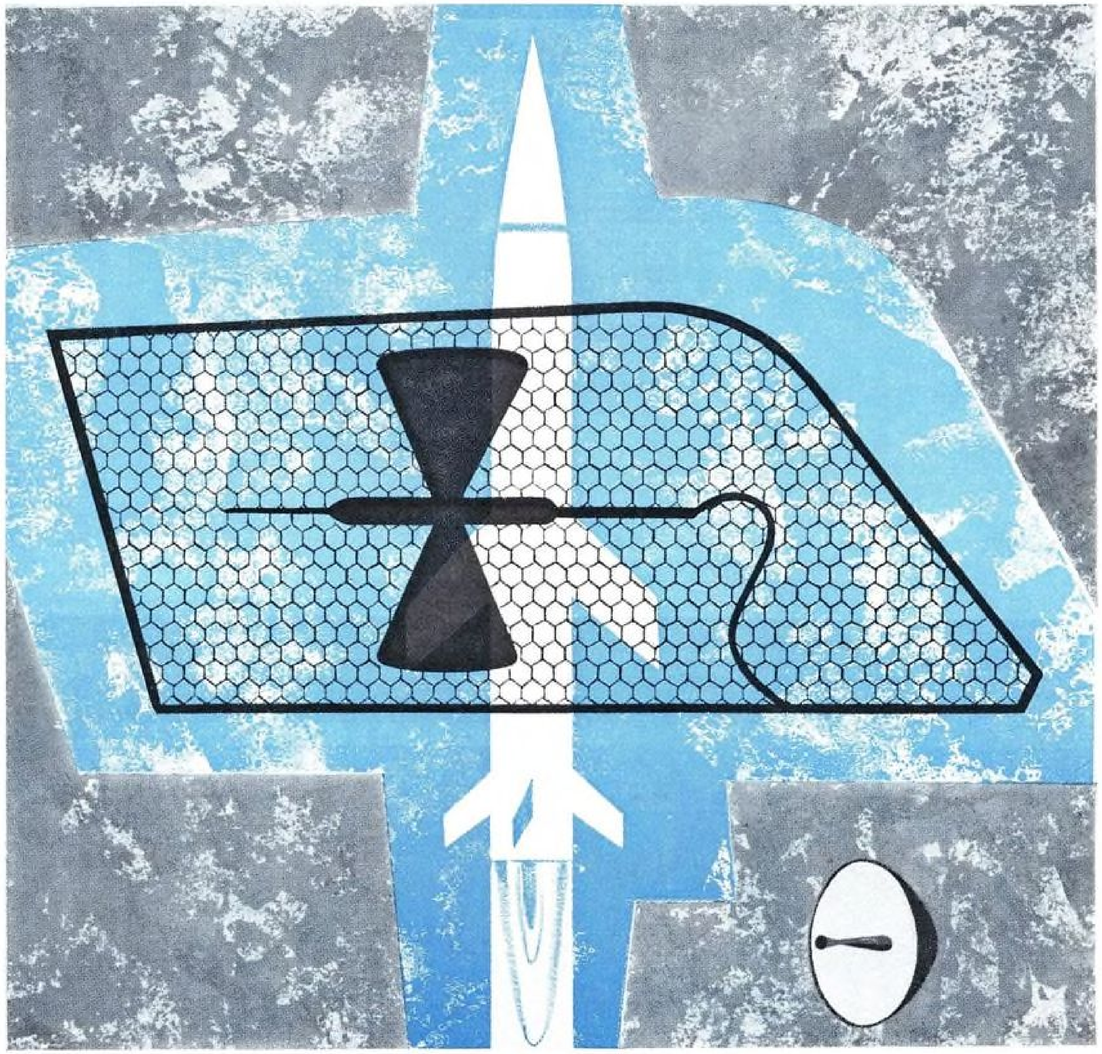
how to get through



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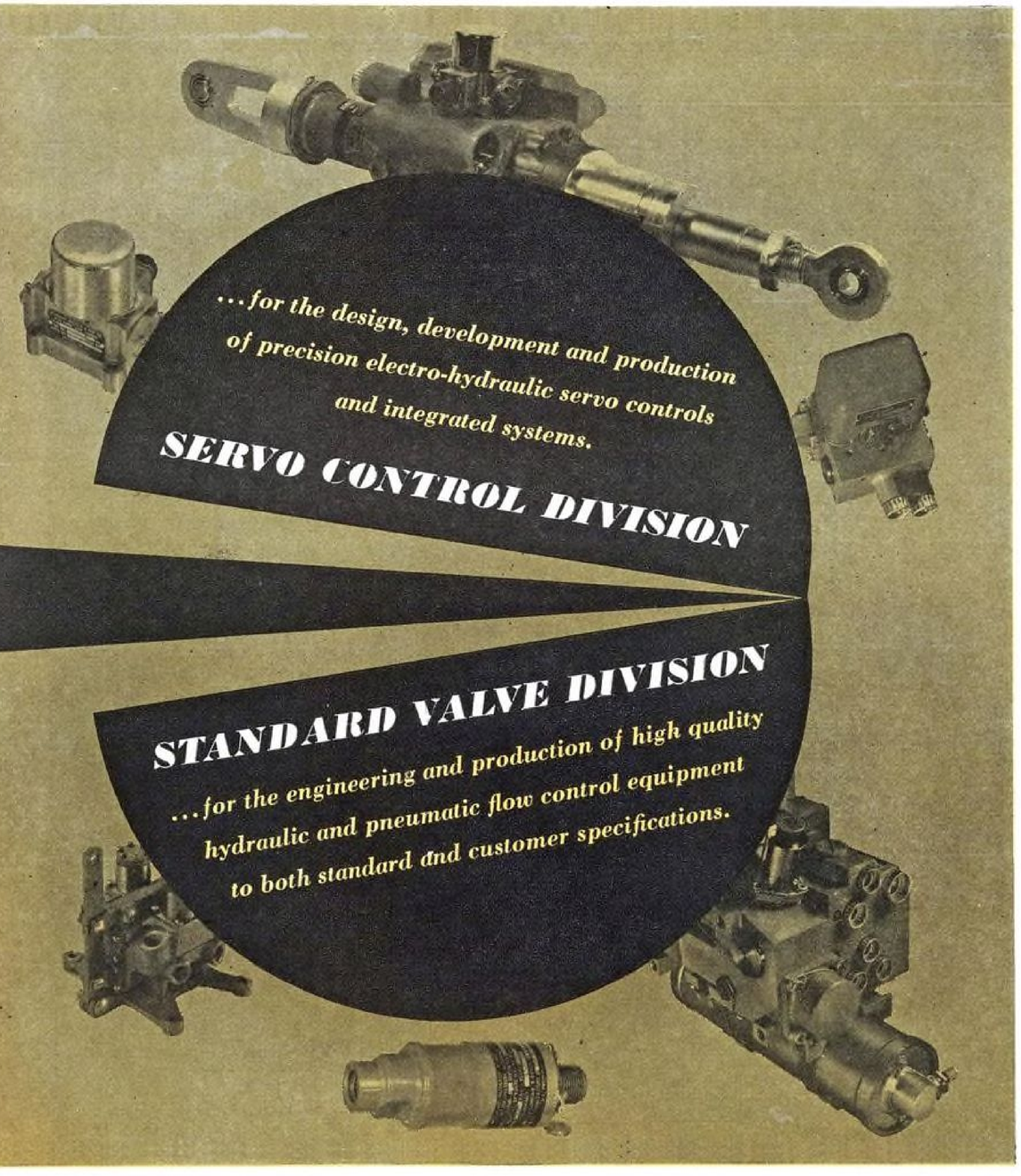

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"Our previous hose gave out after only 1200 to 1400 starts . . .

Thermoid-Quaker Jet-Starter Hose good as new after 3,500 starts"

says Mr. B. V. Darress, Maint. Supr. Pan American World Airways.

Jet-starter hose has to take unusual abuse: transmit hot air up to 500°F at up to 600 MPH under sub-zero conditions . . . withstand dragging over abrasive surfaces. Yet it must be light-weight and flexible . . . easy to handle and coil on the starter truck for storage—and it can't kink, collapse or burst.

Thermoid-Quaker Jet-Starter Hose meets these "impossible" specifications and has proved it can take this kind of abuse with Pan American World Airways and the U. S. Air Force. According to Mr. B. V. Darress of PanAm, their previous hose became unserviceable after only 1200 to 1400 starts. Thermoid-Quaker hose has already outlasted the former hose by *three* to *one* and still looks like new!

Economical service like this is extremely important to both commercial and military jet operations. In fact, this Thermoid-Quaker "Dacron" and Silicone rubber jet-starter hose was developed for military use, and is used by the government. "Dacron" cross-braid construction distributes the load evenly, prevents kinking; and the seamless silicone rubber tube and bonding layer resist heat and provide flexibility under low temperatures.

Get complete information, including Technical Data, on Thermoid-Quaker Jet-Starter Hose from your Thermoid Division industrial distributor, or write *Thermoid Division, H. K. Porter Company, Inc., 200 Whitehead Road, Trenton 6, New Jersey.*

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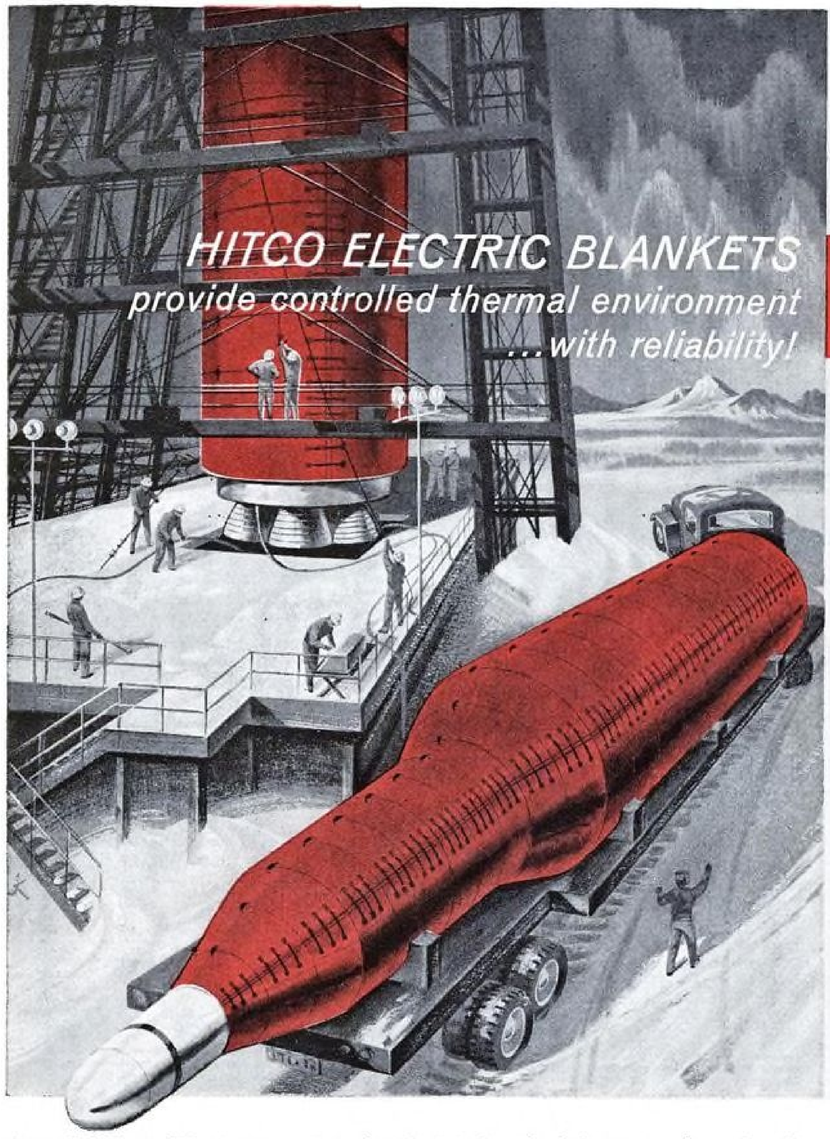

TYPICAL ELECTRIC BLANKET. This is a HITCO "form-fitting" Blanket used to control temperature of hydrogen peroxide tank.

...FOR TEMPERATURE EXTREMES −65° to +2200°F

CUTAWAY VIEW. Shows Heating Element of HITCO Electric Blanket—sealed between cover and inner cover.

HONEYCOMB PANEL BRAZING. New HITCO Electric Blanket brazing technique provides faster, more reliable means of fabricating honeycomb structures.

INDUSTRIAL ELECTRIC HEATING ELEMENTS. HITCO Electric Heating Elements can be provided for a variety of industrial uses where a controlled thermal environment is required.

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HITCO Electric Blankets are designed to provide safe, reliable control of temperatures in a wide range from −65° to +2200°F. HITCO R&D is now developing electric blankets which will be capable of controlling ultra-high temperatures beyond the 2200°F range.

HITCO Engineers are capable of designing and manufacturing a complete Electrical Blanket System to meet your required environment. Such a system would include custom-designed blanket, connectors, thermostats and complete electrical controls. *Call or write us today!*

• *Write for Products Bulletin No. PB 7-4. Our Engineers will be glad to consult with you, without obligation, regarding your Electric Blanket and Electric Element needs.*

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COVER: First attempt to orbit a Lockheed Midas infrared early warning satellite was unsuccessful. The firing, made from USAF Missile Test Center at Cape Canaveral, Fla., marked first time Atlas was mated with Lockheed Agena upper stage. For other photos of this Midas launching, see pp. 54-55.

PICTURE CREDITS

Cover—USAF; 26, 27 (bottom)—Aviation Week; 27 (top)—Applied Physics Laboratory, Johns-Hopkins University; 30—NASA; 46—Lufthansa; 54, 55, 101—USAF; 59—Wide World; 62—U. S. Marine Corps; 71—General Electric; 77—Martin, Space Technology Labs, Inc., Air Products; 87, 89 (top), 95—Sikorsky; 89 (bottom)—W. H. Gregory; 98—Bell Aircraft Corp.; 108, 110—Federal Aviation Agency.

82,291 copies of this printed

EDITORIAL

Airborne Alert

Developing and exercising an effective airborne alert capability for bombers of Strategic Air Command is one of the key points at issue in the Fiscal 1961 defense budget debate. There is general agreement among President Eisenhower, the Joint Chiefs of Staff, Congress and Gen. Thomas S. Power, SAC commander, that an airborne alert capability is necessary to prevent the possibility of a surprise ballistic missile attack from wiping out a significant portion of our nuclear retaliatory forces during the critical 1961-64 period of the missile gap.

This is the period in which, according to our national intelligence estimates, the Soviet Union will have a significant margin of superiority in ballistic missiles, and the bulk of our strategic deterrent capability will still be borne in the bomb bays of SAC aircraft. It is the period when we will have relatively small forces of the Atlas and Titan ICBMs emplaced in hardened sites and only a few Polaris launching submarines on station. It is the period before the bulk of our deterrent strength will shift to mobile missile forces such as the rail-moving Minuteman, the submarine-based Polaris and the air-launched ballistic missile Skybolt.

This is the period when, although there is a possibility of receiving up to 15 minutes warning from BMEWS of an enemy ICBM attack, SAC must operate on the premise that it must preserve its vital retaliatory capability even if no warning at all is available. The only way to do this is to keep a significant portion of SAC bombers continuously aloft in relays with their bomb bays full of nuclear weapons, their defensive missiles in readiness, their targets already assigned and their tankers on station to refuel them regularly. This portion of SAC on airborne alert would be immune to any surprise ICBM attack.

Tentative Steps

Some steps have already been taken to achieve this goal. They include:

• **Authorization by Congress** for the President to order an airborne alert of SAC at any time he sees fit.

• **Initial training exercises** by SAC have proved the feasibility of operating an airborne alert.

• **Initial funds to buy spare engines,** electronic gear and other spare parts required for this operation have been allocated: $20 million from Fiscal 1960 budget and $90 million from Fiscal 1961.

The real debate centers on the question of whether these measures already taken are adequate to achieve the desired goal of safeguard against surprise attack. President Eisenhower, Defense Secretary Thomas Gates and the Joint Chiefs of Staff believe they are. Gen. Thomas S. Power, SAC commander, has repeatedly, emphatically and unshakably testified publicly to Congress that they are not. Among the additional measures Gen. Power believes are necessary to preserve SAC's striking power from surprise missile attacks are:

• **Push as hard and fast** as possible to develop the complete capability to put a significant bomber and tanker force on continuous airborne alert as soon as possible. Cost of this program in contrast to the "on-the-shelf" capability already authorized is estimated at about $500 million annually.

• **Begin putting some portions** of SAC on airborne alert as soon as the technical backup will support it as a clear and unmistakable warning to the Soviet Union that any advantage they may now anticipate during the missile gap will prove to be a military mirage.

Defense Secretary Gates, echoing the Administration's philosophy, told Congress that a decision to go on airborne alert would be made at some later time "if the threat increased." When questioned as to how he would know when this arrived, he replied:

"We would hope we would know."

This may strike many Americans who can still remember Pearl Harbor as a totally inadequate answer in an era when ICBMs require only 30 minutes to hurl multi-megaton destruction from launcher to target.

Need for Lead Time

Gen. Power also emphasized that, although training exercises have established the operational feasibility of airborne alert tactics, it will require many months of lead time for procurement of spares, training of additional crews and maintenance personnel and probably an increase in the tanker and bomber fleet for SAC to achieve a state of readiness where an airborne alert can be executed if the order is given. Without this lead time preparation, any such order for an airborne alert at a later date would be virtually impossible to execute. Without the authorization of full preparations now, the power of decision a year hence could be irrevocably lost.

The issue of the airborne alert should be clear to the American people. If Gen. Power's policies are followed and President Eisenhower, who will no longer be commander-in-chief during the 1961-64 period of maximum missile gap danger, the Joint Chiefs of Staff and Secretary Gates prove to be right, this country could lose $500 million annually for the several years the airborne alert is required.

But, if President Eisenhower's policy on a minimum "off-the-shelf" airborne alert is pursued and Gen. Power proves to be right, we could lose our country in the fraction of an hour it would take an ICBM salvo to reach SAC's bases.

If the facts are presented to them fully and without equivocation, we predict that neither the Congress nor the American people will consider this a gamble worth taking.

—Robert Hotz

WHO'S WHERE

In the Front Office

George A. Spater, a director, American Airlines, Inc. Mr. Spater is an executive vice president, general counsel of the airline.

George S. Vermilyea, president, Nems-Clarke Co., Silver Spring, Md., a division of Vitro Corporation of America, succeeding **Allen S. Clarke**, retiring. Also: **Vernon M. Setterholm**, vice president of Nems-Clarke. **Wayne G. Shaffer** succeeds Mr. Setterholm as director of Vitro's Silver Spring Laboratory, and **John C. Geist** has been named associate director.

Adolphe S. Kromer, president and general manager, Flexonics Corp., Maywood, Ill., a newly-acquired subsidiary of Calumet & Hecla, Inc.

Martin Dubilier, president, International Electric Corp., Paramus, N. J., a division of International Telephone and Telegraph Corp., succeeding **F. H. Lanahan**, now board chairman. Also: **Frederick H. Guterman**, president of ITT's Industrial Products Division, San Fernando, Calif.

Z. W. Pique, vice president-marketing, Hoffman Electronics Corp., Los Angeles, Calif., and **Donald C. Bright**, general manager of Hoffman's new Industrial Electronics Division. Also: **John R. O'Brien**, vice president-government relations, Hoffman's Military Products Division, with headquarters in Washington, D. C.; **Dr. Morton B. Prince**, vice president and general manager of Hoffman's Semiconductor Division succeeding **Maurice E. Paradise**, now corporate vice president in charge of product planning.

Fred L. Dicks, vice president-contracts, Summers Gyroscope Co., Santa Monica.

James W. Evans, a vice president, Hazeltine Electronics Division of Hazeltine Corp., Little Neck, N. Y. Mr. Evans continues as director of the company's Advanced Planning Group. Elected assistant vice presidents of the Electronics Division: **Vernon A. Radom, Edward M. Tyler** and **John B. Winningham**. Also: **Mrs. Elsa T. Ramm**, elected an assistant vice president of Hazeltine Corp.

George E. Hatch, vice president-sales, West Coast Airlines, Inc.

Adm. Sherman E. Burroughs, Jr. (USN, ret.), special assistant to the president, Librascope Division of General Precision, Inc., Glendale, Calif.

Richard B. Uhle, executive assistant-planning to the vice president and general manager of Defense Operations, Crosley Division, Avco Corp., Cincinnati, Ohio.

Joseph D. Blatt, deputy director, Bureau of Facilities and Materiel, Federal Aviation Agency, Washington, D. C. Also: **Dr. Arthur E. Wentz**, neurological specialist, as head of the Clinical Medical Research Branch of the FAA's Office of the Civil Air Surgeon.

Honors and Elections

Dr. Hugh L. Dryden, deputy administrator of the National Aeronautics and Space Administration, has been presented the President's Award for Distinguished Civilian Service by President Eisenhower.

(*Continued on page 111*)

INDUSTRY OBSERVER

► Thrust of the Aerojet first-stage engines for the Air Force-Martin Titan ICBM probably will be increased soon after the missile becomes operational. Engines, rated at 150,000 lb. thrust each, have been operated on static test stands at 230,000 lb. thrust for periods slightly longer than normal burning times. Increase is accomplished by boosting the combustion chamber pressure, which also produces a small increase in specific impulse.

► **Initial launchings of hovering communication satellite systems which will maintain a fixed position over a given point by revolving at the same speed as the earth are being scheduled for 1962 by Defense Department's Advanced Research Projects Agency.**

► Studies are being conducted by Advanced Research Projects Agency to determine the effect high-altitude nuclear explosions can have on military communication systems. Project Argus tests in the summer of 1958, in which nuclear charges were exploded in the exosphere, had noticeable effects on long-distance communication channels.

► **Present May 11 launch date of Air Force's Project 609A four-stage Chance Vought Scout satellite-launch research missile may be delayed because of problems in adapting it to former Thor Pad 18 and associated ground support equipment at the USAF Missile Test Center, Cape Canaveral, Fla. Relatively large number of firings of the vehicle are planned. Aeronutronic Systems, Inc., is coordinator for Air Force vehicle systems.**

► Watch for the formation within Electronic Industries Assn. of a subgroup on microminiature components. The group, to consist of representatives of 21 companies, will make recommendations for physical and mechanical standards of electronic components.

► **National Aeronautics and Space Administration has electronically modified a Sikorsky S-51 helicopter to simulate VTOL aircraft during the hover stage. Thus far, three types of VTOL vehicles have been simulated, and the industry firms involved have been informed of suggested changes in control power and damping.**

► NASA also is using a specially instrumented aircraft to make a detailed study of the nature of cloud turbulence and is checking high-altitude winds by means of rocket smoke trails in related programs. Data obtained will be used in research studies of the trends in aircraft and missile behaviors and modification of current analyses used in the design of flight vehicles.

► **Modification of Jet Propulsion Laboratory's Goldstone, Calif., tracking station to give it a transmitting capability is now under way. Completed facility will include an 85-ft. dia. tracking antenna, a 960 megacycle receiver, an 85-ft. dia. transmitting antenna and a 10 kilowatt transmitter that can operate from 890 mc. to 3,000 mc. First use of the Goldstone transmitter-receiver station will be made in connection with National Aeronautics and Space Administration's Project Echo to study the feasibility of passive communications satellites.**

► Relatively low bending moment limit of interstage structures on the Minuteman solid-propellant ICBM, when combined with the bending resistance of the missile stages proper, presents a problem in developing a support structure for truck transportation. One plan Boeing Airplane Co., weapon system manager, is investigating is the use of rubber shear blocks, which could introduce difficulties if there is an impact load on one of the truck wheels, which would introduce a torsion force to the interstage structures. Air bag system to support the missile also is being considered.

► **Fiat is making a paper study of possibilities of improving present STOL performance capabilities. Results of study may be applicable to the Fiat G.91 light strike fighter. Designation of the study is Fiat G.91.**

Washington Roundup

Research Division is gaining strength as ARDC's reorganization plan becomes a reality. Division got two-star status when Maj. Gen. William Canterbury was assigned as commander, and it will take over the Aeronautical Research Laboratory at Wright-Patterson AFB within the next month. Research Division also may take over the Geophysics Research Directorate and Electronics Research Directorate at the old Cambridge Research Center and the research portion of Air Force Special Weapons Center.

ARDC divisional reorganization was completed last week when Command and Control Development Division was formally established at Hanscom Field, Mass. Headed by Maj. Gen. Kenneth P. Bergquist, this fourth and last ARDC division is taking over portions of Air Force Cambridge Research Center, and electronics supporting systems project offices will be shifted to Hanscom Field from New York and Wright-Patterson AFB.

Next big phase in the reorganization concerns the way remaining centers will be split among the divisions. Presently in limbo are Air Force Missile Test Center, Air Proving Ground Center, Flight Test Center, Special Weapons Center, Missile Development Center, Rome Air Development Center.

Nuclear Management

Watch for further personnel changes in contractor, Air Force and Atomic Energy Commission groups concerned with the aircraft nuclear propulsion program as the new phase of development shakes down and gathers momentum. Major changes will continue at General Electric's Evendale operation, where criticism of management has been heaviest.

Defense Secretary Thomas Gates will be called for a showdown session with the Senate Armed Services Appropriations Subcommittee before the group acts on defense appropriations. Senate group headed by Sen. Dennis Chavez (D.-N. M.) wants to confront Gates with proposals for increased spending presented by the services.

Proposals include increased Fiscal 1961 spending for B-70 and Atlas programs. Air Force wants to add $290 million to the $75 million now programed for the B-70 and $326 million for 18 additional Atlas ICBMs and their installations.

Bomarc Review

Air Force is re-evaluating the Bomarc program, and the study is to be ready for a closed door showdown session with the House Armed Services Appropriation Subcommittee this week. House group is skeptical of the need at this point for continuing large investments in systems for defense against aircraft.

Protracted civil rights debate is delaying Senate confirmation of former USAF Chief Scientist Courtland Perkins as assistant secretary of the Air Force for research and development. Senate Armed Services Committee has not been able to hold a hearing on nominations since Perkin's name was submitted Feb. 23.

NASA Administrator Keith Glennan added fuel to the growing military-NASA feud over space roles last week when he questioned military aeromedical competence in supporting establishment of a NASA life sciences division. Glennan told the House Space Committee that Air Force and Navy aeromedical programs lack the competence to handle life science research on space problems and "just wouldn't know where to begin" to tackle such problems.

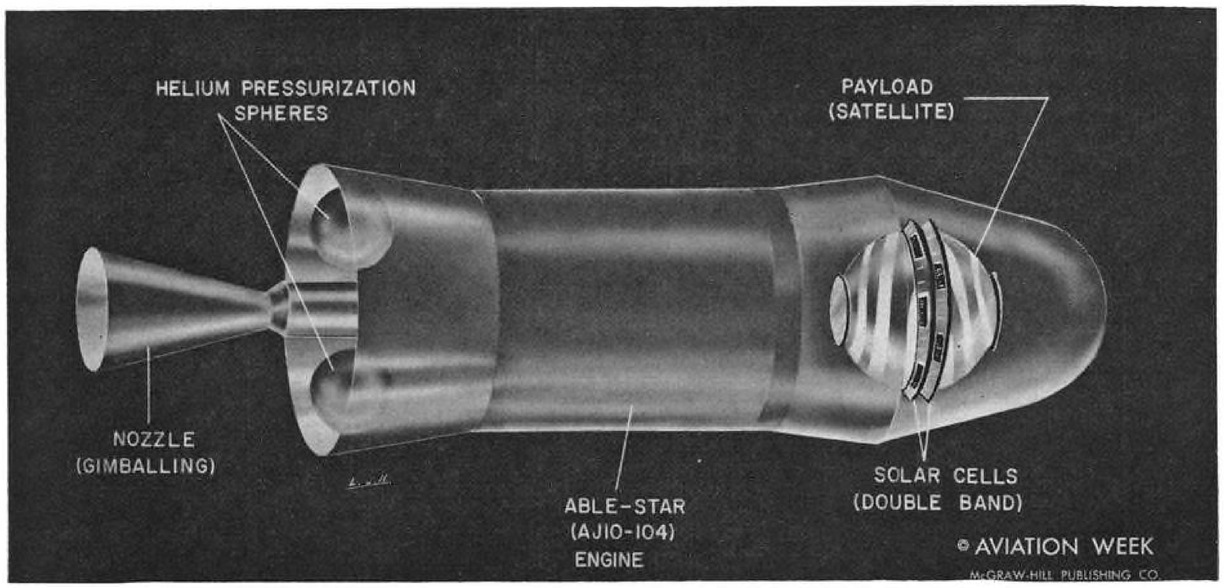
Military aerospace medical experts counter that NASA depends almost completely on military facilities for whatever competence it has in space medicine. They point out that the services pioneered in this field and that NASA depends on long-existing Air Force and Navy facilities for its present life sciences competence.

Soviet space experts have rejected the proposal to establish an International Academy of Astronautics as "premature." Academy was proposed by IAF President Andrew Haley and Dr. Theodore von Karman.

Airline-FCC Dispute

Airlines are involved in an angry dispute with the Federal Communications Commission over a proposed 2,000 ft. television tower at Green Bay, Wis. Air Transport Assn. maintains the tower is a potential air hazard, and the Air Coordinating Committee Airspace Panel has agreed. ATA wanted to intervene in the tower case, which could set new policy on air hazards, but FCC refused as the hearings began last week.

ATA argues that the air hazard issue is the only one at stake in the case, making it imperative that the airlines participate. ATA also maintains that FAA should be hearing the case, since it involves only aeronautical questions. **—Washington Staff**



RESTARTABLE liquid-propellant Able Star second stage houses Transit 1B navigation satellite under nose fairing.

Space Technology

Transit 1B Launch Scheduled for April

Doppler-instrumented forerunner of navigation-aid satellite is second vehicle of ARPA-Navy project.

Washington—Forerunner of a navigation-aid satellite system is scheduled to be fired into an earth orbit on Apr. 12 from Cape Canaveral, Fla.

The doppler-instrumented satellite—Transit 1B—will be the second in the Advanced Research Projects Agency-Navy program to develop an orbiting navigational-signal station for air and sea craft. Such a station could help Polaris missile submarines fix their positions to within one-tenth of a mile. Launch of the first vehicle in the series, Transit 1, failed to put its payload into orbit (AW Sept. 21, p. 30).

For the follow-up third shot scheduled for May, ships on station to receive satellite signals to simulate conditions of an operational navigation system may be added to the ground network. Actual operational missions tentatively are scheduled for next year.

In its elemental form, a navigation-aid satellite will have a continuous wave, crystal-controlled transmitter which will send a signal to earth, where its frequency would be compared with that of a ship-based crystal oscillator to obtain the frequency difference.

As the satellite approaches the ship, the observed satellite signal frequency will be higher than normal because of the doppler effect. As the satellite recedes from the ship, the observed signal frequency will be lower. As the satellite goes over the ship, or approaches its vicinity, the rate of change of the observed frequency would be occurring at maximum value. By observing the frequency difference record, the time of closest approach could be determined by noting the value of the maximum slope and the time of its occurrence.

If satellite orbit is accurately known, the data will indicate the ship's relative position.

With present oscillator stabilities, position accuracy on the order of one mile probably is achievable. With a reasonable amount of equipment refinement, researchers feel that an accuracy of one-tenth of a mile is attainable.

Technical highlights of the Transit 1B experiment are:

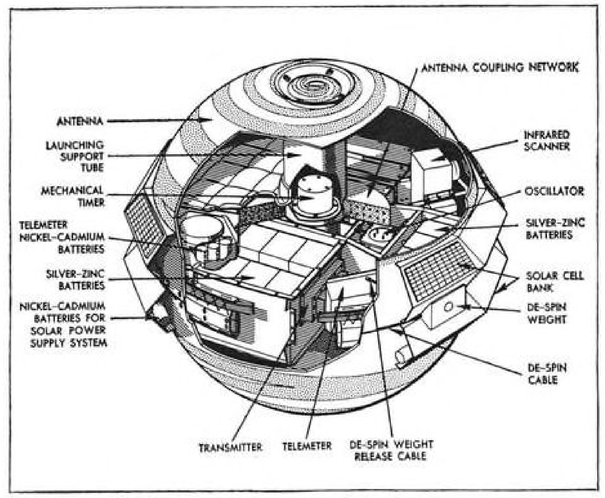
• **Payload, which will weigh 270 lb.,** will be a 36-in. diameter sphere with a double band of solar cell banks around its center. Antenna configuration will be spiral pattern on the sphere's surface. Johns Hopkins University's Applied Physics Laboratory has responsibility for designing and building the payload.

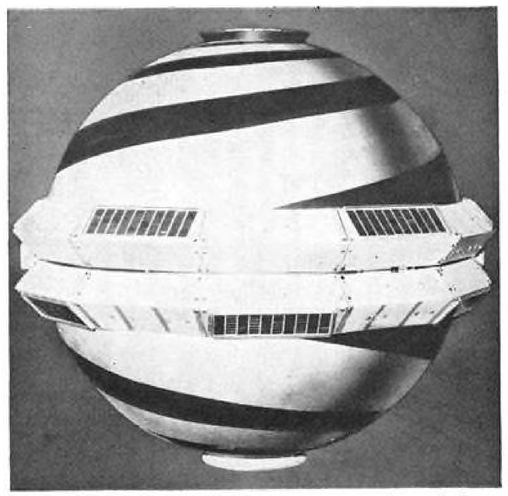
Consideration is being given to a proposal to reduce the weight of Transit payloads to 50 lb. for the operational mission (AW Feb. 22, p. 23), to permit the use of smaller boost vehicles. If the present boost vehicle is retained, the excess payload capacity would permit programing of additional space experiments. However, it is probable that all Transit launchings scheduled for this year will carry 270-lb. payloads.

• **Satellite shell** will be sandwich structure of resin-impregnated nylon honeycomb between laminated face sheets of resin-impregnated glass fiber. The satellite is stiffened internally by a glass fiber cylinder running through the center of the sphere, to withstand forces imposed by the launch. A band located around the internal circumference of the sphere supports the equipment.

• **Nickel-cadmium batteries** complementing the solar power system will operate two transmitters—162 mc. and 216 mc. Silver-zinc batteries which will be used to power two other transmitters—54 mc. and 324 mc.—are expected to last 45 days.

• **Infrared scanner** developed by the Naval Ordnance Test Station will analyze the intensity of the earth's infrared characteristics. This is not related to the primary navigation mission, however. Telemetry transmission, 108.03 mc., of data to ground stations without radio command will be independent of





CUTAWAY DRAWING of Transit 1B (left) shows how equipment is shelved in the midsection of the satellite for optimum balance. De-spin system will introduce a counter-force to retard the satellite's initial spin. A double band of solar cells girdles the sphere's 36-in. diameter (right). The light-colored painted antenna has a spiral configuration. Satellite weighs 270 lb.

the satellite's other telemetry. In addition to the infrared scanner, instrumentation for other scientific experiments is being carried.

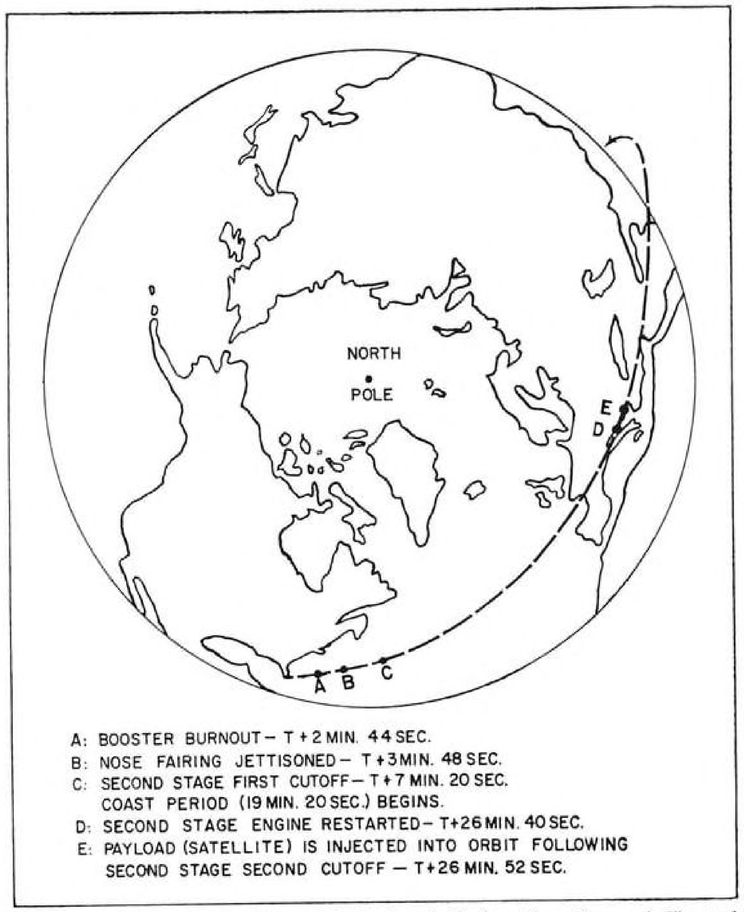
• **Satellite will have** its initial spin retarded by two weights located diametrically opposite on the sphere's girth, with cables attached to the weights wound around the sphere in a direction opposite to the satellite's induced spin. Upon unwinding, the weights will introduce a counter-force to slow the satellite's rotation.

• **Planned orbit is circular,** at an altitude of 500 naut. mi., with an inclination of just under 50 deg., but it's likely that some eccentricity will result.

• **Launch vehicle** will be the Thor-Able Star. This is scheduled to be the first time the Able Star vehicle—the AJ10-104, a complete second-stage package—will have been flown. Similar to the basic Aerojet-General AJ10, the Able Star rocket engine, with about 7,850 lb. thrust, represents a design refinement to increase fuel tankage by a factor of 2.2 for extended burning. The engine also embodies shutdown and restart capability to meet the requirements for injecting Transit 1B into the planned 500-naut.-mi. circular orbit. It is the first restartable engine scheduled to fly. This vehicle differs from the Thor-Ables used for earlier lunar and space probes in that it has no third stage solid propellant rocket.

Propulsion portion of the Able Star package includes a gimbaling thrust chamber burning a hypergolic combination of inhibited red fuming nitric acid (IRFNA) and unsymmetrical dimethyl hydrazine (UDMH), and cooled regeneratively. Dual helium spheres pressurize the fuel system.

• **Nose fairing on the Able Star** will



THOR-ABLE STAR launch vehicle will be fired vertically from Cape Canaveral, Fla., and then rolled to attain 44.5-deg. azimuth. Pitch program then will introduce a turn along northeast trajectory. Trajectory sequence will end vehicle's initial pitch action at about 130 sec. after launch. The satellite enters orbit at "E."

cover the satellite and the vehicle's spin device. The package's equipment compartment includes telemetry for transmitting information on Able Star performance, the shutdown and restart mechanism, tracking beacon, guidance and attitude systems and miscellaneous avionic equipment. Systems engineering and technical direction for the Able Star package is the responsibility of Space Technology Laboratories, which also is supplying the autopilot guidance system for the stage. After the third Able Star vehicle, the autopilot will be built by Space Electronics Corp.

• **Thor-Able Star** will be launched vertically and, shortly thereafter, it will be rolled to attain 44.5 deg. azimuth. Pitch program then will introduce a turn along the northeast trajectory.

• **Trajectory sequence** will end the vehicle's initial pitch action at about 130 sec. after launch.

• **Thor booster burnout** will occur at T plus 165 sec. About three seconds later, Thor's vernier engines will be cut off and the Able Star second stage will be ignited, followed almost immediately by separation from the Thor booster.

• **Nose fairing** enclosing the satellite will be jettisoned at about T plus 229 sec.

• **Able Star cutoff** occurs at T plus 440 sec., and second stage coast period begins for a duration of almost 20 min.

• **Restart of Able Star** is programed at the end of the coast phase—approximately T plus 1,600 sec.

• **Final cutoff of Able Star** occurs about 12 sec. later. Vehicle then will be spun to enter orbit.

• **Satellite will separate** from Able Star about 20 sec. later at T plus 1,632 sec.

• **Spin rate of about 3 rps.** will continue for one week, when despin action will be initiated.

Cooperating in the tracking and data reduction effort for Transit 1B's initial trajectory, midcourse and orbital phases will be Johns Hopkins Applied Physics Laboratory, Air Force Cambridge Research Center, Air Force Space Navigation Center, Army Signal Research and Development Laboratory, Smithsonian Institution's Astrophysical Laboratory and a U.S.-operated van-type tracking facility in West Germany.

Space Technology

NASA Moving to Space Research Lead

By Evert Clark

Washington—Latest comprehensive report on the activities of the National Aeronautics and Space Administration indicates that the agency is rapidly moving into the position of leadership in space research that its predecessor agency held in aeronautical research.

In the year and a half since NASA was created, the problems of organizing, expanding from some 8,000 National Advisory Committee for Aeronautics employes to twice that size and of becoming a contracting and operating agency have tended to overshadow NASA's research role.

The agency's second semi-annual report to Congress, however, presents a picture of significant research being done over a broad spectrum of basic space flight and aeronautical problems. The report, released last week, covers the period from Apr. 1, of 1959, through last Sept. 30.

Extensive effort is being placed on hydrogen, nuclear and electrical propulsion systems (see p. 34), the space sciences—an area essentially new to NASA since it took over operating responsibilities—and the many aerodynamic and other engineering answers still needed for the design of missiles, space vehicles and advanced aircraft (see p. 29).

NASA's investigation of liquid hydrogen, which will be used in the Centaur and Saturn space vehicles and with nuclear rockets, is centered in the Lewis Research Center at Cleveland, Ohio. Projects scheduled for Lewis' Plum Brook Turbopump Facility at Sandusky, Ohio, include tests of:

• **Series of single-stage** axial-flow hydrogen pumps.

• **Series of single-stage** turbines operated with gaseous nitrogen and hydrogen.

• **High-pressure hydrogen** centrifugal pump model of the type to be used in a hydrogen-oxygen booster vehicle.

• **Bleed turbine model** of a hydrogen-oxygen booster vehicle proposal.

• **Gas-generator** for a hydrogen-oxygen booster.

In connection with the Rover nuclear rocket project, NASA is supporting work by Rocketdyne on a high-capacity axial-flow hydrogen pump and work on a turbine to drive the pump. Lewis also is conducting research on such an eight-stage pump drive turbine to supply design data required by industry. Starting characteristics of three hydrogen-flow systems have been analyzed at Lewis and one is being tested under contract by Aerojet-General.

In other hydrogen work, NASA has found that combustion instability increases as chamber output increases; that vaporization rate of propellant controls the combustion rate; that when pumps are operated with liquid nitrogen, which behaves much like liquid oxygen, regions of unstable operation with vapor pulses and reversals of flow occur; that several gas generator systems have proved highly efficient in initial performance tests; that chemical systems for starting hydrogen-oxygen engines operated with great reliability. Studies of electrical and chemical starting systems are being continued under altitude conditions using improved lightweight flow systems.

Studies at Lewis and by Bell Aircraft Corp. under contract have shown that a pump-fed, hydrogen-fluorine engine should be feasible now, NASA said. Regenerative cooling, operation of a bi-propellant valve using hydrogen and fluorine, and prolonged operation of a fluorine seal-bearing and pump system have been demonstrated.

NASA also is studying possible use of plastic bags to keep hydrogen from being contaminated and cooled by pressurizing gases, and is investigating insulation, shielding, tank materials and nozzle operation under simulated space conditions.

Other highlights of the report include:

• **Geodetic satellite** being developed under Goddard Space Flight Center's supervision will be equipped with a flashing light system powered by solar cells and radiating the equivalent of 32,000 lumen seconds as a point source in flashes of one millisecond duration; telemetry pulses synchronized with the light flashes; a stable oscillator for programing the light flashes and transmitting clock pulses, all to an accuracy of one millisecond; optical corner-cube reflectors for use with ground-based searchlights; radio-beacon transmitters for tracking; a command receiver for triggering light flashes of twice normal intensity when desired. A ranging transponder for direct distance measurements may be added. The satellite will be a 36-in. sphere weighing about 150 lb. Light system should have an active life of more than a year and the corner-cube reflectors and beacon transmitters should operate almost indefinitely, NASA said. Photographing of the light flashes against a stellar background should give the satellite's position within about 50-100 ft. at a 1,000 mi. altitude.

• **Instrumentation** is being developed for second generation lunar soft-landing projects. This includes a mechanical complex to obtain surface samples; temperature and gravity measuring devices; X-ray fluorescence spectrometers, advanced plasma-probe equipment. Analysis indicates that vacuum tubes and other equipment carried in gas-inflated plastic spheres for soft lunar landings could withstand impact velocities of 600-1,000 fps. and that payloads as large as 70% of the total mass of the landing vehicle could be accommodated.

• **Guidance system for the Atlas-boosted** Centaur space vehicle is light enough—150 lb.—to be carried in the second stage, permitting active guidance throughout the coasting periods and engine restart operation that are necessary to put 24-hr. satellites into orbit and handle other space missions.

• **Rocketdyne 1.5-million lb.** thrust F-1 engine experienced operating difficulties in the thrust chamber at start-up due to pressure oscillations generated in the burning gases. Engine operated well under limiting conditions of the test stand after corrective work, but by the end of the NASA report period, more development still was required before combustion driven oscillations could be brought under satisfactory control. Rocketdyne studies resulted in recommendations that the thrust chamber be swiveled in a small arc to control thrust vector and that an inert gas, heated in a turbine exhaust heat exchanger, be used to pressurize propellants. Rocketdyne test stands can sustain test runs of only a few seconds at thrusts no greater than one million pounds. The steel strike and other shortages delayed construction of larger test facilities at Edwards AFB, Calif., in turn delaying engine tests at full thrust and full deviation.

• **In solid rockets,** NASA is expected to let a contract within the near future to develop a prototype steering and velocity control system that could be applied to a specific vehicle stage. This would be an auxiliary system separate from the main rocket of the stage. Aeronutronic Division of Ford Motor Co. and Lockheed Aircraft Corp. were investigating possible dimensions, thrust levels and burning times for large future rockets and the potentials of very large clustered rockets. Grand Central Rocket Co. has a contract to develop a prototype motor that will weigh about 500 lb. and have a very high proportion of propellant to inert parts weight. It will use available propellants. Acoustica Associates, Inc., is doing research under contract to determine if the thrust level of a solid rocket can be varied by acoustical energy—for example, by a variable sonic energy generator located in the rocket chamber. Callery Chemical Co. is studying thermodynamics and kinetics of a radically different solid fuel system. Most details are classified but small scale rocket tests have been successful. NASA also is investigating the building block system of forming solids into 10,000-to-100,000 lb. segments that can be assembled at a launch site.

• **Transpiration cooling work** has revealed that as much as 80% of convective heat transferred to a blunt, rotating body moving at high speed through the atmosphere can be eliminated by expelling small amounts of gas through a porous section in the nose. Skin friction can be reduced as much as 65% by the same means.

Satellite Tracker Tests

Dallas, Tex.—Air-transportable general purpose satellite tracking facility will be tested here soon by Alpha Corp., a subsidiary of Collins Radio Co., as part of a $6.25 million contract for three of the stations awarded by U. S. Army Signal Corps. The program will be a joint Advanced Research Projects Agency-Signal Corps venture.

Following test here of the first tracking facility, which includes a 40-ft.-diameter, 66,000-lb. antenna and trailer-type data collection facility, it will be moved to an undisclosed location. All three stations are scheduled for delivery by Alpha by the end of this year.

A highly sensitive receiver coupled to the antenna permits reception of telemetered data which, along with azimuth and elevation information, is handled in the data center and reduced to a form which can be transmitted to a central computing facility. Here data from several such tracking stations is fed through computers and exact position of the vehicle is obtained along with data reduced from that collected and transmitted by the space vehicle.

Indications are that Alpha engineers expect to use Pioneer V deep space probe as a target during the course of their antenna tests. Although the company declines to discuss range of its facility, sources say it could pick up Pioneer V transmissions from its 150 watt transmitter from approximately 10 million mi. out.

Variable Swept Wing May Aid Transport, Attack Plane Design

Washington—New type of variable sweep wing that may substantially increase the attractiveness of supersonic commercial transports and high-speed low-level military attack aircraft has been proposed by the Langley Research Center of the National Aeronautics and Space Administration.

Longitudinal stability problems encountered with the Bell X-5, the only variable sweep aircraft ever flown in the U. S., reportedly have been eliminated on the Langley wing. On the X-5, it was necessary to move the wing root forward as the tip moved to the rear and sweep increased to keep the center of lift within its proper limits. It has proven possible in wind tunnel tests of the new wing to keep the wing root fixed without experiencing a significant shift of the center of lift while the wing sweep angle is varied from zero to 80 deg. This is twice the sweep angle range of the X-5.

Good stability characteristics of this new wing are attributed by NASA officials to improved knowledge of flow around wing root sections, the large degree of sweep used and proper integration of the wing and fuselage design. Slight forward extensions of the wing root combined with proper camber have made it possible to carry most of the wing lift on the root sections during high speed flight when the wing is essentially folded against the fuselage and the air flow is primarily spanwise. About 80% of the wing swings back and the center of lift on the new design moves straight inboard toward the root without moving aft as the sweep changes from zero to 80 deg. This change is made most easily at high subsonic speeds just before the drag rise is reached.

A much lighter mechanical system will be required for the new wing than for the X-5 type because there is no need to translate the wing root forward in the fuselage as the sweep angle is increased.

Langley Research Center officials made a lengthy presentation on this new wing to the Federal Aviation Agency last December. This included a large amount of wind tunnel data and some weight estimates that showed that a substantial fuel saving on a transatlantic flight is possible for a supersonic transport using this wing as compared with those using other designs. In the sharply swept configuration at supersonic cruise speeds, the variable sweep wing compares favorably with other high speed wings.

The new NASA wing proposal also has been of interest to USAF's Tactical Air Command (AW Mar. 14, p. 29). This wing shows promise of meeting the TAC requirements for a STOL attack aircraft which can have low drag and long range during high speed flight below 1,000 ft. altitude when the wings are swept back and then have good high-altitude ferry range and low-altitude, low-speed loiter capability when the wings are extended and a high aspect ratio is required.

Juno II Fails to Put Satellite in Orbit

By Craig Lewis

Washington—Juno II upper stage failure prevented a complex radiation satellite from going into orbit last week to measure a broad spectrum of radiation in the Van Allen belts.

The intricate Explorer satellite was designed to fly a highly elliptical orbit and telemeter a variety of radiation measurements as it passed through the Van Allen belts and through the space beyond them. Telemetry was lost shortly after burnout of the Jupiter first stage. There was some indication of second stage ignition but apparently one of the solid propellant upper stages of the four-stage Juno II failed to fire.

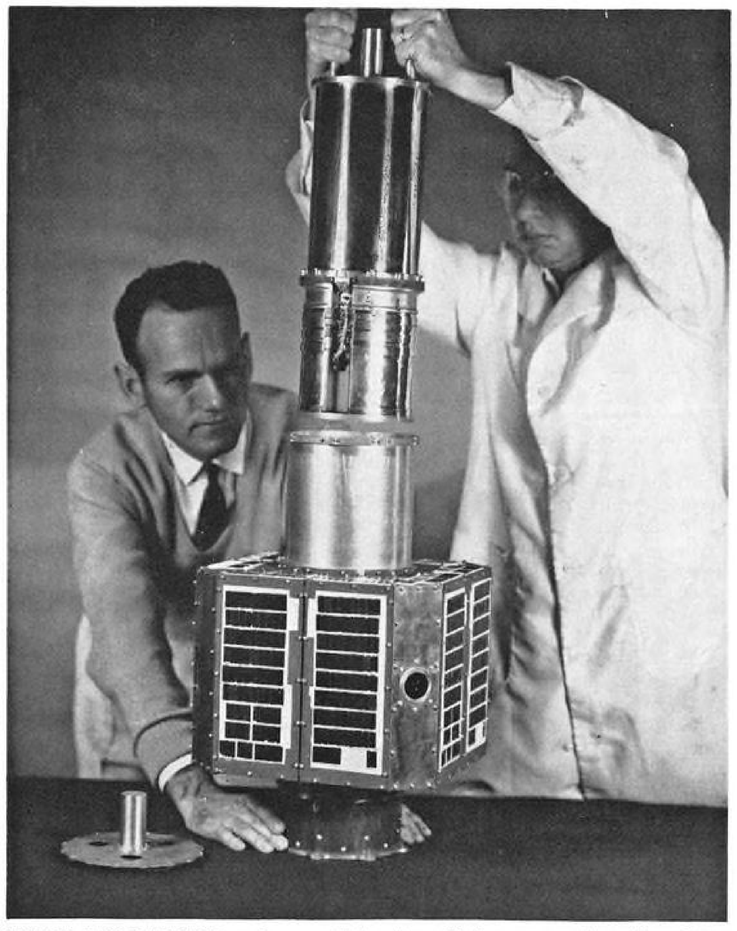
National Aeronautics and Space Administration has other Juno II vehicles available if it decides to make another attempt to launch the radiation payload used last week. The agency is scheduled to launch four other payloads this year to complete the Juno II series.

Satellite Instrumentation

Satellite launched last week was about 21 in. long and 7 in. in diameter. It was attached to the case of the scaled-down Sergeant, which is the Juno II fourth stage. Surrounding the instrumentation cylinder was a box 12 in. square and 9 in. high, which carried solar cells on its surfaces. The 22.8 lb. satellite included a 12.2 lb. instrument pack assembly, a 7.1 lb. solar cell assembly, a 2.5 lb. instrument housing and 1 lb. of smaller components. Attached rocket casing weighed 12.5 lb.

State University of Iowa Physics Department headed by Dr. James A. Van Allen designed the package of five radiation experiments in the satellite. Experiments were contained in a 6.3 lb. pack, which was 9 in. high and 5.5 in. in diameter. It was designed as a plug-in package that could be installed and connected quickly to the power supply and transmitter in the instrument package.

Satellite was launched on an inclination of 28 deg. from the equator. Its orbit was to have had a perigee of 200 mi., an apogee of 33,000 mi. and a period of 17 hr. This highly elliptical orbit would have given a broad reading of radiation throughout the Van Allen belts and through space just beyond. It would have covered a span similar to the path flown by Explorer VI, but the Juno-launched payload would have taken a broader spectrum of measurements.



COSMIC RAY DETECTOR package containing five radiation counters is positioned into cylindrical housing of Juno II radiation belt satellite. Telemetry transmitter components are at bottom of package. Cylinder is surrounded by 1,184 solar cells.

Radiation Detectors

To make this spectrum of measurements, the satellite carried these five detectors:

- **Detector A,** designed to count very low energy particles and termed the first satellite instrument capable of detecting electrons below 20,000 electron volts.
- **Detector B,** similar to and designed to work in conjunction with Detector A to count electrons with energies between 20,000 and 200,000 electron volts.
- **Detector C,** a Geiger tube detector similar to those flown earlier and designed to measure electrons in the 40,000 to 90,000 electron volt range.
- **Detector D,** using a Geiger tube similar to Detector C, but modified so it would measure only high energy particles for comparison with the Detector C counting rate.
- **Detector E,** a Geiger counter lightly shielded to provide data on moderately penetrating particles.

Detector A contained a flake of cadmium sulfide inside a lead shield with a hole in the end. Baffles shielded the flake from light but not from energetic particles. A magnetic field across the hole would bar all electrons with energies less than 200,000 electron volts, so the detector would count all charged particles but electrons—primarily protons.

Detector B worked with Detector A. It was the same as Detector A, except there was no magnetic field across the shield hole to filter out electrons with energies below 200,000 electron volts. The difference between readings from Detectors A and B would provide a count of electrons in the 20,000-to-200,000 electron volt range.

Detector C was a Geiger tube encased in a lead shield with a hole in it which would permit soft radiation to enter. Shape of the hole and strength of a magnetic field across it would limit entering radiation to electrons between 40,000 and 90,000 electron volts.

Detector D was similar to Detector C, except there was no hole in the shield, so it would report penetration of high energy particles. This would have provided new information on the absorption spectrum of the particles and would have furnished data for comparison with Detector C readings.

Detector E was a Geiger counter with light shielding which would have provided data on moderately penetrating particles, showing the general structure of the radiation belts and their fluctuations for comparison with solar and magnetic activity. This instrument was similar to counters carried in Explorers I, III, IV and VII, and its data could have been compared with earlier experiments.

Juno II Launch History

Date	Payload	Result
Dec. 6, 1958	Pioneer III	Space probe aimed at moon reached 63,000 mi. altitude before returning to earth. Returned radiation belt data.
Mar. 3, 1959	Pioneer IV	Space probe launched past the moon and into orbit around the sun. Returned radiation data and was tracked to 407,000 mi. from earth.
July 16, 1959	Explorer radiation satellite	Destroyed 5 sec. after launch when guidance system malfunctioned
Aug. 14, 1959	Beacon inflatable sphere	Air density experiment failed to go into orbit when booster fuel ran out too soon and upper stage attitude control system malfunctioned.
Oct. 13, 1959	Explorer VII	Repeat of July 16 launch put the satellite into orbit and it is returning a variety of radiation data.
Mar. 23, 1960	Explorer radiation satellite	Complex radiation satellite failed to go into orbit when an upper stage apparently failed to fire.

Meeting to Deal With Dyna-Soar Dispute

Washington—Controversy as to whether the Dyna-Soar vehicle should be basically a semi-ballistic shape or a winged glider (AW Jan. 18, p. 31) has not yet been settled. A four-day meeting of contractors and government officials has been called for Apr. 11-14 at Langley Field, Va., partly to settle this question, which has delayed development of Dyna-Soar since shortly after prime contractors were selected four months ago (AW Nov. 16, p. 26).

Subject of the conference is recent research efforts on lifting manned hyper-velocity vehicles. Invitations were issued by Lt. Gen. Roscoe C. Wilson, USAF deputy chief of staff for development, and Ira H. Abbott, director of advanced research programs for National Aeronautics and Space Administration.

First two days of the meeting will cover generalized research, including aerodynamics, heat transfer, motions that will be encountered, stability and control, piloting problems, instrumentation, navigation, structures, materials.

Second two days will deal specifically with Dyna-Soar. Separate presentations will be made by NASA, USAF and Boeing Airplane Co., prime contractor for the manned vehicle portion of the Dyna-Soar system. These will be divided into three main parts:

- **Configuration studies.**
- **Materials and structures.**
- **Instrumentation, piloting,** navigation and control systems.

Three basic questions are involved in the controversy over which type of shape should be developed:

- **Are high-lift, high-drag** vehicles such as the half-cone shape proposed by NASA's A. J. Eggers, Jr., sufficient for maneuverable manned space flight around the earth?
- **Is the extra flexibility** and safety offered by the winged boost-glider in selection of landing sites and maneuverability at lower speeds worth the added complexity and weight of wings?
- **Regardless of which shape** is chosen, is there any military value to either?

The latter question is of considerable importance in determining the speed, money and effort that will be put into the Dyna-Soar program, and yet it is one that cannot be fully answered until a research vehicle has explored the flight regimes that Dyna-Soar is intended to explore.

A glider of the type that dominated Dyna-Soar thinking through the past several years of study gains little or no advantage from its wings until it reaches speeds below about Mach 5-7. Since penetrations over military targets would be made at hypersonic speeds, the basic Eggers capsule or a modification of it that carried very small wing-like surfaces probably would have the same maneuverability.

Phase Alpha was initiated by Joseph Charyk, then USAF assistant secretary for research and development, partly due to skepticism among some members of USAF's Scientific Advisory Board and in the office of Herbert York, Defense Department director of research and engineering, over the glider configuration.

Boeing was required to call in Bell, Lockheed, General Electric, Avco, McDonnell and Chance Vought to assist it with the Phase Alpha review. Work of the Martin Co., which was selected as the booster manufacturer, essentially has been stalled by the delay in decision on the vehicle configuration.

Snap 8 Reactor Award

Washington—Aerojet-General Corp. last week won an $8 million National Aeronautics and Space Administration competition for electrical conversion equipment that will be used with the Snap 8 reactor (AW Feb. 29, p. 26) for an auxiliary power system and for the first flight tests of an experimental ion engine—the first of the nuclear-electric systems that are expected to attain great importance for space propulsion.

An arc-plasma jet propulsion system also will be used later with Snap 8, probably to boost a satellite from a 300 mi. orbit to a 22,300 mi. "stationary" orbit. Atomics International Division of North American Aviation, Inc., is building the 250-lb. Snap 8 reactor under Atomic Energy Commission contract.

Ion engine to be used will be 3/10 to 1-lb. of thrust. Two experimental ion engines have been operated at NASA's Lewis Research Center for a total of 70 hr. without failure.

NASA contract calls for one conversion system with a 90-day reliability (lifetime) to be delivered within 3½ years, and one or more with 1-year reliability to be delivered within 5 years. All elements of the over-all system, including the difficult radiator to expel excess heat into space, can be ready in 3½ to 5 years, NASA believes. The system could be tested on the Centaur vehicle.

Pioneer V Deep Space Reports Parallel Earlier Radiation Data

Washington—Pioneer V probe is returning deep space data from its cosmic ray experiments which appear to confirm the radiation picture predicted from earlier measurements made beyond the Van Allen belts.

Preliminary examination of data from the cosmic ray experiments indicates that measurements are within 2% of the readings made beyond the Van Allen belts by Explorer VI and that the similarity holds as far out as the 1 million mi. mark. Pioneer V passed the 2 million mi. mark late last week as it moved along an orbital path that will carry it close to the orbit of Venus (AW Mar. 21, p. 28).

Explorer VI measured radiation beyond the Van Allen belts as far out as its 26,000 mi. apogee. Pioneer V is carrying some of these measurements beyond that area and will return data on the broad area between the earth and Venus orbits. It is part of a growing effort by National Aeronautics and Space Administration to coordinate the investigation and mapping of radiation near the earth and out into space.

Possible Benefits

Discussing possible benefits from the Pioneer V radiation experiments, Dr. John Lindsay, head of the solar physics program in NASA's Space Sciences Division, points out the probes can transmit data on the speed of particles coming from the sun and can show whether particles in the Van Allen belt arrive as high energy particles or as low energy particles that are accelerated by some process in the earth's magnetic field. Measurements also can provide information on the origin and direction of cosmic radiation and can be used to determine whether variations in solar background near the earth are caused by phenomena close to the earth or whether they also occur in deep space.

Pioneer V is still broadcasting with its five watt transmitter, but it has passed beyond the effective range of all receivers but the 250 ft. Jodrell Bank radiotelescope at Manchester, England. Early next month, when the probe is 4-to-5 million mi. from earth and its signals are too weak for the Jodrell Bank dish, the 150 watt transmitter will be switched on, and NASA hopes to continue to get data through the 150 watt unit until Pioneer V is about 50 million mi. from earth.

Probe's Signals

Originally, all the ground stations receiving the probe's signals were getting data at the rate of 64 bits a second. As distance from the earth increases, the bandwidth is reduced to improve signal-to-noise ratio. By the middle of last week, Manchester was down to eight bits a second, and the station on Hawaii was receiving at the rate of one bit per second. Singapore station, equipped only with helical antennas, lost the probe when it was about 500,000 mi. out.

Pioneer V's 15 watt solar power system is working well and recharging the probe's batteries at the expected rate. Pioneer system is substantially more powerful that such previous systems as Vanguard I and Explorer VII, and it apparently is operating more successfully than the Explorer VI system. Explorer VI solar power system was about twice as powerful as Pioneer's, but it never reached its design output.

Paddlewheel Technique

Pioneer V and Explorer VI are similar probes using the paddlewheel technique to expose solar cells to the sun as a power supply. Changes were made in the Pioneer system, however, to guard against troubles encountered earlier by Explorer VI. Stronger arm structure was designed for the solar paddles with new extension and locking systems. There was some indication that the Explorer VI paddle arms were bent during third stage spinup and that one of the paddles failed to extend fully.

Failure of the paddle to extend fully could have been caused by faulty operation of the cable which held the vanes down before extension. This cable was cut at a single point, but the Pioneer V cable was cut at four points to ensure extension.

NASA Lunar Study

Pasadena, Calif.—Aeronutronic Division of Ford Motor Co., Hughes Aircraft Co. and North American Aviation's Missile Division have received contracts for a six-week study program on design of a 300-lb. lunar capsule for National Aeronautics and Space Administration.

Program is designated Project Ranger. One of the missions will be the rough landing of a scientific package of instruments on the lunar surface. Study is being conducted under the direction of the Jet Propulsion Laboratory. Related NASA program under study by JPL calls for an unmanned spacecraft for a lunar mission weighing about 700 lb., which will be launched by the Atlas Agena-B (AW Feb. 22, p. 32).

Republic-Fokker Deal

Republic Aviation Corp. and Royal Netherlands Aircraft Factories (Fokker) will cooperate in production of aircraft and missiles for the European market through negotiations completed at Amsterdam.

Under the deal, subject to approval by Fokker shareholders Apr. 4, Republic will buy about one-third of Fokker's shares for about $1 million. Two Republic representatives will be appointed to the Fokker board of directors.

Republic will make available to Fokker its know-how in the field of VTOL aircraft, a program that has cost about $2.5 million so far. Fokker will retain responsibility for Fokker F-27 Friendship turboprop transport production, as well as production programs involving the Lockheed F-104G Starfighter, Breguet 1150 Atlantic anti-submarine warfare turboprop, and the Hawk missile.

France Orders One Breguet 941 STOL

Paris—Breguet has received an order from the French government for construction of a single 941 short takeoff and landing prototype aircraft which is expected to fly by the end of the year.

Wingspan of the 941 is 76 ft.; length is 75 ft. The prototype will be powered by four Turbomeca Turmo 3 turboprops delivering 1,170 shp. on takeoff and maximum continuous horsepower of 1,040.

Gross weight of the 941 will be 20 tons; payload will be six tons. The aircraft will cruise at 250 mph. It uses a boundary layer control system and is designed to operate out of airstrips between 600 and 1,200 ft., depending on mission.

Breguet also is studying a pressurized circular fuselage version, the 942, which would carry 50 passengers in economy configuration.

Temco Sales, Earnings Declined in 1959

Temco Aircraft Corp. sales and net earnings declined in 1959, with sales being $100,677,510 and net earnings being $1,163,084 compared with 1958 sales of $119,097,849 and a net of $2,555,883.

Orders backlog as of Dec. 31, 1959, totaled $83 million compared with $108 million the same time in 1958.

Temco last week announced that it omitted payment of a first quarter dividend, noting funds are needed for weapons and space systems development, capital investments and new market investigations.

Army Establishes Future Aviation Policy

By J. S. Butz, Jr.

Washington—Army aviation policy over the next few years has been firmly established along the following lines as a result of an intensive three-month review ordered by Chief of Staff Gen. Lyman Lemnitzer:

- **Design competition for a new** close-support observation helicopter will be initiated in about 30 days to replace the Cessna L-19 light plane and the Bell H-13 and Hiller H-23 helicopters now in service.
- **Development of a new transport** aircraft for forward area movement of troops and equipment will not be undertaken until further improvements have been made in the technical state of the art. Programs directed toward this end probably will be undertaken in conjunction with one or more of the other services.
- **Decision to develop** a new high-speed surveillance aircraft for deep penetration behind enemy lines will not be made until further review of the technical state of the art and operational requirements has been made.

Army has rejected VTOL aircraft until a later time period pending more conclusive engineering and operational information indicating that these vehicles can provide the most effective aerial means for troop use. This is in line with a recent Air Force decision to postpone development of a high-performance VTOL fighter for TAC for at least four or five years (AW Mar. 14, p. 29).

Army officials indicate that the decision to make their new close support observation aircraft a helicopter rather than a high speed VTOL vehicle was based largely upon five points:

- **Fuel requirements** of the VTOL was considerably higher than that for a helicopter.
- **More stability and control** research work is needed before present types of VTOL aircraft will have acceptable maneuverability, while the precision controllability of the helicopter has been well proven.
- **Downwash velocity** of the helicopter is much lower than that of the VTOL, and the effect of this in raising dust and debris during tactical operations is still unanswered.
- **Helicopter still has considerable** development potential that can be exploited within a relatively short time.

Another parameter of vital concern to the performance of VTOL aircraft—engine power-to-weight ratio—was not cited by the Army as a primary reason behind its choice of the helicopter. Army officials feel that engine performance in this area is now adequate for small VTOL aircraft, although improvements would be welcome. They contend that the present Defense Department cooperative engine development program is providing adequate turbine powerplants for any VTOL aircraft development initiated during the next four to five years.

Army policy decisions began as recommendations by an ad hoc board of 10 general officers established by Gen. Lemnitzer to review the status of Army aviation and report directly to him on the course of action that should be followed in the 1960-1970 period (AW Dec. 14, p. 34). Action by this board, the Army Aviation Requirements Review Board headed by Lt. Gen. Gordon B. Rogers, was based heavily upon recommendations and state of the art evaluations submitted by a number of aviation and avionic industry firms last Dec. 15. Army had requested this industry help on Dec. 1.

The board reached its decisions on schedule by Mar. 15 and Gen. Lemnitzer approved them almost immediately so that budget discussions with the Defense Department could be conducted on the basis of a definite long-range Army aircraft development program.

Funding requested for the program apparently was in line with the appropriations of recent years for Army aviation research and development, which has been approximately $100 million to $150 million per year.

Over-All Objective

Over-all objective is to steadily improve the Army's air mobility and target acquisition ability. If this is to become a reality, Army officials must persuade the Department of Defense to provide more procurement funds after this long-range development program is approved.

Army not only received considerable help from industry but also consulted extensively with the Air Force, Navy, Marine Corps, National Aeronautics and Space Administration and its own scientific advisers in reaching its policy decisions.

For this reason, Brig. Gen. Clifton F. von Kann, director of Army aviation, and the other members of the ad hoc board which formed the policy, believe their conclusions were based on the best available advice.

There are a number of strong dissenters in industry, however, who believe that prototype work thus far has been successful enough to warrant a new generation of these vehicles which should be purchased in large enough numbers to allow a complete operational evaluation. They also believe that further VTOL progress cannot be made until an operational evaluation has been completed and definite requirements established.

Surveillance aircraft, which apparently is the next type that will come under development by the Army, is still awaiting the outcome of studies to determine the vulnerability of winged vehicles over an atomic battlefield and the effectiveness, current and future, of aerial reconnaissance systems in target acquisition.

Experimental data to speed these studies is expected to materialize soon after the Grumman Mohawk becomes operational. The Mohawk will be used to test the fire control systems of current anti-aircraft weapons, including the latest missiles, against high speed vehicles operating at low altitudes.

Preliminary program already has been completed using the Cessna T-37 and showed primarily that pilots can effect good visual reconnaissance while flying at low levels up to 300 mph.

Development of a new type front-line transport probably is several years away, since two aircraft will soon be available. Several de Havilland AC-1 Caribou three-ton payload fixed-wing aircraft are now undergoing service evaluation prior to a decision on quantity procurement. The Vertol HC-1 will soon enter this phase of its development. These aircraft will substantially increase the Army's front-line cargo-hauling capability, and they both have considerable growth potential so that replacements are not anticipated for some years.

AMC Consolidating Contract Management

Wright-Patterson AFB, Ohio—Air Materiel Command plans to consolidate its contract management functions into three regions—Wright-Patterson, Middletown Air Materiel Area, Pa., and Mira Loma Air Force Station, Calif.

The three regions, which will take over contract management responsibilities of the present eight materiel areas, will have jurisdiction over all air procurement districts, Air Force plant representative offices and test site offices within their geographical areas.

Contract management mission of each region will include contract surveillance, production, industrial property control, flight test, readjustment, quality control, transportation, accounting and finance and legal and inspection functions relating to Air Force and other government contracts.

Approaches to Controlled Fusion Detailed in Congressional Hearing

By Ford Eastman

Washington—Multiple attacks on plasma research problems must be continued before a successful method of fully achieving controlled thermonuclear reaction can be found, a Joint Congressional Subcommittee on Atomic Energy was told last week.

Dr. Arthur E. Ruark, chief of controlled thermonuclear branch, with Atomic Energy Commission's Division of Research, told the subcommittee that, while total achievements of the various approaches have been impressive, it is still not known which plan may prove to be the most successful and ultimately lead to the development of an efficient fusion powerplant.

Major Research

Ruark said major research is presently divided into the five following programs aimed at overcoming the crucial problems of means of confining and stabilizing of plasma:

- **Stellarators,** "endless tubes" in the shape of hollow doughnuts or figure 8s, being used at Princeton University.
- **Magnetic mirror injection,** where particles of high energy are injected into straight magnetic bottles, used at Livermore Radiation Laboratory and the Oak Ridge, Tenn., National Laboratory.
- **Self-confinement methods,** where strong currents are passed through the gas, which is confined by the magnetic field of these currents. These methods are practiced at Los Alamos Scientific Laboratory, Livermore, the University of California at Berkeley and the Naval Research Laboratory.
- **Astron program,** where currents of very fast electrons are employed to confine and heat the plasma, used at Livermore.
- **Spinning plasmas,** in which both electric and magnetic fields are employed. Small efforts in this program are carried on at Los Alamos Scientific Laboratory and the University of California at Berkeley.

Dr. Ruark and other leading U. S. physicists appeared before the Subcommittee on Research and Development headed by Rep. Melvin Price (D.-Ill.) to report on progress being made in the various controlled thermonuclear reaction programs to date, all under AEC's Project Sherwood.

Witnesses said many "promising" advances have been made in the field and that thermonuclear temperatures probably will be realized in a "relatively short term of years." Plasma temperatures of about 15 million F have been obtained, but temperatures in the area of 50 million F are required for thermonuclear ignition.

However, since temperatures required to generate controlled thermonuclear power would be even higher, witnesses said development of the first fusion powerplant probably will be from 10 to 20 years away.

Dr. Paul W. McDaniel, acting director of AEC's Research Division, warned the committee that "it must not be supposed that our scientists or those of any other nation are likely to achieve startling results quickly in this field of research, through some stroke of good fortune." Instead, he said it is a matter of gradually increasing capabilities.

McDaniel told the committee the Soviet Union also has supported a multiple approach to controlled thermonuclear reaction problems but that the greatest present interest apparently is in the large magnetic mirror known as OGRA.

He said the Soviets have advised the U. S. informally that they have completed a round of preliminary experiments on this machine and that they plan to increase the injection energy and current of the entering ions.

Despite the work in other parts of the world in this field, Dr. McDaniel said he believed the U. S. continues to hold its position of leadership.

Two U.S. thermonuclear physicists—Dr. James L. Tuck, of Los Alamos Scientific Laboratory, and Dr. Alan C. Kolb, of the Naval Research Laboratory, have expressed beliefs that they already have achieved thermonuclear reaction, although plasma temperatures reached were about one-fourth those needed for ignition.

Both men heated plasma in a shock apparatus using a rapid rising magnetic field in a mirror geometry.

Dr. Tuck said that recently, however, emphasis has shifted to another line—high energy injection into a picket fence magnetic system. "The experiment," he said, "is now our top priority operation and, while proving to be a little more complicated than was envisioned in the beginning, is looking rather hopeful . . . for the first time in all Sherwood, in this device I see faint glimmerings of a possibility of making a thermonuclear reactor."

In this method, Tuck said, an intense jet of plasma from a previously developed plasma gun is projected at the axial cusp of a picket fence. The jet is intended to drill through the magnetic field and fill the interior of the hollow fence and become diffused and, therefore, contained in the fence.

Tuck added that there is now an "urgent need for guns that will provide a good clean jet of plasma that already has the energy we need to produce thermonuclear reactions, and we therefore are turning a substantial part of our effort into understanding the plasma gun we now have and developing new ones."

Cryogenic Coils

Dr. Richard F. Post, of the Lawrence Radiation Laboratory, told the committee that a promising step toward reducing the huge power needed to generate large volumes of intense magnetic fields appears possible through the use of cryogenic coils. These coils are not connected with the phenomenon of superconductivity, which cannot exist in the presence of a high magnetic field. They are wound wire made of either very high purity aluminum or high purity sodium metal encapsulated in stainless steel tubes.

The theoretical reductions in the power required by the coil itself amounted to more than 1,000, Post said, so that, when the refrigerator power was added in, over-all gains of a factor of 20 or more were still predicted.

Companies Deciding Wind Tunnel Future

Pasadena, Calif.—Decision is expected around the middle of April on the future of the transonic cooperative wind tunnel here which is operated by California Institute of Technology for the five major airframe companies who own the facility.

Due to the decline in the number of manned aircraft designs which the tunnel was built to test at speeds up to Mach 1.8, three possibilities for the tunnel have been discussed:

- **Complete closedown** of the tunnel, followed by dismantling during early or mid-summer.
- **Owners, Convair, Douglas,** Lockheed, McDonnell and North American, may make a gift of the tunnel to Cal Tech and guarantee support for operation on a reduced scale in limited research work.
- **Some company may take** it over and operate it on a reduced scale.

Minuteman Site

Malmstrom AFB, Great Falls, Mont., was named last week as the support base for the initial operational deployment of the Minuteman solid-propellant ICBM. Three Minuteman squadrons will be located in hardened sites in the Malmstrom area.

House Will Attempt to Strengthen Mild Conflict-of-Interest Bill

Washington—House Armed Services Committee, after nine months of study, has in effect left the solution of the problem of "influence peddling" by former military officers to self-policing by Defense Department and the force of public opinion.

The investigating subcommittee headed by Rep. Edward Hebert (D.-La.) launched its comprehensive investigation of "munitions lobby" charges to block legislation that would have barred defense contracts to firms that hired high-ranking military officers within five years after their departure from service. The legislation, offered as an amendment to the defense budget last June by Rep. Alfred Santangelo (D.-N. Y.), first passed 131-to-130, but was later defeated 125-to-147 on assurances of the Hebert investigation (AW July 13, p. 35). And, when the mild legislation voted by the Armed Services Committee comes to the floor for action during the week of Apr. 4, attempts will be made to make it more severe. House Rules Committee last week granted an "open rule" which will allow amendments after three hours debate.

Two key actions taken by the Armed Services Committee are the following:

• **Establish a "director of enrollment"** in each of the military services. Defense firms, under the proposed legislation, would be required to submit a list of all former military officers they employ and their activities to the "director" for public record. All bids for contracts also would have to include such a list. Penalty for failure to comply would be suspension of contract payments. Retired officers employed by military contractors also would be required to register under penalty of loss of retirement pay.

Objective of these provisions is to give a complete and public picture of the activities of former officers. One committee member said: "At present, we do not know what we are shooting at. There is no complete record showing the extent of lobbying at the Pentagon. Now we will have a record open for daily inspection by the press and the public."

• **Establish a Defense Department** "code of ethics." The committee "urgently" requested the Secretary of Defense to take steps to accomplish this in its report on the legislation. The committee said that "codes of ethical conduct should be generated by and from the groups to whom they are to be applicable. These groups are presumptively in the best position to know the possibilities, the needs, and the requirements."

Defense Department is opposed to any type enrollment requirement for contractors—executive or public—and wants the enrollment of former officers with their former service considered an executive matter. J. Vincent Burke, Jr., Defense general counsel, told the committee:

"The requirement that a contractor furnish a listing of retired officers in his employ each time he received a contract would undoubtedly result in many employers refusing to engage retired military officers rather than comply."

The Armed Services Committee legislation also bans "selling" to Defense Department by officers for two years after they leave their service. The penalty provided—loss of retirement pay for the time during the two-year period the officer is engaged in selling—is not expected to be an effective deterrent to high-ranking officers, some of whom receive top positions with defense firms.

Officers with less than eight years active service who have at no time served in procurement, maintenance or supply are exempted from the two-year-ban provision. The committee said it did not think such officers could exert effective influence with their former service.

There already are statutes on the books providing for loss of retirement pay for "selling" to a former service: a two-year ban for Army and Air Force and a lifetime ban for Navy and Marine Corps. In addition to making the two-year ban uniform, the armed services measure for the first time prohibits a former officer of one service from selling to another service, as well as to his own service.

Defense Department and the committee also are at odds as to what should constitute "selling"—and be considered an improper activity for former officers.

Defense Department wants a narrow definition that would include signing a bid, proposal, or contract; negotiating a contract, or contacting an officer or Defense Department official in connection with contract terms.

The committee in its report proposes an all-inclusive definition under which "selling" would include any activity from the promotion of an idea or the display of a concept to the negotiation of contract terms for hardware.

News Digest

Controlling interest of about 60% of Britain's Eagle group of air transport companies is to be acquired, following an agreement in principle, by Cunard Steamship Co., Ltd. BOAC simultaneously announced it is exploring with Cunard ways and means in which the two groups might collaborate.

Westinghouse Electric Corp. announced last week that it is withdrawing from the jet engine business and plans to return to the Navy the Kansas City, Mo., facilities that house the firm's Aviation Gas Turbine Division. Westinghouse shares the Navy-owned Kansas City facilities with Bendix Corp., which occupies approximately one-third of the floor space, and with a regional office of the Internal Revenue Service. Bendix is considering expanding into at least a portion of the plant space now occupied by Westinghouse, but the Navy said late last week that no final decision on this has yet been made.

La Guardia Airport will be provided with a second ILS and approach lights offshore of the 22 end of instrument Runway 4-22. Runway 22 has no approach lights now and back course approaches, with higher minimums, are made with aid of ILS localizer of fully-instrumented Runway 4. Relocation of a ship channel will be necessary and project is expected to take three to five years.

Bell Aircraft Corp. has an option for U.S. manufacturing rights to the supersonic ramjet-powered CT-41 and subsonic turbojet CT-20 target missiles developed by Nord Aviation of France.

Contract for construction of the glass fiber airframe for the Marvel STOL aircraft under development for the Army by Mississippi State College (AW Nov. 30, p. 59) has been let to the Parson's Corp., Aircraft Division, of Traverse City, Mich. First set of glass fiber, camber-changing wings and the shroud for the ducted propeller will be joined to a metal fuselage and flight tested at Mississippi State in August.

Air Force-Martin Titan was fired 5,000 mi. last week in its second full range test. Data capsule was ejected from the prototype Avco Mark IV operational nose cone, and the capsule was recovered near Ascension Island. This was the second Titan launch made without static testing the engines at Atlantic Missile Range, and it indicates there will be no more flight readiness firings of the missile at AMR.

MATS Equipment Plan Gains Momentum

Growing support in Congress of fleet modernization program may retard airline cargo expansion hopes.

By Robert H. Cook

Washington—Military Air Transport Service gained strong congressional support last week for an early start on a $2 billion fleet modernization program in airlift hearings which airlines fear may seriously retard industry plans for expansion of air cargo operations.

Industry hopes for a greater share of MATS overseas cargo business apparently were crippled in the wake of military testimony which stressed the obsolescence of aircraft currently in both the MATS fleet and the Civil Reserve Air Fleet before sessions of the House Armed Services Subcommittee and the Senate Appropriations Subcommittee on the Armed Services.

What the industry had hoped would be a logical sounding board on which to campaign for additional MATS traffic has evolved into a major push to grant MATS the highest priority for its airlift needs, with the cargo problems of scheduled airlines a secondary issue.

Outcome of the first round of testimony before the two subcommittees is a promise from Sen. A. S. Mike Monroney (D.-Okla.) and Rep. L. Mendel Rivers (D.-S.C.), chairman of the House subcommittee, of maximum support for MATS modernization needs, with Sen. Monroney promising "to do everything humanly possible" to give MATS $100 million for modernization rather than the $50 million included in the Fiscal 1961 budget. Rep. Rivers said that, while he favors $100 million a year, he will not ask for any specific amount but will request that any final modernization sum be tailored to the number of off-the-shelf cargo aircraft manufacturers can supply in a year's time.

This apparent agreement between Rep. Rivers, who has long advocated revamping MATS' obsolete aircraft fleet, and Sen. Monroney, who also has recognized this need while urging that the military "get out of the airline business," is a matter of serious concern to many airlines. They fear they may be losing the industry's most influential spokesmen in Congress.

Lone Legislation

At the same time, the industry also has lost what may have been its best lever on MATS business and the promise of future development of an air cargo transport acceptable to both the military and commercial carriers by failing to support Sen. Monroney's guaranteed loan legislation for the purchase of cargo aircraft (AW Mar. 14, p. 25).

Rejected by American, Eastern, Pan American and the Flying Tiger Line, the Monroney bill is now a "dead issue," Monroney said, so that providing the nation with adequate airlift for cargo is a matter of the "highest priority" which can best be accomplished by modernizing the MATS fleet. The bill, which would provide the Civil Aeronautics Board with authority to guarantee loans of up to $85 million for cargo aircraft, directed all government departments to shift more of routine government traffic to commercial carriers and required that aircraft selected for purchase with the loans meet specifications of both the Department of Defense and the Federal Aviation Agency.

Exaggerated Need?

Supporters of the Monroney legislation are now concerned that failure of the airlines generally to support the bill might be interpreted by Congress as an indication that the industry as a whole may have exaggerated its need for a greater share of MATS business and its over-all desire for a new all-cargo transport.

Basic re-equipment needs of MATS, described by MATS commander Lt. Gen. William B. Tunner, include 50 "outsize" cargo planes, such as the Douglas C-133, 30 of which already have been delivered to MATS.

More immediate modernization of the fleet with turbine-powered transports could be accomplished, Gen. Tunner said, by ordering 45 Boeing KC-135 tankers converted to cargo configuration for "fast reaction" flights (AW Mar. 21, p. 41), along with 49 cargo versions of the Douglas DC-8, Boeing 707 or Convair 600 as an interim aircraft, pending the development of a turbofan "workhorse" cargo transport within five years. The converted tankers, powered by Pratt & Whitney JT3D turbofan engines and capable of landing on runways of 6,000-to-7,000 ft., could be delivered to MATS within 12-15 months if the funds are provided in the Fiscal 1961 budget, Gen. Tunner estimated.

A total of 242 of the specially-designed "workhorse" aircraft will be needed to meet specific Air Force operational requirements calling for a turbofan or turbojet-powered aircraft with a speed of at least 440 kt. and cargo/range capabilities of 40,000 lb. at 4,000 naut. mi. and 20,000 lb. at a range of 5,500 mi., Gen. Tunner said.

Delivery Time

Boeing Airplane Co. supported Tunner's estimate of delivery time on the KC-135 "fast reaction" aircraft with a 60-70,000 lb. payload and estimated that conversion costs would run about $1.5 million per airplane. Speculation that MATS' orders might interfere with Strategic Air Command orders for the tankers also was discounted by the company, which said it is now producing aircraft at the rate of seven per month and could easily double its production rate to accommodate both the SAC and MATS orders.

The manufacturer also has offered MATS an interim cargo version of the Boeing 707, a 735 version powered with turbofan engines, as an off-the-shelf item. The aircraft would have a cargo capacity of 100,000 lb. and could be designed in either a swing-tail, rear or side-loading configuration. A more recent Boeing proposal would include a truckbed height loading feature.

MATS testimony also has succeeded in touching off a flurry of new proposals for both interim and workhorse aircraft.

Swept Wing Plan

Lockheed Aircraft Co. has presented plans for a swept wing, turbofan version of the Super Hercules designated the GL 207-42 designed to meet MATS' specific operational requirements. Essentially, the new design is a 280 in. stretchout of the C-130B cargo transport and includes truckbed height flooring. Estimated price for the Lockheed transport was set at $4.9 million if it was ordered in quantity.

Convair Division of General Dynamics Corp. also is prepared to submit a basically new design for MATS workhorse designated the Convair 105. The swept wing aircraft is about the size of the Model 600 transport and would be powered by four Pratt & Whitney or General Electric turbofan engines. It would include low bed loading and would exceed the specific operational requirements set forth by the military, the company said.

Douglas Aircraft Co. previously submitted designs for a cargo version of the DC-8 in a swing-tail conversion with J75 powerplants and recently offered MATS a second version with a stretched fuselage powered by Pratt & Whitney J57 turbofan engines. The later design also incorporates a complete cargo handling system involving computers and conveyors. Delivery time on the first model was estimated by the manufacturer at between 20 and 24 months.

Designs Discussed

While final selection of the MATS aircraft may later be influenced by testimony from government agencies and airlines, Gen. Tunner and Sen. Monroney both succeeded in verbally sifting the proposed designs.

Criticizing MATS' present high operational cost cargo transports as containing a "lot of built-in headwind" so that "no commercial operator in his right mind" could afford to operate them, Sen. Monroney later told AVIATION WEEK he doesn't agree with Tunner's suggestion of ordering KC-135 cargo conversions because they would be too costly for a five-year-old-plane.

Sen. Monroney feels "beefed up" cargo versions of the present Boeing 707, Douglas DC-8 or Convair 600 might be a better choice, even though they lack many of the requirements sought by MATS, while the turboprop Lockheed Super Hercules is one of the only off-the-shelf aircraft available to meet MATS needs.

Gen. Tunner conceded that either the Canadair CL-44D swingtail cargo transport or the Super Hercules could satisfy MATS specifications for both speed and capacity as a "fast reaction" aircraft, with the main problem being one of delivery time and cost as compared with KC-135 conversions.

Beyond the matter of flight hardware, MATS told the subcommittees it is seeking legislation to place all management, ground maintenance and flight crew members of the Civil Reserve Air Fleet under its command in time of emergency. MATS said it wants to retain the present methods of bidding contracts with the airlines and can expect to offer the carriers more business only when the airlines are equipped with transports capable of carrying out its long-range missions.

Airline reaction to the MATS presentation has been a mixture of bewilderment and anger tempered with some optimism, since the White House, Department of Commerce and Defense Department have clearly spelled out the need for more MATS traffic to be handled by the industry.

Government agencies, including the Federal Aviation Agency and the Civil Aeronautics Board, and the airline industry are scheduled to appear before the Senate and House subcommittees in the MATS airlift hearings while the Air Force is expected to submit a report to the Department of Defense on recommendations to implement the MATS program approved by President Eisenhower (AW Feb. 15, p. 36).

The carriers take issue with MATS contentions that it needs a fleet of 337 modern aircraft operating at a five-hour daily utilization rate, primarily to meet its training needs for any "hard-core" operations it might be called upon to undertake in support of an initial Strategic Air Command wartime mission. Contending that MATS is ignoring both White House and Defense Department directives that it cut back its commercial type airlift, the airlines say that, while MATS has definite responsibilities requiring extensive training and equipment, it is attempting to justify its total air fleet needs by saying that all of the flight equipment is needed for emergency purposes.

Grand Slam

Recent staging of the MATS airlift of 21,000 troops to Puerto Rico in the Grand Slam experiment was considered by many airlines as an intentional promotion designed to demonstrate MATS logistics problems and thus gain congressional support for modern flight equipment.

Results of the test drew mixed reactions. Lt. Gen. Mark E. Bradley, Jr., USAF deputy chief of staff-materiel told the Senate subcommittee that the experiment was "very successful" and a "very fine tribute" to MATS. Sen. Stuart Symington (D.-Mo.) termed the exercise a definite demonstration of the "great deficiency of airlift which will be required to fight the type of war which is highly more probable than the probability of a nuclear conflagration."

MATS insistence on retaining its present method of awarding contracts to the low bidder also has drawn the fire of the airlines, which point out that it too often results in heavy financial losses and instability among carriers that are tempted to enter bids too low to cover their expenses. The recent Department of Commerce transportation study (AW Mar. 21, p. 42) also called for a change in military bidding practice on airlift contracts, they point out.

Sen. Monroney backs this airline stand, as does Rep. Rivers. Monroney scores the MATS bidding process as a "type of rotating bankruptcy" in which the military sends bid invitations to a legion of carriers, many of which own no aircraft but use leased transports. He is pressing for an agreement which will permit the award of contracts on a common carriage rate basis set by the Civil Aeronautics Board.

Such a policy was proposed to USAF several months ago by Northwest, Pan American, TWA and Seaboard & Western Airlines and is understood to be awaiting a final report of the Reed Committee, now studying changes in MATS policy for the Air Force. The committee was created to advise on the best methods of implementing the policy guidelines approved by the President in the recent report, "The Role of MATS in Peace and War."

Contract Bidding

Rep. Rivers also supports Monroney's views on contract bidding and adds that he favors passage of a bill that would favor contracts lasting five years to permit the airlines to amortize the cost of new cargo transports.

National Airlines made a move in this direction last week when it offered to purchase five Lockheed C-130B freighters at a cost of $14 million if the Air Materiel Command awarded it a coast-to-coast Logair contract for a period of one year with a guaranteed five year renewal. The airline noted that it had worked out the details with Lockheed officials and made the offer in answer to the government's need for expanded military air cargo service.

In further action affecting contract awards to the airlines, Sen. Vance Hartke (D.-Ind) has introduced a bill that would permit the awarding of MATS contracts only to certificated air carriers included in the Federal Aviation Act and regulated by the Civil Aeronautics Board. The CAB-supported bill is aimed primarily at Part 45 operators subject only to FAA safety performance requirements. Board members contend that freedom of these carriers from regulatory powers under which certificated carriers must operate gives them a decided competitive advantage allowing them to offer lower rates.

Mohawk Suspends Service Over Strike

Utica, N. Y.—Mohawk Airlines' operations were still shut down last week following a brief strike by its 63 stewardesses. The airline's management suspended all service Mar. 18 after pilots refused to cross the stewardess picket lines.

As of last Wednesday, Mohawk's management was holding to its position that no negotiations or mediation meetings would be held until an agreement was signed.

Intensive Electra Test Program Planned

By L. L. Doty

Washington—Series of intensive flight and static test programs on the Lockheed Electra turboprop transport was begun last week, with the strong possibility that new performance restrictions will be placed on the aircraft by the Federal Aviation Agency.

The wide-scale test program, to be conducted by FAA, Northwest Airlines, Lockheed Aircraft Corp. and National Aeronautics and Space Administration, followed an FAA order limiting cruising speeds on the Electra. The order, imposed 72 hr. after the crash of a Northwest Electra near Tell City, Ind., was issued because of a marked similarity between the circumstances of that accident and the still unsolved midair disintegration of a Braniff Airways' Electra near Buffalo, Tex. on Sept. 29 (AW Oct. 5, p. 28).

Steps being taken include:

• **Northwest Airlines** has taken back three Boeing 377 Stratocruisers originally traded to Lockheed for its fleet of Electras. A Northwest Electra, with approximately the same flight time as the stricken aircraft, has been sent to Lockheed for thorough structural analysis. The Stratocruisers will be used to fill schedule gaps expected to result from Northwest's new accelerated inspection, maintenance and overhaul procedures on the Electra, plus the loss of the Tell City aircraft and the one sent to Lockheed.

• **New performance restrictions** on top of the cruising speed limitations can be expected. Representatives of seven airlines operating Electras met last week with FAA Administrator E. R. Quesada and Lockheed officials in analytical discussions of the airplane. The next day, Quesada met with Lockheed officials behind closed doors to determine what action should be taken.

• **Lockheed will conduct** a re-evaluation program on all theoretical data on the aircraft. NASA will undertake structural studies, and FAA will direct extensive flight and static tests to give the Electra one of the most detailed shakedown analyses undergone by any airplane.

No overt move had been made as of late last week to ground the Electra, but it was conceded that such drastic action could occur if the results of the Civil Aeronautics Board investigations of the two accidents appear to warrant such a step.

The speed restriction was set in Mar. 20 telegrams sent by Quesada to the presidents of airlines operating Electras in the U.S. effective immediately upon receipt of the telegram. It established a 275 kt. calibrated airspeed, or Mach .55, as the maximum normal operating speed. Former normal operating speed was 324 kt.

During the week, the speed limit was having only a slight effect upon airline operations, and there were no immediate plans by the seven domestic operators of Electra fleets to undertake major schedule revisions as a result of the order. Most carriers said the lower speeds would add about five minutes to each hour of flight, although Northwest estimated that no more than two minutes would be added to each hour of scheduled operations.

American said that its flight schedules would remain in effect without change. Western admitted that the speed restrictions would add about 17 min. to its Los Angeles-Minneapolis/St. Paul schedules but added that the additional change of speeds would have no noticeable effect upon shorter-haul routes such as Los Angeles-San Francisco.

Carriers operating the Electra on domestic routes are American, Braniff, Eastern, National, Northwest, Western and Pacific Southwest, a California intra-state operator. The rule on speeds does not apply to foreign carriers operating the Electra.

The speed order was instituted on suspicion that a structual failure near the wing root due to clear air turbulence may have been the cause of the two accidents. The lower speed would lessen the effect of such turbulence on the structure of the Electra's wings, an FAA spokesman said.

Meanwhile, Civil Aeronautics Board investigators at the scene of the accident were in the dark late last week as to the cause of either the Northwest or Braniff accidents, although early investigation of the Northwest crash pointed-up some close similarities between the two. Both planes disintegrated in the air and both planes apparently lost wings prior to the midair breakup.

There were these differences, however. The Northwest fuselage plunged in a dive at such speed and with such a ground impact that it gouged out a crater in the earth approximately 25 ft. in diameter and 40 ft. deep where it exploded and burned for several days.

The Braniff fuselage, however, followed a flight trajectory after losing its wings that caused it to scatter components and parts along its proposed flight path. Pieces of the plane were found as far as 13,900 ft. from the site of the main wreckage.

Both wings of the Braniff plane failed in-flight, although the left wing apparently was the first to fail. It broke at the inboard third of the No. 2 tank whereas the right wing failed just inboard of the No. 4 nacelle. On the Northwest plane, the right wing failed between the fuselage and the inboard nacelle. Most of the left wing remained intact. There was evidence of fire on the left wing inboard portion of the Braniff plane. There was some burning of the wing of the other plane at the break point.

CAB investigators agree that the clue to the cause of the Northwest accident probably lies in the study of the wing root in the fuselage now deeply embedded in soggy earth. In addition to the physical difficulties involved in reaching this area of the airplane for study, Indiana state health authorities last week were threatening to seal the crater for health protection of the surrounding area even before the investigation was completed.

Unless this section of the fuselage can be reached, Board investigators feel that chances are strong that the Northwest accident may go unsolved. And, even if it is reached, possibilities are slim that enough of the section can be recovered to complete a partial mockup of the fuselage of the airplane.

In the Braniff accident, CAB investigators recognized that a mockup of certain airframe areas was essential to the investigation and, consequently, most of the aircraft structure was shipped to a warehouse in Dallas for the mockup studies. Such parts as wiring bundles, interior furnishing and trim were buried at the scene.

Parts were recovered by searching the area with troops from Ft. Hood, Tex., in a line patrol over the land where parts and components fell.

Facts Outlined

Here are the facts the Civil Aeronautics Board investigation of the Braniff accident has produced thus far:

• **Aircraft broke up in flight,** distributing components approximately along its flight path.

• **One part, a piece of tubing** from the left hydraulic heat exchanger, was found 13,900 ft. upstream from the main wreckage. Proceeding from the tubing to the site of the main wreckage, these major components were found: No. 1 propeller and gear box, left wing, No. 4 powerplant, left outboard stabilizer, right outboard stabilizer and right outboard wing. Main wreckage consisted of fuselage, tail, inboard right wing and No. 3 powerplant.

• **Two impact craters** and the wide distribution of fuselage panels at the main site indicated an in-flight breakup of the fuselage, although this apparently occurred at a very low altitude. Complete demolition at the two craters gave evidence of heavy impact forces, therefore high speed.

• **In-flight fire** was confined to the extreme inboard portion of the left wing, causing heat damage to windows on the left side rear of the trailing edge and smoking the left rear fuselage.

• **No. 2 fuel tank** showed no indications of internal pressure or explosion, and the planking fragments were burned or smoked in a random pattern.

• **Left inboard leading edge,** the lower planking and rear spar showed that the left wing failed at the inboard third of the No. 2 tank in upward bending and nose-up torsion. The relatively small fragments of the upper planking indicated a strong probability that the left wing failed during a high positive load.

• **Right wing failed in flight** just inboard of the No. 4 nacelle in a combination of nose-down torsion and drag loads. Other right wing damage was confined to ground impact.

• **Left stabilizer leading** edge area was seriously damaged by wing plank material prior to stabilizer failure.

• **Right stabilizer failed** as a result of a heavy object passing through the front spar and the box ribs.

• **Vertical rudder and tail cone** were subjected to no in-flight damage, with the exception of light impact marks on the fin leading edge.

• **Only ground fires occurred** at the left wing and the No. 4 powerplant sites.

Meanwhile, the Navy is maintaining close liaison with the FAA in its investigation of the Electra crashes, according to Vice Adm. Robert Pirie, deputy chief of naval operations for air. The P3V, a military adaptation of the Electra for anti-submarine patrol duty, is in the Navy's procurement program, and Pirie has said that the results of the FAA investigation will determine whether the Navy will "beef-up or terminate" the P3V program.

The Navy called for heavier structural material and thicker sections in the P3Vs, but the Navy emphasized that strengthening of the aircraft was undertaken only because of the additional stress the aircraft are subjected to in military maneuvers.

The Lockheed Electra has undergone some difficult shakedown problems since it was first introduced into scheduled service by Eastern Air Lines Jan. 12, 1959 (AW Jan. 19, 1959, p. 38).

During the spring, excessive vibration resulted in a modification calling for a change in the engine thrustline from its former position of one degree nose down below the fuselage reference line to a tilt-up position of two degrees above (AW May 4, p. 47).

During the summer, Eastern experienced wing skin cracks on seven Electras and Western on one Electra. It was determined that the cracks were caused by tension loads in the skin resulting from vertical loads on the landing gear being transmitted to the wing skin. Skin cracks on a Lockheed test Electra resulted from an excessively hard landing which was caused by the throttle being inadvertently moved into the Beta range while the airplane was still airborne and making a maximum rate of descent landing.

Skin cracks were eliminated through the installation of a chord-wise reinforcing strap approximately 4 in. wide and 42 in. long over the rib fore and aft of the point where the cracks occur. There have been no reports of skin cracks since.

1959 Electra Performance Record On Domestic Trunklines

Carrier	Date Inaugurated	Seat Miles Offered (000) Operated	Revenue Passenger Miles Operated (000)	Aircraft Fuels Issued (Gal.)	Total Aircraft Miles	Revenue Hr. per Aircraft per Day
American	Jan. 24, 1959	656,566	516,293	23,772,954	10,189,950	5:20
Eastern	Jan. 21, 1959	1,633,253	919,182	56,988,084	25,187,733	6:26
National	Apr. 26, 1959	229,943	128,719	7,586,281	3,278,316	6:47
Braniff	June 15, 1959	157,616	89,031	9,708,535	5,571,072	8:55
Northwest	Sept. 8, 1959	127,483	87,647	4,060,927	2,017,491	6:55
Western	Aug. 1, 1959	118,282	88,517	4,265,447	1,974,263	7:49

JAL Plans Jet Fleet Expansion

New York—Japan Air Lines plans to expand its jet transport fleet with three Convair 880s at a basic price of $3.9 million each. At the same time, Aviation Week has learned that JAL is negotiating the possible lease of a Boeing 707-320 from Pan American World Airways to enter the Pacific jet competition before the Japanese carrier's own Douglas DC-8 equipment is delivered.

Delivery of the three 880s is expected in May or June of next year. They are scheduled for JAL's Southeast Asia routes and routes to Europe, with service to begin in early summer, 1961. Powerplants are General Electric CJ805-3B turbojets.

The order requires Japanese government permission, which JAL was seeking last week. The airline's decision for the 880 followed a recent report by an engineering team that has been studying medium-range jet equipment for the carrier's needs (AW Feb. 15, p. 35).

Pan American will not discuss details of the proposed lease agreement, but it is understood to involve a limited time period, probably only through this year. JAL expects to begin DC-8 transpacific service in August.

Pan American was operating some nonstop scheduled eastbound flights in its Tokyo-West Coast services, but has suspended these. Japan Air Lines and Pan American both stop at Honolulu. Later, when both carriers have jets, nonstop schedules presumably will be resumed.

Some pressure reportedly had been brought to bear by the Japanese government to restrict Pan American's jet operations during the period when JAL is still operating piston-engine equipment on the Pacific. The possible jet lease therefore may have diplomatic overtones.

Japan Air Lines previously had negotiated with Continental Air Lines for lease of a Boeing jet transport (AW Aug. 17, p. 43), but no agreement was reached.

Braniff Files Suit Against Curtiss-Wright

New York—Braniff Airways last week filed a $3,750,000 negligence suit against Curtiss-Wright in a federal district court here on charges that the manufacturer had failed to use reasonable care in the design and selection of material in an engine powering a Douglas DC-7 which crashed near the Miami airport on Mar. 25, 1958 (AW Jan. 26, 1959, p. 40).

Braniff charged that, before the crash, the plane's No. 3 engine caught fire because of this negligence. The suit contends that, prior to the crash, Curtiss-Wright "had become aware of certain defects in the manufacture, design and construction of engines of the same type as No. 3, but negligently failed to notify Braniff of such defects and as a result, these defects contributed to the crash."

Dallas-Ft. Worth Airline Pilots Criticize Love Field Facilities

Dallas, Tex.—Members of Airline Pilots Assn. councils operating in the Dallas-Ft. Worth area last week supported a letter signed by "900 ALPA pilots residing in the Dallas-Ft. Worth area" who strongly criticized approach and landing facilities at Love Field.

Main target of attack in the letter was lack of a "Configuration A" centerline approach lighting system (see p. 108) on Love Field's 7,750-ft. instrument runway. Pilots termed as "ridiculous" the fact that "today at Love Field we are still operating with the antiquated left row approach lights, 2,700 ft. in length," and term as "fortunate" that they have as an all-weather alternative Amon Carter Field, midway between Dallas and Ft. Worth.

According to airline pilots, Dallas aviation officials responding to queries about the letter have been intimating that it did not represent a majority opinion of ALPA membership in this area.

In rebuttal, members of councils representing airlines operating in this area quickly approved resolutions indicating that views expressed in the letter were backed by rank and file opinion.

A survey of pilots in the area also indicated that they plan to keep the issue alive. The letter also was sent to FAA Administrator Elwood P. Quesada, Sens. A. S. (Mike) Monroney and Lyndon Johnson, and L. C. Elliott, FAA regional administrator, ALPA President C. N. Sayen and other parties.

Safety Improvement

The airline pilots' letter notes that they do not consider Love Field as unsafe, but that operational safety could be greatly improved. It points out that airline pilots, aware of Love Field's facilities, simply proceed to an alternate field, usually Amon Carter, when ceiling and visibility conditions go below the minimums allowed by the "antiquated approach light facilities."

American Airlines has a 300-ft. and three-quarter-mile company minimum for the Boeing 707 jet transport on straight-in approach to Amon Carter, a 400-ft. and one-mile minimum for Love Field. Amon Carter's instrument runway contains a standard centerline high intensity system with stroboscopic flashing lights and paint markings for runway visual range permitting landings with 2,600-ft. forward visibility, with no requirement on cloud height above the ground.

So far, since the start of the 707 service into Dallas last summer, approximately a dozen landings have been made into Amon Carter instead of the original destination, Love Field, in addition to several diversions to El Paso or Tulsa, Okla., when Love and/or Amon Carter air fields were considered below minimums.

Another main contention of pilots is that they have been unsuccessful in establishing a pattern of discussing what they call "mutual problems" in airport operations and future planning, pointing out that they have not been approached or asked what they consider adequate minimum requirements. Dallas aviation officials queried apparently feel that these problems are properly handled only with airline airport engineers and qualified Federal Aviation Agency personnel.

Airport Relations

Pilots note that they enjoy considerably more favorable relations with the manager of Amon Carter Field and quote a letter written them in 1953 which asked advice directly any time they saw anything on that field which they felt could stand correction to improve safety conditions. The letter pointed out that pilots "are better qualified than anyone else that I know to keep us advised on what should be done to make your landings and takeoffs better and safer."

Dallas aviation officials noted that they will ask the FAA to approve a plan for a so-called "short system" of centerline lighting, which envisages replacing the current 2,700-ft. left row approach lights. This would fall some 300 ft. short of a standard "Configuration A," but Dallas officials point out that the standard configuration would require condemning some dwellings in line with the current lighting system and say that they are reluctant to exercise the right of eminent domain to oust the property owners until all avenues of solving the problem have been ascertained.

Indications are that obtaining approval for such a non-standard system would be dim; the airport has been turned down previously on such a plan. Also, pilots here oppose any deviation from the standard concept.

Shorter Runway

Pilots also are critical of the fact that Love Field's instrument runway is some 800 ft. shorter than Amon Carter's and point out that a new parallel runway, approximately 8,000 ft. long, planned for installation at Love Field next summer, also falls short of the standard minimum length. "We beg of you, however, to bring the existing instrument runway up to minimum national standards, before building another runway that will also not meet the requirements for all modern facilities," the pilots' letter states.

Not Critical Factor

In rebuttal, Dallas officials contend that experience indicates that the length of the instrument runway has not been a critical factor on the comparatively short-haul Dallas-New York, Dallas-Chicago and Dallas-Los Angeles and San Francisco jet services because the airplanes are operating considerably below takeoff weights required for the longer New York-West Coast and transatlantic flights. They also feel that technical improvements, such as additional power slated for American's fleet of 707s and advent of the lighter Boeing 720, will make runway extensions unnecessary.

That this does not match up with FAA thinking is indicated in that agency's recent refusal to approve a $2.8 million grant to Love Field for construction of the parallel runway. Among the reasons are that the agency felt that its length did not meet its requirements on the ultimate indicated need for this location. Local Dallas supporters claim that they will, if necessary, proceed with building the new runway with money raised by revenue bonds supported entirely by airport income.

TAI Will Lease DC-8s For New Pacific Routes

Paris—TAI, privately-owned French airline, will lease two Douglas DC-8 turbojet transports from another private French carrier, UAT, to begin jet service between Paris and New Caledonia in July.

TAI is receiving the first of three DC-8s it has on order in June, with the balance scheduled for delivery in May, 1961. However, TAI is renting the UAT DC-8s so that it can begin service on its newly awarded route through Sydney to New Caledonia from Paris (AW Mar. 7, p. 344) as soon as possible.

The jet service will be extended to Tahiti, Honolulu and Los Angeles from New Caledonia when the Tahiti airport is completed, probably sometime this fall.

In the meantime, DC-7s will serve the New Caledonia-Los Angeles segment of the route.

UAT reportedly has decided the DC-8 does not fit its Franco-African route pattern but, beyond the TAI rental agreement, it has made no announcement as to the disposition of the two aircraft.

Airline Traffic—January, 1960

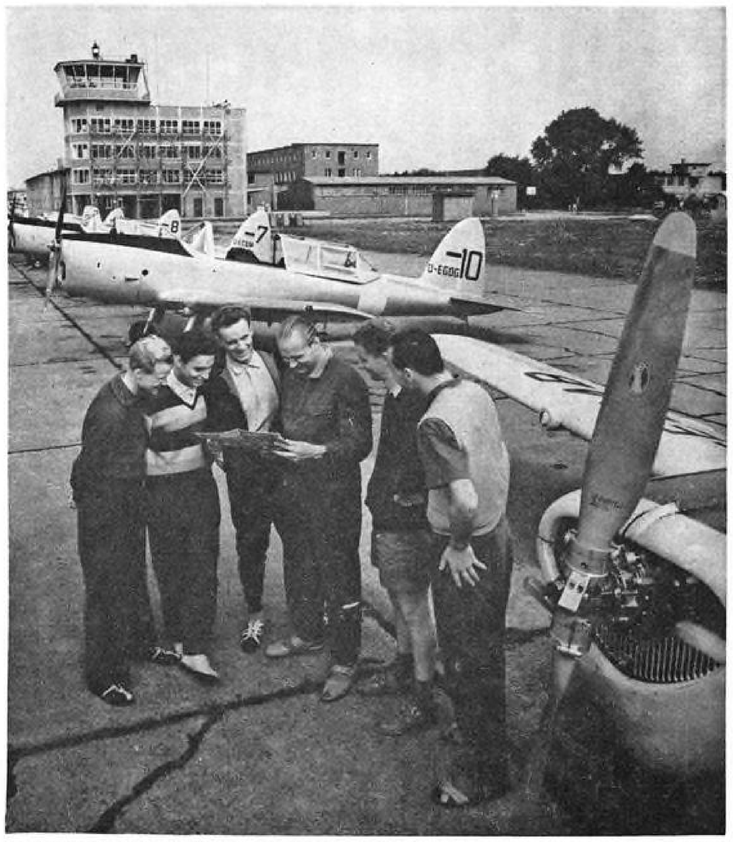
	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	655,132	508,492	67.0	1,931,318	996,102	8,250,836	60,043,782	57.9
Braniff	175,032	81,206	55.2	329,633	171,475	533,208	8,816,413	48.9
Capital	273,626	118,590	52.0	445,946	234,435	368,252	12,425,889	47.0
Continental	111,755	78,058	55.0	172,118	123,304	298,914	8,708,572	42.7
Delta	267,572	148,884	59.2	397,571	277,692	1,174,047	16,194,167	49.3
Eastern	698,054	390,822	51.17	1,120,960	513,963	1,483,073	40,843,073	40.93
National	145,513	103,836	57.1	333,842	77,355	576,046	11,073,533	46.0
Northeast	103,758	50,666	51.91	121,036	35,885	170,109	5,197,049	44.75
Northwest	158,984	125,301	56.8	588,586	281,290	1,401,223	14,319,534	50.3
Trans World	403,702	368,085	65.3	1,683,716	787,996	2,846,892	40,580,669	55.8
United	523,367	352,187	63.6	2,174,532	785,485	5,234,458	42,028,827	56.5
Western	151,441	87,261	62.7	326,701	98,259	291,188	9,078,540	54.8
INTERNATIONAL								
American	10,819	11,515	69.0	8,451	230	153,518	1,351,396	67.9
Braniff	3,809	7,127	42.3	21,431	.....	110,654	904,278	38.7
Caribbean Atlantic	31,902	2,273	55.6	1,901	.....	6,264	248,075	61.0
Delta	2,858	3,996	44.2	6,603	.....	40,833	486,455	42.3
Eastern	35,245	52,784	49.03	77,240	.....	133,811	5,599,055	47.73
Mackey	10,542	1,948	45.4	.....	232	4,272	214,856	45.3
National	4,773	3,720	53.8	4,218	604	11,112	409,161	45.9
Northwest	14,971	24,744	42.9	1,188,330	18,041	758,409	4,585,525	47.8
Pan American								
Alaska	3,767	3,937	41.5	32,839	.....	101,418	561,449	41.1
Atlantic	82,480	121,052	61.7	1,233,170	.....	3,066,741	17,043,232	54.6
Latin America	116,715	138,125	64.8	428,093	.....	4,018,851	18,156,363	64.3
Pacific	29,412	102,760	67.4	1,527,179	.....	1,667,367	13,955,446	57.9
Panagra	10,294	15,267	58.8	71,453	.....	494,755	2,217,508	60.3
Resort	.....	.....	.....	.....	.....	3,241,322	3,241,322	80.4
Trans Caribbean*	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	15,492	46,683	49.8	972,741	.....	1,043,357	6,963,735	49.3
United	6,011	14,960	61.8	127,828	6,206	78,629	1,729,999	61.8
Western	5,520	8,583	78.6	6,868	.....	13,078	923,759	81.6
LOCAL SERVICE								
Allegheny	34,394	6,129	39.0	10,705	22,583	28,733	647,951	38.7
Bonanza	19,813	5,009	39.9	8,126	2,696	8,792	498,831	41.1
Central	11,728	2,414	36.5	6,272	2,512	7,671	247,613	32.9
Frontier	25,032	6,636	36.0	23,700	8,301	58,738	730,516	40.0
Lake Central	16,515	2,590	35.6	5,731	17,491	.....	271,286	39.4
Mohawk	42,308	8,283	43.3	12,804	16,472	18,413	838,898	40.6
North Central	70,817	12,536	40.68	34,917	42,981	27,876	1,328,181	41.87
Ozark	35,820	6,344	39.0	13,123	20,783	26,053	667,876	41.6
Pacific	36,510	8,440	44.2	13,622	4,358	5,789	829,197	41.9
Piedmont	30,924	6,748	39.6	10,019	12,382	13,155	683,568	40.7
Southern	21,341	3,893	33.7	11,878	11,373	12,900	410,019	35.4
Trans-Texas	22,271	5,363	35.1	17,420	9,672	34,119	575,454	36.1
West Coast*	.....	.....	.....	.....	.....	.....	.....	.....
HAWAIIAN								
Aloha	26,515	4,276	60.9	2,263	.....	5,714	310,134	51.7
Hawaiian	41,727	8,678	63.9	11,694	.....	153,811	895,616	59.4
CARGO LINES								
AAXICO	.....	.....	.....	.....	.....	5,774,525	5,774,525	64.67
Aerovias Sud Americana	.....	.....	.....	.....	.....	558,250	558,250	87.4
Flying Tiger	5,296	27,570	100.0	69,925	55,033	7,217,950	10,099,922	79.0
Riddle								
Domestic	.....	.....	.....	9,356	30,347	1,406,141	1,445,844	73.4
Overseas	.....	.....	.....	7,104	.....	480,978	488,082	68.1
Seaboard & Western	2,067	8,086	100.0	455,882	.....	3,356,033	4,636,012	76.8
Slick	1,276	4,717	70.48	.....	.....	5,988,669	6,460,380	95.06
HELICOPTER LINES								
Chicago Helicopter	19,239	330	53.0	1,014	.....	.....	32,589	44.0
Los Angeles Airways	2,921	102	52.6	4,377	2,376	.....	16,496	60.4
New York Airways	9,524	199	42.9	1,362	1,292	704	22,390	48.0
ALASKA LINES								
Alaska Airlines	9,355	9,248	60.3	54,591	2,972	309,150	1,271,132	60.6
Alaska Coastal	2,507	297	55.0	3,771	.....	3,600	37,697	62.0
Cordova	1,143	212	35.1	2,825	.....	30,533	54,688	37.1
Ellis	3,513	229	53.3	1,963	.....	1,366	26,514	61.2
Northern Consolidated	1,154	358	31.7	30,176	.....	33,728	102,824	55.1
Pacific Northern	6,803	6,289	35.1	99,606	5,443	311,035	999,253	45.4
Reeve Aleutian	907	896	27.0	40,752	.....	88,183	227,635	52.4
Wien Alaska	1,355	392	24.9	31,906	.....	65,677	138,385	38.8

* Not available.
Compiled by AVIATION WEEK from Airline Reports to the Civil Aeronautics Board.

LUFTHANSA introduced its first jet service on the North Atlantic route on Mar. 17, with the Boeing 707-420, of which it has five on order. The last is scheduled to be delivered in spring 1961. The jet transports also will be used later on for extensions of Lufthansa's long-range network to other parts of the world. The 707s will be based at Frankfurt/Main.

Lufthansa Gains Despite 1959 Deficit

By Edith Walford



LUFTHANSA German Airlines' pilot training school at Bremen has a fleet of nine de Havilland Chipmunk trainers in addition to two twin-engine Beech Bonanzas and three Saab Safirs. Current enrollment is 120 pilot students.

Cologne—Lufthansa German Airlines, faced with its biggest deficit since its postwar comeback, is looking to its recently inaugurated Boeing 707-420 jet service on the North Atlantic as a major move toward financial recovery.

Despite its 1959 loss, which is expected to total about $10 million, Lufthansa's operation last year showed across-the-board improvements (see p. 47). In addition, the airline is close to solving the major problems which Lufthansa officials believe were the chief causes of the large deficit. These are:

- **Traffic diverted** by the attraction of jet service operated by competitors.
- **Unfavorable cabotage** position with respect to foreign carriers, particularly Scandinavian Airlines System (SAS).
- **Fare cuts by Panair do Brasil** and Aerolineas Argentinas on Europe-South America routes.
- **Ten-year lead of its competitors** on most major routes.

The price-cut war on the South Atlantic was settled last year through the ratification of an agreement between the two South American carriers and members of the International Air Transport Assn. and Lufthansa began Boeing 707 service earlier this month. Although negotiations between Lufthansa and SAS on cabotage broke off in deadlock earlier this month, the German carrier is still hopeful of improving its cabotage position with respect to SAS.

The company was able to cover 85% of the previous year's loss amounting to 32 million DM (about $8 million) out of earnings, compared with only 54% of the 1955 deficit, the first full year of the company's postwar activities. But the 1959 deficit, the highest since Lufthansa's re-establishment in May-June, 1954, will have to be met in the form of special grants by the West German government, which controls 87% of the company's capital. Only the remaining 13% will be borne by private shareholders.

- **Burden of maintaining** personnel and equipment in nine large German airports to which a tenth in West Berlin, for which plans are under way, may soon be added. The company argues that it would be in a better competitive position if Germany's air traffic source could be confined to at least one or two airports.

Lufthansa points particularly to the severe competition it is suffering on its own national network from KLM and Swissair, but especially from SAS. Figures recently published in Hamburg show that the Scandinavian airline accounts for 50% of all scheduled international flights, and all other foreign airlines for another 380 services, through Germany. For example, KLM has been able to increase its flight frequencies to or through Germany from 66 in the summer of 1955 to 90 last summer; Swissair during the same period from 59 to 66 and Sabena from 57 to 71.

First Agreement

The first agreement between the governments of both countries was signed in January 1957. At that time it was based on completely unrealistic and unrelated considerations, Lufthansa says, such as the high volume of goods exported from Germany to Scandinavia compared with a much smaller quota vice versa. The then still young and struggling re-established German airline had little say in the agreement finally signed and had to submit to political and commercial pressure.

This first postwar agreement between West Germany and Scandinavia is due to expire on Mar. 31 this year. The entire situation is now under review with special emphasis on the frequency with which Lufthansa may land in Scandinavia. The new negotiations, started last December between Sweden and the West German government in Bonn, were suspended for a period and are now being resumed.

While Lufthansa is endeavoring to solve its severe financial problems, its share of total air traffic is steadily improving. From carrying 4.6% in 1958 of total passengers carried by all airlines, it increased its share to 5% in 1959. With 68,000 passengers carried on scheduled and 3,500 on nonscheduled flights, Lufthansa now takes second place among all non-jet operators on the North Atlantic route.

Recent growth is shown below:

	1958	1959	Percentage of Increase
Revenue miles flown	14.2 mil.	17.5 mil.	23%
Revenue hours flown	72,502	83,200	15%
Passenger miles available	775.8 mil.	971.2 mil.	25%
Revenue passengers carried	550,114	692,400	26%
Revenue passenger miles	412.5 mil.	519.1 mil.	26%
Cargo ton-miles	7.0 mil.	10.0 mil.	44%
Mail ton-miles	3.3 mil.	4.3 mil.	29%

With the delivery in spring 1959 of the last of nine Vickers Viscount 814s Lufthansa ordered, the company was able to extend its European network to Athens, Barcelona, Geneva, Milan, Nice and Stockholm. The Viscounts were also used on routes to Turkey, Lebanon, Syria and Iraq.

During the peak summer travel period, Lufthansa flights to New York were stepped up to 16 a week, increasing seats available on this run by 20% compared with the previous year.

Although some of the Douglas DC-3 aircraft still in service on short hops within Germany were replaced by Convair Metropolitans during last summer, Lufthansa was unable to increase its passenger load factor on these runs appreciably.

Major addition to the airline's route structure last winter was the introduction on Nov. 1 of two weekly Super-G Constellation flights to Rome-Cairo-Karachi-Calcutta-Bangkok. This is a route which Lufthansa shares and intends to develop together with its Air Union partners, Alitalia and Air France, and also with TAI, which has been operating flights to South and East Asia.

Lufthansa's present fleet consists of nine Vickers Viscount 814s; seven Lockheed Super Constellation 1049s; four Lockheed Super Constellation 1649s; nine Convair Metropolitans and three Douglas DC-3 freight carriers.

Two of the four Super Constellation 1649s are presently being converted into cargo carriers at the Lockheed Aircraft Service plant in Ontario, Calif. Delivery of the first of these is expected in June, the second in July this year. They will go into service immediately on a nonstop run from Frankfurt/Main to New York six times weekly both ways. Lufthansa introduced its first jet service on the North Atlantic route on Mar. 17, with Boeing 707-420s, of which it has five on order. Later on, they are also to be used for extensions of the airline's long-range network to other parts of the globe. The Boeings will be based at Frankfurt/Main, which at present is the only West German airport with runways long enough to accommodate the large jets.

In addition, Lufthansa recently decided to buy four Boeing 720B transports at a cost of about $4.6 million each, delivery to begin this spring. These aircraft are to be employed on the airline's South American and Far Eastern routes. The price will probably only partly be written off and the remainder met out of credits from U.S. banks. German government approval for the proposed financing of the project was granted in principle last month, but details have to be worked out.

Lufthansa also plans to extend its network this year to San Francisco, and probably from the already existing Far Eastern route to Bangkok-Hong Kong-Tokyo, but final dates for inauguration of extensions have not been fixed.

The company is waiting for the Air Union partnership to come into full operation. This should automatically eliminate many of the disadvantages it has lately suffered in competition with some of its future Air Union partners. Major advantages expected by Lufthansa from this pooling of interests are:

- **Reduction** of over-all costs.
- **Coordination** of flight schedules.
- **Common sales** organization.
- **Simplification** and standardization of air fleets.

On Jan. 1, 1960, Lufthansa's total staff numbered 7,500; pilots, flight engineers, radio operators, navigators and air hostesses together numbered 742.

CAB Investigating Fares to Puerto Rico

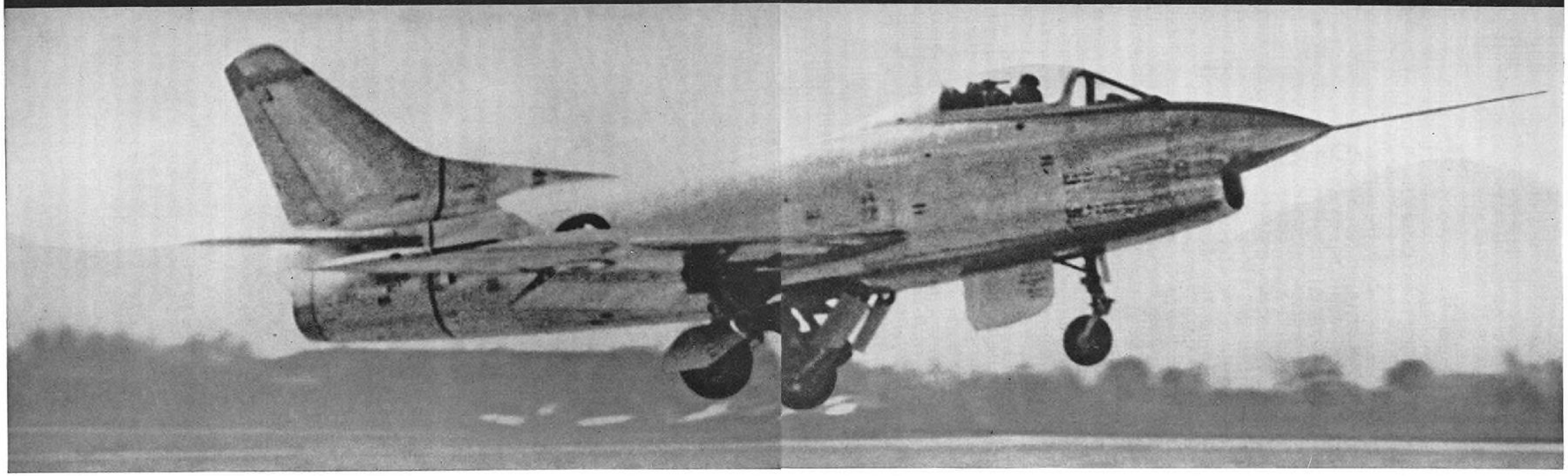
Washington—The Civil Aeronautics Board has ordered an investigation of fare increases between New York and San Juan.

Pan American World Airways and Trans Caribbean Airways have filed proposals with the Board to increase New York-San Juan thrift fares from $45 to $52.50 and cancel reduced midweek round trip fares on 17 day excursion tickets. Eastern Air Lines filed a proposal for cancellation of the reduced round trip excursion ticket. Pan American also filed proposed surcharges of $5 on turbojet flights from Miami to San Juan and $8 on New York-San Juan jet flights.

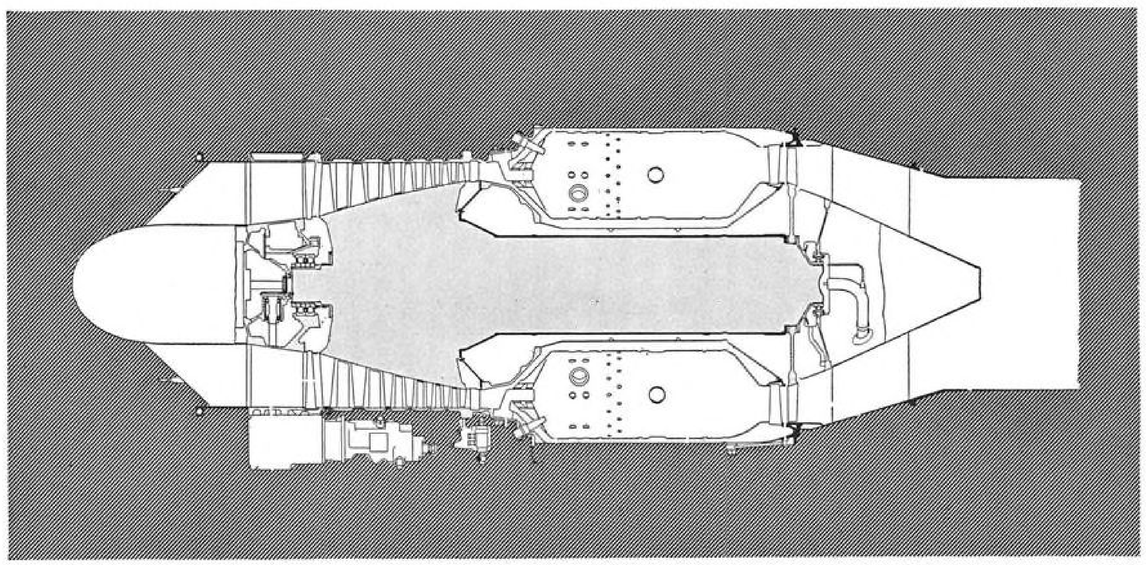
Commonwealth of Puerto Rico filed a complaint with the Board, charging the increased fares, reduced rate cancellations and jet surcharges would "undermine the Board's regulatory powers" because of the pending Puerto Rico Fare Investigation since the lawfulness of all New York-San Juan fares would depend on the decisions in that investigation. The Puerto Rican government also said the increases would be unreasonably high and urged the Board to preserve the status quo.

In its order of investigation, CAB suspended the proposed increases and reduced-rate cancellations until June 12 and prohibited changes in the fare structure on New York-San Juan routes before then. Pan American jet surcharges were not included in the suspension and investigation.

Orpheus turbojet – already flying in 6 different aircraft – now reaches 6,810 lb thrust dry, over 6:1 thrust/weight ratio . . .



. . . ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY



ORPHEUS 803 – general arrangement showing the two-bearing layout

The design philosophy behind the Orpheus family of engines was based on two conflicting requirements—extremely light weight and exceptional reliability. That these requirements were successfully reconciled is shown by the fact that the Orpheus has been specified in five countries for no fewer than 14 distinct types of aircraft, six of which are already flying. The Orpheus is undoubtedly the most advanced medium-thrust turbojet engine in the world and the latest version, the B Or 12, has more than twice the thrust of the original Orpheus which first flew in 1955.

The Bristol Siddeley Orpheus B Or 12, like the earlier versions, achieves its outstanding performance through basic simplicity of design. Producing 6,810-lb thrust dry (8,170-lb thrust with simplified reheat), for a weight of 1,100 lb, the B Or 12 has a very high thrust/weight ratio of over 6:1. This is combined with a good specific fuel consumption (0.933 lb/lb/hr at maximum continuous rpm, sea-level static conditions), very compact dimensions (81.4 in from intake flange to exhaust flange; 32.4 in diameter), and minimum servicing requirements.

Omnipresent Orpheus. The Orpheus family has a far wider range of applications than any other aero-engine in its class. The design has been proved by a remarkable record of trouble-free operation and various Orpheus versions power aircraft ranging from trainers and executive transports to research aircraft and lightweight strike fighters. The last category includes the Fiat G 91, NATO's standard strike fighter, powered by the Orpheus 803 (shown above).

The Orpheus is in production in India and Italy as well as Great Britain, and will shortly be built in Germany. *For further information, please write to:— Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Telephone: University 6-5471.*

BRISTOL SIDDELEY ENGINES LIMITED

Passengers Enplaned in Latin America By U. S. Flag Carriers in 1959

	American	Braniff	Caribbean	Delta	Eastern	Mackey	National	Panagra	Pan American	Western	Total	Rank
Antigua, St. Johns B.W.I.	.....	.....	.....	.....	.....	.....	.....	.....	4,510	.....	4,510	31
Antofagasta, Chile	.....	.....	.....	.....	.....	.....	.....	723	.....	.....	723	47
Arequipa, Peru	.....	.....	.....	.....	.....	.....	.....	17	.....	.....	17	58
Arica, Chile	.....	.....	.....	.....	.....	.....	.....	169	.....	.....	169	55
Asuncion, Paraguay	.....	2,540	.....	.....	.....	.....	.....	.....	281	.....	2,821	36
Balboa, C.Z./Panama City R.P.	.....	7,217	.....	.....	.....	.....	.....	29,031	60,378	.....	96,626	4
Barbados, Bridgetown, B.W.I.	.....	.....	.....	.....	.....	.....	.....	.....	3,491	.....	3,491	34
Barranquilla, Colombia	.....	.....	.....	.....	.....	.....	.....	.....	10,254	.....	10,254	20
Belem, Brazil	.....	.....	.....	.....	.....	.....	.....	.....	1,739	.....	1,739	44
Bimini, Bahamas	.....	.....	.....	.....	.....	2,473	.....	.....	.....	.....	2,473	38
Bogota, Colombia	.....	5,027	.....	.....	.....	.....	.....	.....	.....	.....	5,027	30
Buenos Aires, Argentina	.....	3,684	.....	.....	.....	.....	.....	20,111	9,631	.....	33,426	6
Cali, Colombia	.....	.....	.....	.....	.....	.....	.....	5,323	.....	.....	5,323	27
Camaguey, Cuba	.....	.....	.....	.....	.....	.....	.....	.....	4,194	.....	4,194	32
Caracas, Venezuela	.....	.....	.....	13,695	.....	.....	.....	.....	43,345	.....	57,040	5
Cayenne, French Guiana	.....	.....	.....	.....	.....	.....	.....	.....	578	.....	578	48
Ciudad Trujillo, Dom. Rep.	.....	.....	819	744	.....	.....	.....	.....	14,433	.....	15,996	12
Cochabamba, Bolivia	.....	.....	.....	.....	.....	.....	.....	2,584	.....	.....	2,584	37
Concepcion, Bolivia	.....	.....	.....	.....	.....	.....	.....	355	.....	.....	355	50
Cuenca, Ecuador	.....	.....	.....	.....	.....	.....	.....	1,270	.....	.....	1,270	45
Curacao, Neth. Antilles	.....	.....	.....	.....	.....	.....	.....	.....	5,623	.....	5,623	26
Georgetown, British Guiana	.....	.....	.....	.....	.....	.....	.....	.....	2,034	.....	2,034	41
Guadeloupe, French West Indies	.....	.....	.....	.....	.....	.....	.....	.....	2,261	.....	2,261	40
Guatemala City, Guatemala	.....	.....	.....	.....	.....	.....	.....	.....	24,090	.....	24,090	8
Guayaquil, Ecuador	.....	1,066	.....	.....	.....	.....	.....	12,714	.....	.....	13,780	15
Havana, Cuba	.....	1,990	.....	11,779	.....	3,794	39,165	.....	82,713	.....	139,441	1
Kingston, Jamaica, B.W.I.	.....	.....	.....	.....	.....	.....	.....	.....	9,895	.....	9,895	22
La Paz, Bolivia	.....	2,517	.....	.....	.....	.....	.....	5,240	.....	.....	7,757	24
Lima, Peru	.....	7,218	.....	.....	.....	.....	.....	19,256	.....	.....	26,474	7
Managua, Nicaragua	.....	.....	.....	.....	.....	.....	.....	.....	10,807	.....	10,807	19
Manta, Ecuador	.....	.....	.....	.....	.....	.....	.....	72	.....	.....	72	57
Maracaibo, Venezuela	.....	.....	.....	.....	.....	.....	.....	.....	7,886	.....	7,886	23
Martinique, French West Indies	.....	.....	.....	.....	.....	.....	.....	.....	2,353	.....	2,353	39
Merida, Mexico	.....	.....	.....	.....	.....	.....	.....	.....	5,119	.....	5,119	29
Mexico City, Mexico	45,302	.....	.....	.....	24,473	.....	.....	.....	32,261	27,743	129,779	2
Montego Bay, Jamaica, B.W.I.	.....	.....	.....	5,221	.....	.....	.....	.....	10,647	.....	15,868	13
Montevideo, Uruguay	.....	.....	.....	.....	.....	.....	.....	.....	3,556	.....	3,556	33
Nassau, Bahamas	.....	.....	.....	.....	.....	38,684	.....	.....	88,257	.....	126,941	3
Oruro, Bolivia	.....	.....	.....	.....	.....	.....	.....	211	.....	.....	211	54
Paramaribo, Surinam	.....	.....	.....	.....	.....	.....	.....	.....	1,844	.....	1,844	43
Port Au Prince, Haiti	.....	.....	.....	1,348	.....	.....	.....	.....	16,535	.....	17,883	10
Porto Alegre, Brazil	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	12	59
Port of Spain, B.W.I.	.....	.....	.....	.....	.....	.....	.....	.....	13,322	.....	13,322	16
Puerto Suarez, Bolivia	.....	.....	.....	.....	.....	.....	.....	126	.....	.....	126	56
Quito, Ecuador	.....	.....	.....	.....	.....	.....	.....	11,053	.....	.....	11,053	18
Rio de Janeiro, Brazil	.....	3,032	.....	.....	.....	.....	.....	.....	7,117	.....	10,149	21
Rebore, Bolivia	.....	.....	.....	.....	.....	.....	.....	254	.....	.....	254	53
St. Maarten, Neth. Antilles	.....	.....	2,862	.....	.....	.....	.....	.....	.....	.....	2,862	35
San Ignacio, Bolivia	.....	.....	.....	.....	.....	.....	.....	466	.....	.....	466	49
San Jose, Bolivia	.....	.....	.....	.....	.....	.....	.....	314	.....	.....	314	52
San Jose, Costa Rica	.....	.....	.....	.....	.....	.....	.....	.....	14,502	.....	14,502	14
San Salvador, El Salvador	.....	.....	.....	.....	.....	.....	.....	.....	16,859	.....	16,859	11
Santa Cruz, Bolivia	.....	.....	.....	.....	.....	.....	.....	2,019	.....	.....	2,019	42
Santiago, Chile	.....	.....	.....	.....	.....	.....	.....	18,415	.....	.....	18,415	9
Sao Paulo, Brazil	.....	2,317	.....	.....	.....	.....	.....	.....	4,117	.....	6,434	25
Talara, Peru	.....	.....	.....	.....	.....	.....	.....	977	.....	.....	977	46
Tampico, Mexico	.....	.....	.....	.....	.....	.....	.....	.....	336	.....	336	51
Tegucigalpa, Honduras	.....	.....	.....	.....	.....	.....	.....	.....	5,121	.....	5,121	28
West End, Bahamas	.....	.....	.....	.....	.....	11,288	.....	.....	.....	.....	11,288	17
Totals	45,302	36,608	3,681	32,787	24,473	56,239	39,165	130,700	520,101	27,743	916,799	

Source: Civil Aeronautics Board Carriers Form 41

AIRLINE OBSERVER

► **American Airlines has abandoned hopes for short field modification on its current generation Convair 600 jet transports, first of which is scheduled for delivery early next year. The airline, while expecting the 600 to more than meet performance guarantees, had sought further improvements through such possible devices as boundary layer control (AW Jan. 25, p. 41). The jet probably would operate out of such airports as La Guardia Field and American had hoped for a greater margin in stalling speed and short field airport characteristics. However, the modifications appear impracticable at this stage of development of the airplane, which is expected to fly this spring.**

► Proposed plan to place air traffic controllers under a number of military-type regulations is making no headway. Federal Aviation Agency was under congressional instructions to submit a proposed plan to Congress by Jan. 1 but was unable to meet the deadline and requested a postponement which was granted. Purpose of the proposal was to permit closer integration of civil and military air traffic control activities and to ensure a strong and experienced cadre of controllers in the event of a national emergency. Original plan, which for example, would subject controllers to overseas assignment and require six months notice prior to resignation, has been watered down substantially but still faces a number of legal hurdles. Even the constitutionality of the plan has been challenged.

► **Trunkline available seat miles declined from 4.04 billion in January to 3.79 billion in February. However, the February total represented a 14.4% increase over the 3.31 billion available seat miles generated by the trunklines during February of 1959.**

► Aeroflot has finally begun nonstop proving flights between Moscow and Khabarovsk with four-turboprop Tu-114s. Russia's Tu-114s, which were originally slated to go into scheduled service last fall, are now scheduled for regular trans-Siberian service this spring.

► **Pilot's role in future supersonic jet transports may become that of a supervisor or monitor rather than a direct controller of vehicle's flight path and powerplant, with greatly increased use of avionics to perform routine functions automatically, FAA Administrator E. R. Quesada told a recent meeting of the Electronic Industries Assn. Although such automaticity will come in stages, the entire flight from takeoff to landing may ultimately be controlled automatically, Quesada predicted. This will challenge the industry to provide extremely reliable avionic equipment, he added.**

► Airline bomb hoax incidents totaled 16 in January, according to Sen. John Marshall Butler (R.-Md.). Between September, 1957, and December, 1959, reported bomb hoaxes directed against airlines amounted to 142. Sen. Butler has introduced legislation calling for a penalty against convicted bomb hoaxers of a $5,000 fine or five years in jail or both. Present penalty is $1,000 or one year in jail or both.

► **Export-Import Bank of Washington will finance the sale of four Douglas DC-8 turbojet transports to Alitalia. The seven-and-one-half-year loan of $13.7 million will be disbursed to Istituto Mobiliare Italiano for use by Alitalia to buy the airframes which will be powered by Rolls-Royce Conway bypass engines.**

► International Air Transport Assn. proposed resolution that no member airline shall honor credit cards for the sale of transportation other than a Universal Air Travel Plan card or member's credit card has been disapproved by the Civil Aeronautics Board on grounds that the resolution violates anti-trust laws. In proposing the resolution, supporting carriers argued that the additional costs of outside credit cards would be substantial, would not generate new traffic and would call for an increase in working capital and in the cost of financing airline operations. Board found that the resolutions "amount to boycott of outside credit plans."

► **Middle East Airlines has purchased a fleet of four de Havilland Comet 4C aircraft powered with Rolls-Royce Avon turbojet engines for delivery beginning late this year.**

SHORTLINES

► **Flying Tiger Line** has received all-cargo contracts from the Military Air Transport Service totaling $1,081,000 to fly 33 transatlantic and transpacific flights during March and April.

► **KLM Royal Dutch Airlines** is scheduled to begin transatlantic Douglas DC-8 turbojet transport service on Apr. 16, with one flight a week. On Apr. 27, the airline will start flying three weekly nonstop round trips from New York to Amsterdam and, on May 15, will increase the DC-8 service to a daily basis. By the end of the summer, KLM hopes to have 14 round trips per week on the Atlantic route. On July 13, the Dutch carrier will place DC-8s on its Amsterdam-Montreal-Houston route on a two round trips per week basis.

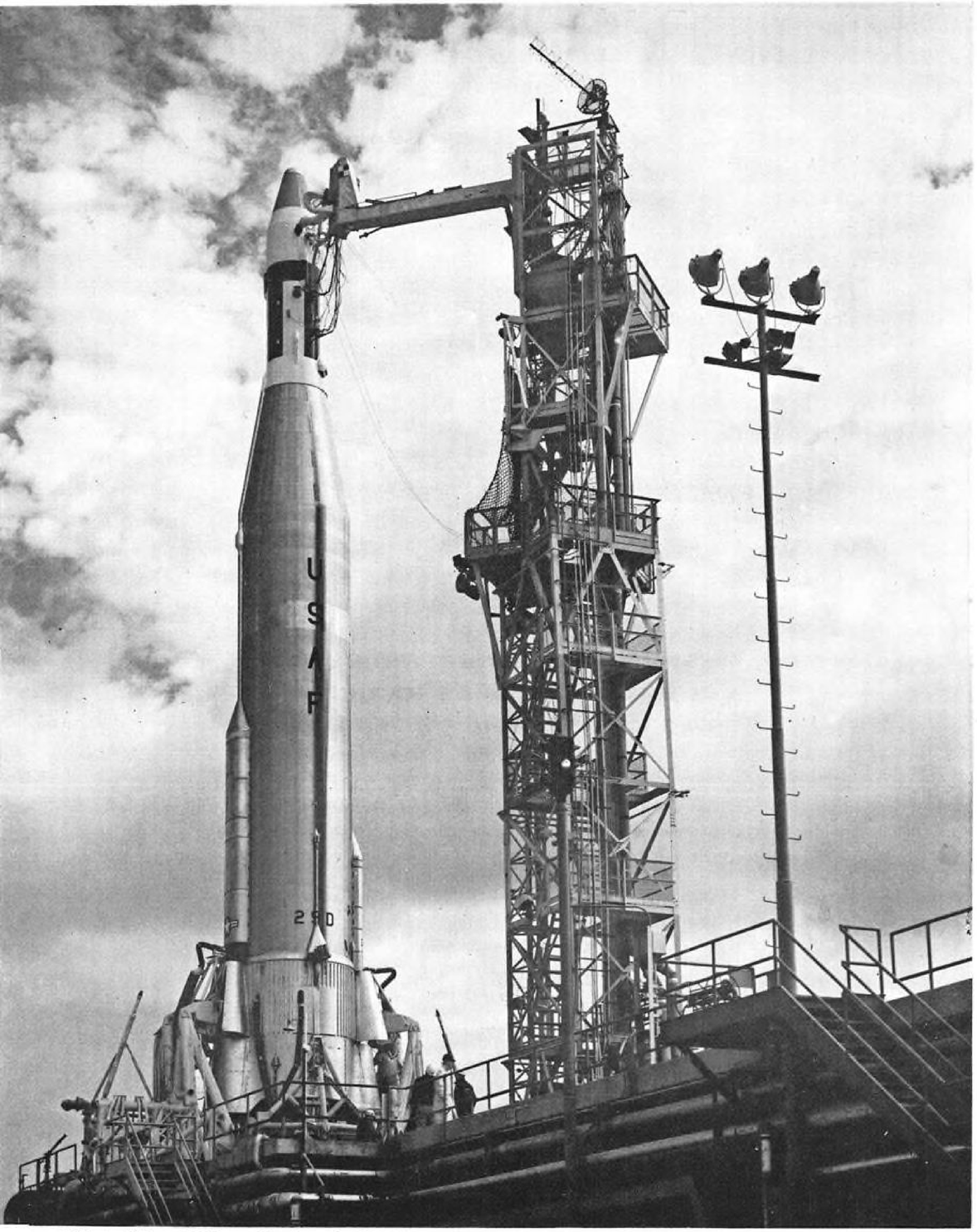
► **Lufthansa German Airlines** has been awarded an amended foreign air carrier permit by the Civil Aeronautics Board to serve San Francisco in addition to New York and Chicago. Flights originating in Germany and stopping in several European cities will fly the Atlantic, stop in three Canadian points and terminate in San Francisco.

► **National Airlines** was scheduled to resume daily Douglas DC-7B nonstop flights from New York to Havana following a two-month cutback because of a drop in vacationists desiring to go to Cuba. The carrier has been operating a reduced weekend schedule.

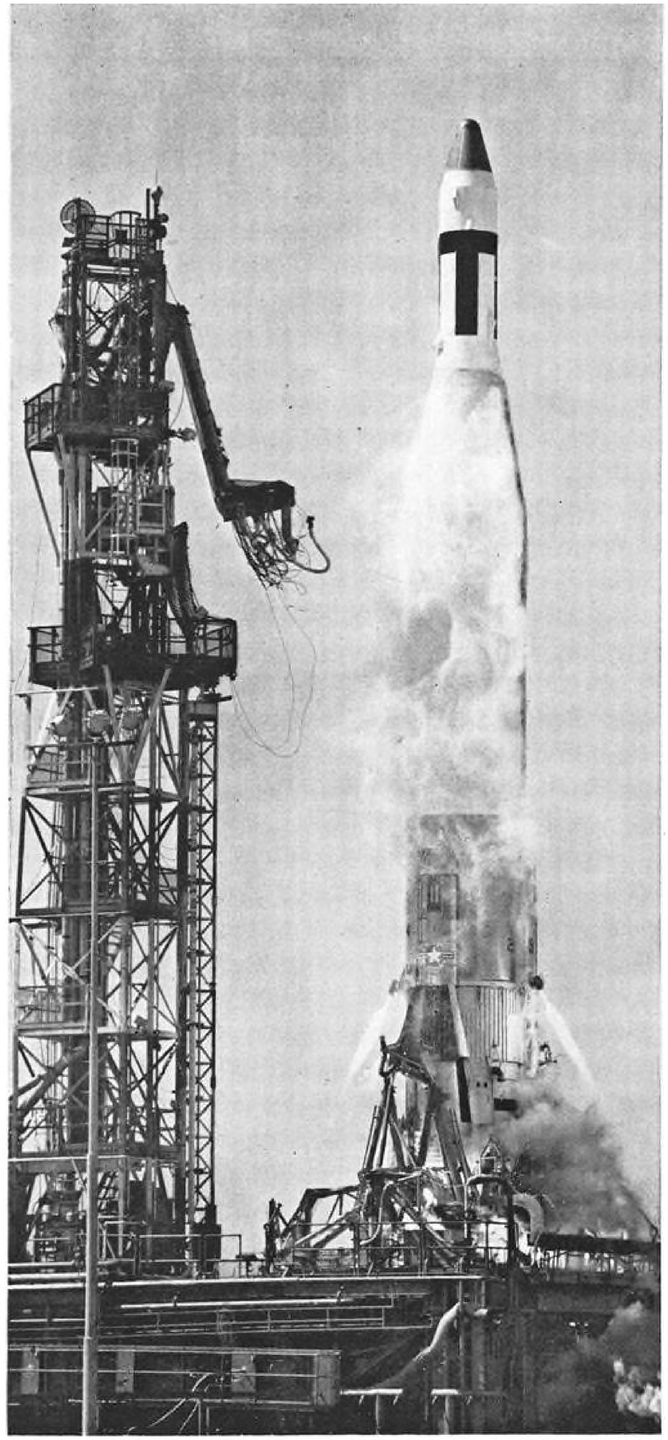
► **Pan American World Airways** will begin serving the new Brazilian capital of Brasilia on Apr. 3 on a two flights per week basis. Brasilia will be included on Pan American's New York, Caracas, Rio de Janeiro, Sao Paulo, Montevideo, Buenos Aires route. Initially, the airline will operate with Douglas DC-7B aircraft, adding turbojet equipment as soon as airport improvements can be made at Rio de Janeiro. Pan American, beginning June 1, will add Lisbon, Barcelona and Nice to its route from New York to Rome using turbojet equipment. There will be two flights per week until June 15, when the frequency is scheduled to be accelerated to three flights a week.

► **Southern Airways'** temporary mail rates for the period July 1 have been established by Civil Aeronautics Board through Nov. 30 at $1,180,922. For each calendar month after Dec. 1, 1959, the Board ordered that Southern be paid at a rate of 56.10 cents to be applied to the scheduled revenue miles flown during the month, or 13,500 mi. times the number of days in the month, whichever is lower.

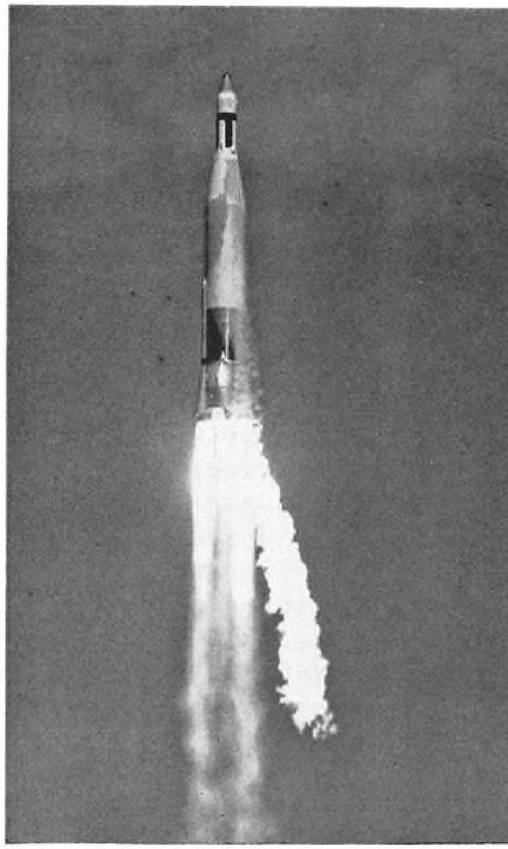
Atlas-Agena Vehicle Fails to Orbit Midas



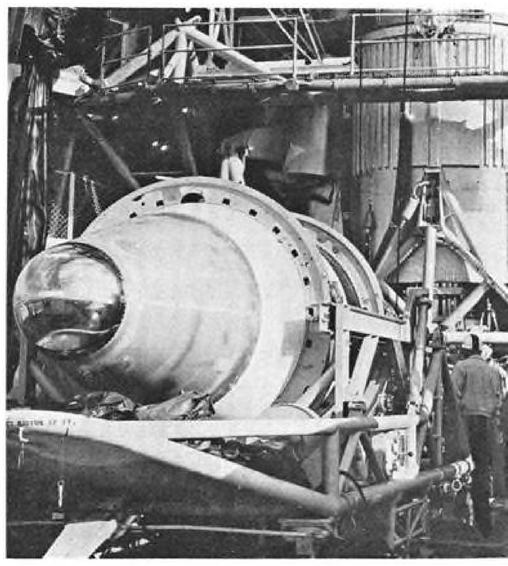
First test firing of Midas satellite shows Lockheed Agena stage mated to Convair Atlas for first time.



First Midas infrared early warning satellite launch late last month was unsuccessful. Agena stage has served as Discoverer satellite aboard Douglas Thor and will be used on both Thor and Atlas in space missions. Samos optical reconnaissance satellite system also uses Atlas plus Agena. Agena, powered by Bell Hustler engine, is earth-oriented in operational use. Prototypes of Midas infrared detection system have been flown in aircraft to test their ability to detect and monitor trajectory of test missile launches (AW Feb. 8, p. 23). Later firings of Midas may be shifted to Vandenberg AFB, Calif.



Failure of first attempt to put Midas in low orbit from USAF Missile Test Center, Fla., was believed to have been caused by malfunction in Atlas 29-D.



Space Research in Life Sciences—Part II:

Report Details Bioscience Plan for NASA

(Second of two installments in which Aviation Week *is publishing the National Aeronautics and Space Administration study that led to the creation of NASA's Office of Life Sciences begins below. It details the seven recommendations made in the report for establishment of such an office and how it should operate. The first installment was published in the* Mar. 21 *issue (p. 50).*

This office (Office of Life Sciences) should have the responsibility and authority for planning, organizing and operating the Life Sciences program of NASA, including intramural and extramural research, development and training. This office would also advise and consult with the other divisions of NASA and with the administrator in matters involving biology, medicine, and psychology. It should have the responsibility for safeguarding the welfare of human subjects and the public health as well as definite participation in those projects which might jeopardize satisfactory investigation of possible extraterrestrial life.

The Director of Life Sciences would be vested with the responsibility and authority of the Office of Life Sciences and should be responsible directly to the administrator of NASA in the same manner and at the same directional level as the other program directors. The caliber of the incumbent is obviously of fundamental importance. He should be a man of high scientific stature, an able administrator with demonstrated capability in the selection and direction of staff. It is probable that the director will be found among physicians who have had considerable experience in the basic medical sciences, although there are others who are not physicians who might have the requisite background.

The committee proposes that the Office be organized in four sections, each with an Assistant Director responsible to the Director of Life Sciences.

- **Section on Basic Biology.**
- **Section on Medical and Behavioral Sciences.**
- **Section on Applied Medicine and Biology.**

The substantive nature of the program of each of these three sections is indicated under the respective heading in Section III of this report, although considerable latitude in planning should be given to each assistant director.

- **Section on Extramural Program.**

This section should be responsible for the administration and in collaboration with the other assistant directors, and the Director of Life Sciences, the planning of the extramural program.

The Director of Life Sciences may desire an advisory committee made up of consultants outside the NASA, recommended by him and appointed by the administrator. Such a committee would normally report to the Director of Life Sciences or on occasion directly to the administrator of the NASA.

The assistant directors of the four Sections may well need advisory committees for their activities. These could be made up of NASA personnel plus outside consultants.

For a number of cogent reasons, an intramural program in the life sciences of significant size, diversity and excellence should be established by the NASA. It is urgent that this program be initiated without delay.

The present research effort in this field within NASA appears to be concentrated upon a single specific goal, exemplified by Project Mercury, at the possible expense of broader, more remote, but fundamental aims. It is important that the biomedical aspects of the Project Mercury be placed squarely under the jurisdiction of the Office of Life Sciences and that it be coordinated with other aspects of the Life Sciences program. The remainder of the national space biomedical effort, as found in military, industrial and academic laboratories, is sporadic and incidental to other primary interests or responsibilities. These efforts are, on the whole, of excellent quality and should be maintained and supported; there is need, however, in addition to these and coordinated with them, for a broad and thoughtfully planned biomedical program of research extending from the most fundamental aspects to their most practical applications. The nucleus of such a national undertaking should be the NASA intramural program in biology, medicine, and psychology.

The number of competent biological, medical and psychological scientists motivated toward space research and skilled in its special problems and techniques is, at present, seriously limited. It is necessary to create a number of career opportunities in these fields on a long-term, full-time basis and to increase the number of laboratories and facilities in which post-graduate training for such careers may be accomplished.

An important ingredient of a productive and creative research effort is the opportunity for interaction among scientists in all the relevant disciplines; between those whose interests are in the fundamental areas and those working in the applied aspects of the problem. The need for interaction has become essential in recent years as the result of the high degree of specialization which modern science and technology demands and the accelerating rate at which new knowledge is accumulating. The older formula for creativity which depended upon the accumulation by a single mind of all the information necessary to a new concept is becoming increasingly difficult to achieve; it may, partially at least, be replaced by the daily contact and collaboration among scientists within a single institute.

An active and distinguished research program in the biological, behavioral and medical sciences within NASA should provide an atmosphere of knowledge and responsibility in which the national effort in these fields can best be planned, administered and coordinated. It should be represented at the highest administrative levels within NASA and should participate in the planning and direction of the entire space program. Its members should be available for consultation and should be given appropriate responsibility and authority in all of NASA activities which involve biology, medicine or psychology.

To fulfill these objectives the committee recommends an intramural research program whose ultimate dimensions may be envisioned as follows:

- **A broad central facility** with laboratories ranging from the most basic biological, behavioral and medical disciplines through their highly applied aspects. A site at Goddard Space Flight Center at Greenbelt, Md., or adjacent to the National Institutes of Health (near Washington) recommend themselves, each for somewhat different reasons. The latter would offer the advantages of the unsurpassed facilities of the National Library of Medicine and of interaction with basic and clinical medical, behavioral and biological scientists at the National Institutes of Health, the adjacent Naval Medical Center, and the Walter Reed Army Medical Center and Armed Forces Institute of Pathology which are only a few miles away. All of these opportunities would make the NIH site especially advantageous and attractive to scientists in the medical, biomedical, and behavioral fields. The Greenbelt site, on the other hand, would offer active interfaces both with the space sciences and space technologies and also with the basic biological sciences represented in the laboratories of the Department of Agriculture. This site has a further advantage in the potential for expansion as a national space center which the greater congestion and the different orientation of the NIH could not make possible. Further plans regarding the facility should be the responsibility of the Director of Life Sciences and his staff who will make specific recommendations to the administrator.
- **A limited number of additional** facilities situated at some of the present or future NASA installations and possibly an institute at one or two universities. Each of these accessory groups would be somewhat differently oriented depending on the special functions and the variety of competences represented in their environs. Thus, an institute located at a university with an important biological tradition should be more heavily weighted toward basic astrobiology, while one situated where astronomy and physics were emphasized should reflect an orientation toward astrophysics. The groups to be incorporated into NASA installations, on the other hand, should be primarily representative of the technological and engineering aspects of biology and medicine. They would thus be in a position to utilize the unique facilities of these installations in the furtherance of astronautical research and, conversely, this would ensure that engineering development of space vehicles would be carried out with due regard for the requirements of future occupants.

The committee is reluctant to stipulate the dimensions which these facilities should attain or to indicate more precisely their scientific complexion. It would suggest, however, that the directors would give prior

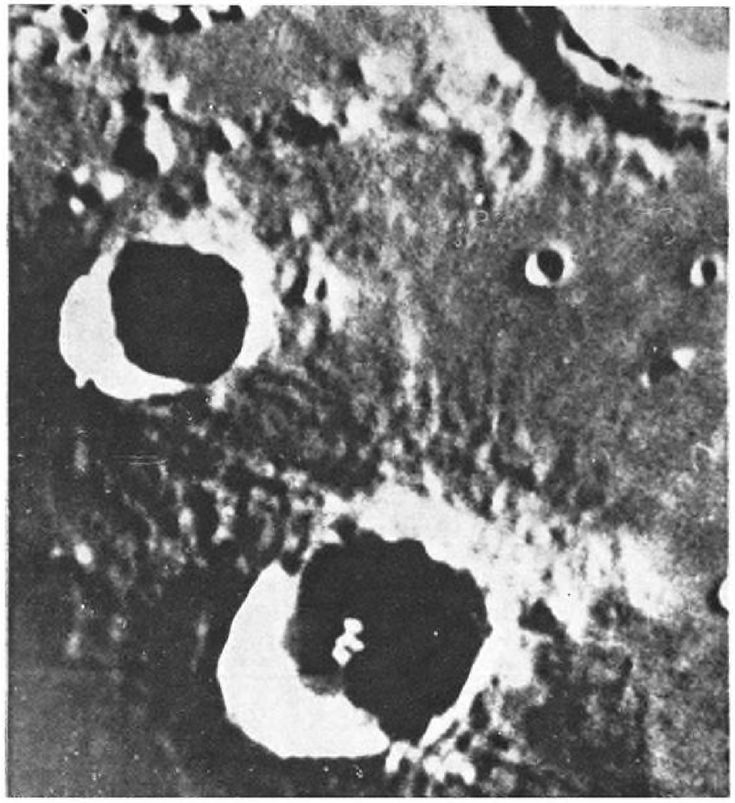
consideration to high quality rather than quantity, realizing that excellence is not necessarily proportionate to size.

It would emphasize, however, that at least some of the peripheral units, as well as each of the three units of the central facility, be planned in terms of a minimum critical mass, defined as an adequate variety of disciplines and number of professional personnel and their necessary supporting staff and physical facilities to constitute a self-sufficient, mutually interacting and sustaining unit.

It is of some interest that the varied experience of the committee members converged on an estimate of 20 scientists and 30 to 35 supporting personnel as constituting such an minimal staff. An annual budget of $800,000, exclusive of permanent equipment but including overhead or reimbursement, would probably be required to support such a minimum unit, and a facility of 30,000 sq. ft., over-all, to house it, based upon acceptable standards of biomedical research in other fields. This would indicate therefore an annual budget for the central facility of the order of $2.4 million and a total of 90,000 sq. ft.

Even where the program of a unit were oriented to one or another aspect of the field as would be the case in the accessory laboratories, the scientific staff should be representative of numerous disciplines, basic as well as applied.

The rate of growth toward an intramural program of the scope outlined above will perforce be limited by the total budget and the competitive needs of the parent agency. More important, perhaps, may be the limitation, self-imposed by the program's directors in recognition of the paucity of adequately trained personnel and the other



Air Force Studies Moon's Surface

Air Force has completed two moon studies which used photographic techniques to improve lunar surface data and provide new data for lunar mapping. In one project, 280 of the best photographs available from Mt. Wilson, Lick, McDonald and Yerkes observatories in the U. S. and Pic du Midi Observatory in France were studied to develop improved technical data on lunar surface features. Results of the study are available for government use, and the University of Chicago is publishing a commercial edition. Second project involved a contract with the University of Manchester, England, to photograph specific areas of the lunar surface during sunrise and sunset on the moon. With this technique, and using a variation of the microdensitometer, relative heights of lunar prominences can be obtained with improved accuracy, and the data can be used in drawing lunar charts. This photo, made from the Pic du Midi Observatory, shows the craters of Autolycus (top) and Aristillus (bottom). White area in center of Aristillus is sunlight reflecting off the top of a mountain inside the crater. Autolycus is about 40 mi. in diameter.

For the eyes of the Pentomic Army

Advanced Honeywell will guide high-performance Miniature Inertial System surveillance drones

Smallest, lightest unaided inertial system will direct complex flight path over enemy territory for scanning, mapping and pinpointing targets, and return drones to recovery area.

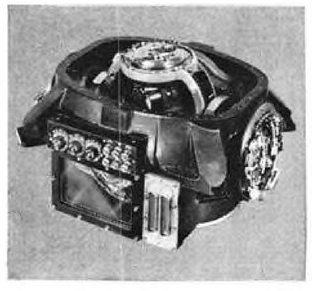
The new theories and techniques of warfare call for missions that can be carried out only by combat surveillance drones that are increasingly sophisticated and recoverable for use again and again.

Under the guidance of the U. S. Army Signal Corps, Honeywell is providing for the newest of these unmanned aircraft the most advanced, versatile and accurate *miniature* inertial guidance system yet developed. The system enables programming to provide surveillance over several areas during each flight, and safe return of the drone to the recovery area.

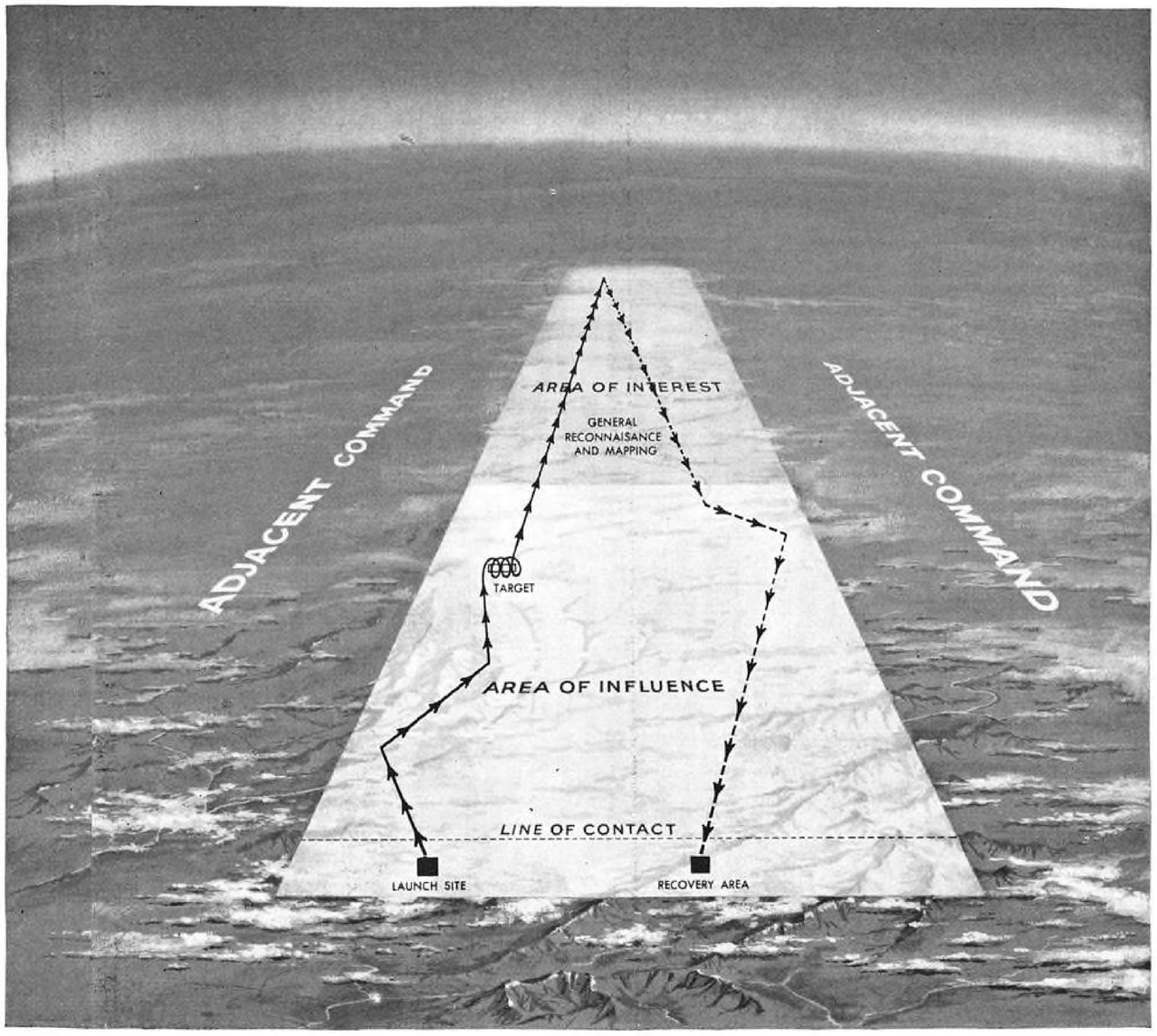
Although missions include reconnaissance and mapping, the most important is target pinpointing. Here it is necessary that the inertial system of the drone be extremely precise, since the target-position information the drone gathers is utilized by the inertially-guided ballistic missile which is fired on the target. Honeywell achieves such precise performance characteristics through the use of an advanced miniature integrating gyro and pulse-torqued accelerometer.

Both vehicles—the AN/USD-5 (Fairchild Engine and Airplane Company) and the AN/USD-4 (Republic Aviation Corporation)—will accomplish separate missions using virtually the same Honeywell inertial guidance equipment. The heart of this system was designed for adaptability to other navigation and stabilization requirements for Army surveillance, as well as to other inertial applications that include developments for the Centaur Space Probe and the Bomarc Interceptor Missile.

Honeywell's program management approach and experience in development and production of similar equipment on several programs results in precise miniature inertial systems for less cost than is customary in the industry. For additional information on Honeywell's background in inertial guidance and navigation, write to Honeywell, Minneapolis 8, Minnesota.



Inertial platform, heart of the inertial guidance system. This platform is the inertial reference and utilizes a highly precise GG8001 Honeywell gyroscope and GG116 pulse-torqued accelerometer.



Flight path programmed for a typical advanced-drone mission is shown in this diagram. The Honeywell miniature inertial guidance system will direct the aircraft from launch to target and beyond, and back to recovery area without ground commands.

Honeywell

Military Products Group

national needs for such individuals, including the needs by the military departments for national defense and security and the needs of academic and other institutions for teaching and research.

The committee recommends, therefore, that the development of the intramural program be deliberate and gradual with cooperative utilization of presently available manpower and facilities which are outside of NASA and their judicious duplication or replacement by the intramural NASA program as those facilities become obsolete or overutilized and as the total resource of competent and motivated scientists is augmented by a training program which NASA itself will substantially support.

The immediate and most pressing need of the program is the appointment of a Director of Life Sciences and, on his recommendation, the assistant directors. It should be the responsibility of the director and his assistant directors, in consultation with an Adivsory Council, should one be appointed, to plan a national program for NASA in the Life Sciences, to determine its complexion, establish its philosophy, recruit its senior personnel, and guide its development.

The committee recommends that the Director of Life Sciences and his staff in their initial planning select those segments of the national program which are currently being carried out by existing facilities in the military services, in universities and research institutes, and by industry, or which certain of these facilities are capable of carrying out in the immediate future. By appropriate contracts, transfer of funds, construction grants or other mechanisms of support, participation of these existing facilities in a coordinated national program should be invited and made feasible.

At a very early date, the Director of Life Sciences and his staff should begin the planning, construction and organization of the central and certain of the auxiliary facilities, concentrating on those areas of basic and applied science not adequately provided for in existing programs.

As major physical facilities utilized by the NASA biomedical program on a cooperative basis and of primary concern to that program (i.e. centrifuge and controlled and environmental chambers) become obsolete or overutilized, or as completely new designs become necessary and feasible, these may be constructed by NASA within its intramural program and maintained as national and international facilities. This should not prevent the construction of similar facilities by other agencies where necessary to the execution of their respective responsibilities. Present cooperative arrangements are a fitting precedent for the continuance of the concept that these expensive facilities should be shared wherever possible both in cost and usage, but that the initiative and responsibility for the construction of any one of them should lie with the agency which has the greatest need.

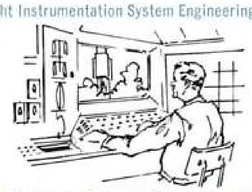
Investigations in extraterrestrial biology and resolution of problems related to manned space flight provide an area for research and development necessitating many diversified contributions. An optimum rate of achievement will require further cooperation with other government agencies. Important contributions are expected to come from scientists working in universities, research institutes, and industry. Thus a strong extramural program is an essential aspect of the activities of NASA in the Life Sciences: (1) to mobilize the relevant research talent; (2) to obtain ideas, information and participation essential to the activities of NASA from the best qualified available sources; (3) to generate among the scientific and industrial communities

Mercury Capsule Abort System Tested in Drop

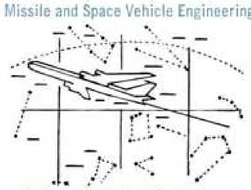
U. S. Marine Corps Sikorsky HR2S-1 helicopter lifts a Project Mercury capsule for one of a series of abort test drops from 2,500 ft. over the Salton Sea (AW Feb. 15, p. 52).

Research and Development Engineering

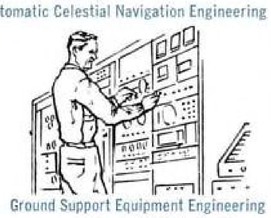
Flight Instrumentation System Engineering



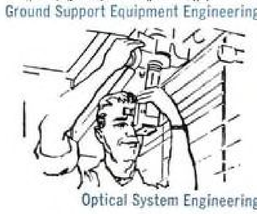
Missile and Space Vehicle Engineering



Automatic Celestial Navigation Engineering



Ground Support Equipment Engineering



Optical System Engineering

STAR TRACK FOR A HOUND DOG

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Helping to launch the deadly air-to-ground Hound Dog missile represents one of the many exciting new areas in which you'll find advanced Kollsman engineering talent assuming a leading and critical role.

This calls for the precision Kollsman Astro Compass to help guide the B-52 mother ship and for the Kollsman Star Tracker to help launch the Hound Dog missile accurately.

Working with Autonetics, a division of North American Aviation, Kollsman once again has demonstrated its engineering capabilities in the optical, mechanical, electromechanical, and electronic sciences.

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an awareness of the activities of NASA and to secure support of its programs.

NASA should set up a system of research grants for individual scientists or groups of scientists working in universities or non-profit research institutes based on original research proposals and with appropriate means for their review and approval. Such grants should be for the support of basic or applied research in areas of interest to NASA. These areas of its interest should be broadly interpreted. Proposals from well qualified interdisciplinary groups should be encouraged.

Enter Into Contracts

We believe that the NASA should enter into contracts with industrial corporations and governmental agencies for specific research needs, particularly in the field of technology but also in fundamental research. Such research contracts are particularly favorable for the solution of short-term problems which might be inefficiently studied in an intramural program and which might require the hiring of specialized scientists or the building of particular equipment that would have no long-term value to the agency.

The committee strongly recommends that the grant program and perhaps research contracts should be initiated so that money is available to the recipients at the earliest practicable date. The initiation of this program need not await the setting up of the permanent organization of the Life Sciences. The NASA may be able to borrow an experienced official from the United States Public Health Service, the Office of Naval Research, or the National Science Foundation to get this program under way. Alternately, the NASA could delegate the approval of such grants to the National Research Council-National Academy of Sciences. The sort of study section mechanism used by the United States Public Health Service could serve as an excellent model.

The effort to put living animals and men into space and to maintain them there for considerable periods of time requires the development of many new techniques for protection from unfamiliar stresses. The nature of these stresses is reviewed elsewhere in this report. Study of the physical, chemical, biological, and psychological stresses of space flight requires an extensive array of apparatus and a large staff of trained scientists and technicians. Additional facilities and close liaison with the physical scientists and engineers engaged in vehicle research and development are essential to provide proper life support systems and protection for the passengers in this new form of transportation.

Existing Capability

The existing capability for studies of this character is found almost entirely in the military services. Except for a few aircraft companies, civilian agencies have had little need to develop studies on high altitude, high speed flight, and NASA itself has so far concentrated almost entirely on the physical and engineering aspects of flight problems.

The military medical services on the other hand have been continuously engaged since the First World War in developing facilities and personnel for aeromedical studies. No attempt will be made here to draw up a list of the facilities now available. It is only necessary to note that taken together, these installations provide a variety and quantity of controlled environment chambers, centrifuges, acceleration tracks, and other relevant apparatus which may not be equalled anywhere else in the world.

Especially Impressed

The committee was most especially impressed with the quality of the personnel available for work in these laboratories and their enthusiastic dedication to the job. It is difficult to measure the existing capability in terms of money but the investment in men and machines must represent at least $80,000,000 and perhaps a good deal more. More important is the time which would be required to build similar installations or train comparable personnel for use elsewhere.

It appears that the military capability in aeromedicine is, at present, not fully utilized. The reasons for this are somewhat complicated and require at least brief exposition. In the first place many of the biomedical problems of conventional high altitude flight are now reasonably well solved. Furthermore, the military requirement for conventional aircraft is increasingly uncertain. Fewer such vehicles are planned for the future and there appears to be a declining need for the use of existing aeromedical facilities for the training and indoctrination of conventional points. Current military plans emphasize the use of unmanned ballistic missiles. Although certain forward-looking elements at various points in the military establishment foresee a tactical need for manned vehicles in space, such weapons systems do not form a major part of current operational plans. The military budgets for aeromedical research are not therefore defended at present on the basis of a clearly defined existing military objective or requirement. They depend for the most part on the declining momentum of the conventional aircraft program, and the existence of a few experimental projects of which the X-15 and Dyna-Soar vehicle series are examples. For completeness, it may be noted also, that understanding of aerospace medicine benefits indirectly by research funded for other reasons. For example, work on hot, noisy environments desired by the the tank corps may help in understanding some of the biological problems involved in satellite launchings; closed ecological systems under development for use in submarines may be adapted to space vehicles; and so on.

Selecting Astronauts

Somewhat paradoxically, NASA, which does have a clearly defined mission to put and maintain men in space, has essentially no existing capability for studying the biological and medical problems involved. Faced with the necessity for selecting a group of astronauts for Project Mercury and providing for their safety during this series of missions, the agency turned for assistance to the military services. The services, in turn, have responded with enthusiasm and good will to this new challenge. In spite of the apparent success of the arrangement, the fact remains that authority for ensuring the health, safety, and effective functioning of the astronauts is not firmly in the hands of the agency responsible for the success of the project as a whole. The medical personnel were not

Space Biology Computer

Brooks AFB, San Antonio, Tex.—A $100,000 Pace analog computer has been delivered to the USAF School of Aviation Medicine here to assist in basic and advanced aerospace medical research.

The specially designed machine will be utilized in simulating factors of stress situations. The computer would permit study of a human's reactions, saving costly time-consuming laboratory trial and error.

It is also expected to be helpful as a diagnostic aid.

The computer was built by Electronic Associates, Inc., Long Beach, Calif.

selected by the NASA but by representatives of the military services which provided them on a loan basis for this particular task. Their continued presence in the project is as much a matter of continuing good will as it is a clear contractual agreement, and the individuals themselves must of necessity feel a primary loyalty to the services in which they have elected to develop their entire careers.

The establishment of an Office of Life Sciences in NASA will greatly improve its capability for discharging its biomedical responsibilities. Even though the agency will probably wish to continue to draw on many other sources for help in solving its biological problems, the presence of at least a small staff of highly qualified biologists and medical men is essential for the formulation of over-all policy, the direction of research and operations within the NASA, and the negotiation of satisfactory working agreements with other government agencies and the military services.

For the next few years, and possibly indefinitely, the NASA will need to rely heavily on the military services for help in the technology or applied aspects of aeromedicine. For reasons outlined above, the military services presently appear to possess a capability in excess of their own need and are anxious to cooperate in every possible way. The committee was impressed by the ease with which NASA has arranged cooperative research between individual and small groups of workers in the military laboratories. It is apparent that personnel may be lent from one agency to another, apparatus may be transferred or time made available at military installations with a minimum of administrative difficulty so long as the scale of the operation is kept reasonably small.

All those who provided information for the committee were unanimous on this point.

The situation is far more dubious with respect to large or long-continued programs involving extensive transfer of personnel, facilities, or funds. Complex contracts of this character would doubtless have to be channeled to rather high levels in the Department of Defense with noncommittant delays and uncertainties. A more serious question involves the over-all government policy in relation to the budget. To what extent will or should the Bureau of the Budget or the Congress permit the transfer of segments of the NASA budget to other agencies for the execution of NASA directed and supervised objectives? To put the question another way, how far can the military services go in justifying the salaries and allowances of military personnel a substantial part of whose time is spent on civilian missions.

Another difficulty arises from the fact that the apparent excess of space medical capability now available in military establishments may be temporary. How far the present cordial cooperativeness of military personnel is dependent on this temporary excess is difficult to determine, but the possibility cannot be ignored. The present situation is at best an unstable one. Either of two things may happen. The military decision to rely heavily on unmanned ballistic or guided vehicles may become more firmly established. This will lead to a further decline in military requirements for aeromedicine with noncommittant budget cuts for the support of aeromedical installations. Conversely, and in the opinion of the committee more probable, present skepticism in regard to the utility of manned military vehicles will gradually disappear and the services will be provided with increased funds for research in space medicine. In either case, the excess military capability now available to NASA is likely to decline if not completely disappear.

Recommendations

Faced by these considerations the committee makes the following recommendations:

• **The Applied Medicine** and Biology Section of the proposed Office of the Life Sciences should, in the immediate future, make the fullest possible use of the excellent facilities and personnel for biomedical research now available in the military services. The exact mechanisms for this cooperation must be worked out in the large part by the administrator, the Director of the Life Sciences, and his staff together with the proposed Section on Extramural Research. In many cases, the necessary arrangements can be based on informal agreements to assign personnel or make facilities available. In others, formal contracts guaranteeing definite sums of money over stated periods of time will be necessary. In order to facilitate the negotiating of such arrangements, additional liaison machinery should be set up between the Department of Defense and NASA in the Life Sciences. This might well be a committee composed of the directors of bioastronautics of the Air Force and Navy, the Director of the Office of Life Sciences, and the assistant director for the Applied Medicine and Biology Programs of NASA. This committee should be empowered by general directives from the Department of Defense and NASA to work out contractual and other arrangements for the conduct of research and development in aerospace medicine.

A Civilian-Military Liaison Committee is in existence to arrange for cooperative interagency undertakings. It is felt, however, that astro-medical matters involve quite different considerations from those regularly dealt with by the Civilian Military Liaison Committee. The amounts of money involved are much smaller and other factors in the situation are such as to make it unlikely that the human problems of space flight will get the attention their importance merits unless they are dealt with by a specially constituted group.

• **As soon as possible** the NASA Applied Medicine and Biology Section should develop an in-house capability for research and development as part of the intramural program recommended in this report.

The exact extent of in-house capability cannot be foreseen at this time. In view of the uncertain availability of military facilities in which much of the immediate research program must be developed, it seems wise to recommend that the long-term program include facilities for the study of every aspect of bioastronautics except those which involve heavy expenditures for special items of equipment.

• **The provision of adequate access** to large and expensive apparatus raises special problems. At the present time, the most notable example is the human centrifuge for simulating space flight problems at Johnsville. In most instances, one such installation should be enough to serve the national interest, if proper arrangements are made in advance for its construction and utilization. The present practice is that one or another of the services develops a given installation to meet its own needs and then invites or allows the other services to use it on the basis of ad hoc agreements. The committee wishes to recommend that in the future such facilities be planned and operated on an explicit NASA-interservice basis. Various administrative patterns may be thought of to achieve this end. In some cases the facility might be set up as an independent authority with its own budget to provide research service to other government agencies much as the Bureau of Standards does now. In other instances the facility could be held and operated by a NASA-interservice committee with a budget provided by one or more of these services represented on the committee. This pattern has worked well for the Armed Forces Institute of Pathology.

In common with every agency of government and industry which utilizes and depends upon scientific and technical specialists, NASA has a stake and responsibility in the education and training of such men and in the continued supply of scientific manpower generally. An agency which attempts completely to fulfill its responsibilities in this area may recognize a dual nature in these responsibilities. It is, of course, necessary to create and maintain a cadre of scientists properly equipped with the specialized knowledge, skills, motivation, and philosophy which are required for the particular mission, but it is also important that this be done without depletion of other important activities which include: national defense, health, aviation medicine, and the basic biological, medical, and behavioral disciplines upon which these areas depend.

Training Program

The committee recommends that NASA take immediate steps to initiate a diversified program of training and the support of training administered by the Office of Life Sciences through the Section on Extramural Activities and that in the planning of such a program attention be given to the following types of activities:

• **Post-graduate fellowships** or traineeships at NASA installations, at space biology institutes, or in certain laboratories of the armed forces, the United States Public Health Service and other governmental operations, or at appropriate departments in universities here and abroad for individuals, including members of NASA staff, foreign scientists and others, who have chosen a career in astrobiology, space medicine, or immediately related fields.

• **Training grants** to appropriate institutes or university departments to support existing teaching activities or initiate new ones in areas of general or special relevance to the NASA Life Sciences Division.

• **Short-term visiting scientist** appointments (from two months to two years) to permit qualified scientists from this country and abroad to utilize certain of the special

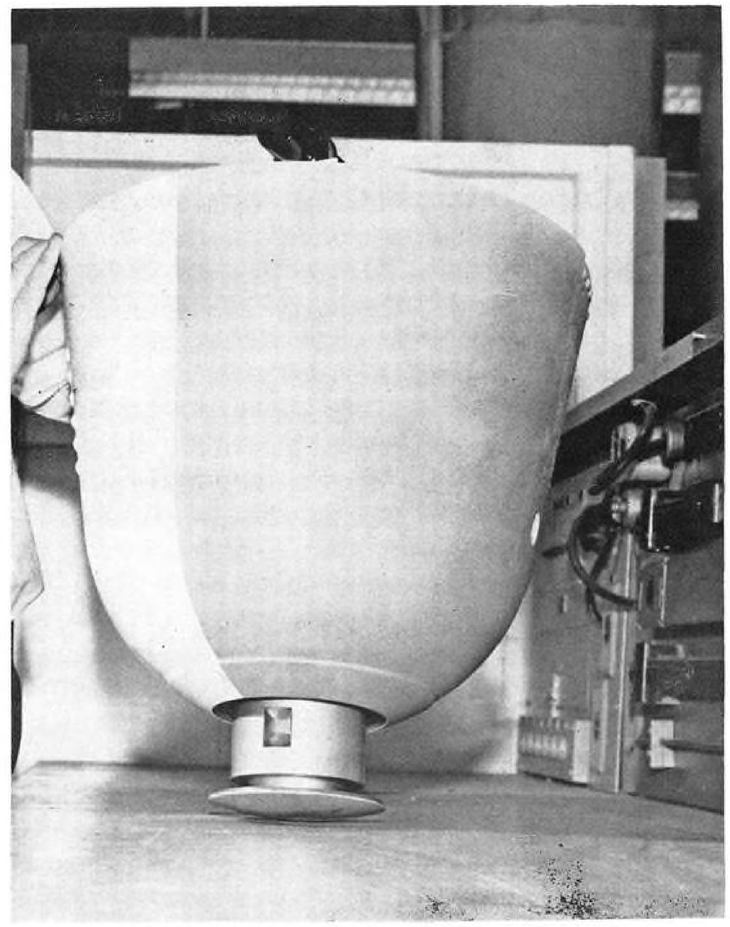
facilties of NASA or the armed forces in research of relevance to the Life Sciences program.

The committee, in common with scientists generally, believes that the primary purpose of science, which is to increase man's understanding of the universe, is best fulfilled by free exchange of scientific findings, information, and criticism among all scientists. The Congress, in establishing this agency, declared "that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind." To this end, the committee recommends that NASA give serious thought to those mechanisms and guarantees which will facilitate free scientific interchange with respect to the Life Sciences program. Among those which the committee has considered and which it supports are the following:

- **Judicious use of travel funds** to permit the exchange of information between individual scientists, or among scientists at national or international meetings and symposia without arbitrary restrictions but guided by the value of such interchange to the advancement of knowledge.
- **The sponsorship by NASA** of bulletins, journals, and of conferences, meetings and symposia on topics or in fields where such media or opportunities for exchange of information would be of value.
- **The establishment of a policy** of the free reporting of all scientific information obtained in the Life Sciences through the extramural or intramural operations of NASA in the open scientific literature. Security regulations with respect to personnel or publication and in the areas of grants, contracts and fellowships must be exercised with great caution and limited to those specific projects where a direct relationship to national security can be clearly demonstrated.

Although much basic research related to problems of space can be conducted in appropriate facilities on earth, it is apparent that many observations must be made in space vehicles. The study of the effect of weightlessness is an obvious example; spectographic analysis of the surface of the planets from platforms high above the disturbing influences of the earth's atmosphere is another. For some time to come, the space available for scientific instruments in space vehicles is likely to be strictly limited. At the present time almost all such space and bandwidths available for telemetry are being absorbed by the equipment necessary to monitor the function of the vehicle itself or to make limited physical observations of its immediate environment. Prospective improvement of propulsion systems will soon provide more commodious vehicles, but for years to come the supply of facilities is likely to be far less than the demand. Proper allocation of such space facilities will be very difficult to arrange and certainly cannot much longer be left solely to the good will of those responsible for the design and operation of launching equipment, or to random excitement as to who can inject the largest mammal into orbit.

Attention may be drawn to the fact that at present two great powers between them enjoy a monopoly in operations in space. Although this list may be expanded somewhat in years to come, the extensive resources needed to support such missions make it likely that they can be carried out only by the very largest nations. It is a tradition of long standing in the United States that a monopoly position carries with it the obligation to conduct affairs with due regard to the public interest. In the present instance the monopoly is essentially worldwide, since it includes the control not only of the vehicles themselves but of the most suitable launching sites throughout the world. It follows that these facilities should be administered so far as it is possible in the public interest of the world at large. The committee is heartened by the provisions which the NASA has made towards greater international cooperation. As man stands before the moment when at last he may break the bonds which have chained him to a single planet, it seems fitting and proper to ensure that all mankind, and not two nations alone, should have the opportunity to meet this momentous challenge.



Space Radiation Package Tested in Drop

Nuclear emulsion recovery vehicle (NERV) for testing space radiation (AW Nov. 9, p. 70) was successfully tested in a high altitude drop from a USAF Lockheed F-104 jet fighter. Package weighed 75 lb. and was developed by GE's Missile and Space Vehicle Department. NERV will be launched by NASA's Argo D-8 research rocket to 1,800 mi. height.

Lockheed Satellite Contracts Negotiated

Los Angeles—Contracts totaling $273 million for work on Discoverer, Midas and Samos satellites have been negotiated by Air Force with Lockheed Aircraft Corp.'s Missile and Space Division. This brings Lockheed's contracting total for these programs to more than $500 million.

Breakdown for the new figure is $56 million for the Discoverer development satellite, $60 million for the Midas infrared warning satellite and $157 million for the Samos optical surveillance satellite. The contracts, to be signed soon, were preceded by letter contracts.

Lockheed said it expects a slight increase in employment as a result of the new contracts.

AVIONICS

CRYO ELECTRONIC DEVICE	ORGANIZATION	AERONUTRONIC	AFCRC	AIRBORNE INSTRUMENTS LAB.	AMER. BOSCH ARMA	ARTHUR LITTLE	AUTONETICS	BELL TELEPHONE LABS.	BURROUGHS	CARNEGIE TECH.	CONVAIR	GENERAL ELECTRIC	HUGHES AIRCRAFT	IBM	JET PROPULSION LAB.	KEARFOTT	LINCOLN LAB.	LOUISIANA STATE	MARTIN	MIT	MINNEAPOLIS-HONEYWELL	NAT'L BUREAU STAN.	NAT'L PHYS. LAB.	NEW YORK U.	OHIO STATE	PURDUE	RCA	RADC	SPACE TECH. LAB.	SPERRY GYROSCOPE	TEXAS INSTRUMENT	USASRDL	U S NAVAL SCHOOL	U. OF MICHIGAN	WESTINGHOUSE	WADD
ACCELEROMETERS												R			R & D																					
AMPLIFIERS										R		R & D	R & D	R					R					R						R & D						
AMPLIFIERS (VARACTOR)								R & D																												R
ANTENNAS																			R																	
BOLOMETERS						R													D																	
COMPUTING ELEMENTS	R & D										R						R & D			R				R												
COMPUTING ELEMENTS (SUPERCONDUCTING)						R & D	R		R			R & D		R & D					D	R			R & D	R		R	R & D		R & D	R & D	R & D			R		R
GYROSCOPES					R		R					R & D			R	R & D			R		R						R	D		R & D	R					R
IR DETECTORS													R, P																						R	R
MAGNETS/OR TRANSFORMERS				R & D								R & D	R	R & D	R			D	D	R		R														
MASERS		R	R & D				R	R & D		R			R	R	D		R & D			R					R		R		R				R & D		R	R & D	
MICROWAVE SWITCHES													R & D															R								
MIXERS										R'			R & D																							
OSCILLATORS												R & D	R & D	R								R		R					R & D	R & D						

R = RESEARCH D = DEVELOPMENT P = PRODUCTION

CRYOGENIC ELECTRONIC COMPONENTS and devices in varying stages of research, development or production at the indicated laboratories in this country and abroad are expected to have wide airborne and space applications.

Space Spurs Cryogenic Avionic Research

By Barry Miller

New York—Cryogenic electronics, an infant technology of electronic devices and equipments operating at very low temperatures, appears likely to play an important role in aircraft and space vehicle navigation, detection and communication systems, a recent AVIATION WEEK survey of 44 avionic firms and research laboratories indicates.

A primary interest in cryogenic avionic devices and equipments stems from their potentially small size, light weight, low power consumption, high reliability and extreme accuracy.

Space Applications

Initially these advantages are expected to be exploited in airborne projects and a restricted number of space applications. Further in the future is the promise of extended space applications for cryogenic equipment using natural and designed space environments.

A few of the immediately more attractive applications which are now feasible and will become more interesting as device development progresses are:

• **Long range radar** and communications—Aircraft can carry highly-sensitive and therefore long-range radar and communication equipment using supercooled Masers and parametric amplifiers and can employ liquid helium refueling for cryogenic devices between short missions.

• **Inertial systems**—Navigation and guidance systems with cryogenic gyroscopes (AW Feb. 1, p. 72), accelerometers and perhaps at some future time guidance computers also may be appropriate for short-life guided missiles and/or ballistic missile submarines.

• **Infrared**—Aircraft and satellite infrared reconnaissance and fire control systems using detectors cooled to liquid nitrogen (77.3K at atmospheric pressure) and eventually liquid helium (4.2K at atmospheric pressure) temperatures are among the first applications. Radiation-sensitive superconducting bolometers may also be applied here. Other infrared systems including missile guidance and ballistic missile defense systems can also tie in with cryogenics.

• **Magnetometers**—Airborne anti-submarine warfare patrols equipped with superconducting magnetometers as magnetic anomaly detectors are another promising application.

Ultimate Developments

Ultimately complete cryogenic systems with sensitivities almost unique among avionic equipments will evolve, according to several firms and military sources questioned by AVIATION WEEK.

The cryogenic research programs of a few companies, and the thinking of a number of others, are already pointed in this direction. Cryogenic electronic research at the Martin Co., for example, is directed toward developing superconductive components and circuitry needed for complete cryogenic systems. All-cryogenic systems of interest to Martin and others, include inertial guidance using superconducting gyros, cryogenic sensing and processing circuitry, and meteor avoidance radar receivers with several parallel digitalized trajectory computers. An all-cryogenic inertial system, according to one proponent of such systems, might halve the size of any inertial system presently known.

Cryogenic Electronics

But for the present cryogenic electronics is still in its infancy. It constitutes primarily a broad research and development effort, involving an annual investment of over $5.5 million at 24 of the 44 questioned firms alone. This research and development must progress, many engineers feel, before all-cryogenic avionic systems are realized. Much more must be learned about superconductivity and superconductive materials, about the behavior of semiconductors and paramagnetic materials at cryogenic temperatures, and about fabrication techniques, these engineers argue.

There is also some feeling among scientists working in cryogenics, although it is a minority opinion, that swift development of tunnel diodes has dampened both interest in and need for cryogenic computer components. Should the tunnel diode win wide acceptance and be produced as cheaply as some predict, this reasoning continues, cryogenic components will find only limited applications in computers. This could in turn be reflected as a general slowdown in interest and development of other cryogenic equipments.

Regardless of the pace and extent of cryogenic electronic developments, it is likely that cryogenic devices will be introduced in steps before the all-cryogenic system becomes practical, just as semiconductor devices were before the advent of completely transistorized systems. The cryogenic gyro, a key device now in research and early development at many laboratories, will have to prove practical and comparable to other exotic low-drift gyros as a typical initial step in this progression.

One obstacle which threatens to block widespread use of cryogenic avionic equipment is the need for lightweight, compact and reliable helium liquefiers. Most cryogenic devices (superconductive) can operate only at liquid helium temperatures or operate most effectively at these temperatures. For operation at higher temperatures (liquid nitrogen) to which infrared equipment is cooled, the problem is essentially solved, in principle, with closed-cycle nitrogen cryostats and with nitrogen cryostats which use the atmosphere for their supply, engineers at Rome Air Development Center point out.

An airborne helium refrigerator is another matter, however. A device needed to continuously cool a cubic foot of cryotron circuitry dissipating one watt from an ambient of 50C, would measure 15 in. in diameter, 48 in. in length, would weigh 100 lb. and its 6-cu.-ft., 5-hp. compressor would add 300 lb. more, according to a manufacturer of liquefiers.

Nevertheless there are a number of applications in which this difficulty can be sidestepped. Aircraft flying on short missions could refill their helium dewars between flights. Similarly, in missiles and satellites which are expected to have short lives, a recirculating cooling system might not be necessary or desirable. Gyros in missiles might be designed to prevent excessive thermal transfer from their supercooled regions. At the launching site, liquid helium could be supplied continuously to the gyro by an external recirculating refrigerator which would be detached at short notice before missile launching.

Cooling requirements may be simplified in space. Martin engineers point out that the low temperature requirement is less severe with the low external temperature available in space and with proper exterior design of the container. Cryogenic rocket propellants, they observe, might provide a low-temperature environment in the vehicle, for much of the trip at least, without added weight. The small power dissipation of cryogenic circuitry would cause insignificant boil-off of a propulsive fluid.

Device Research

Of the 44 groups surveyed by AVIATION WEEK about 30 are in the midst of device research and development, much of it for space or airborne applications (see chart, p. 72). Devices include:

• **Gyroscopes (superconducting)** which will have extremely low random drift rates, perhaps as low as 0.0001 deg. per hour. These are under study at the organizations indicated in the chart, and another firm, Republic Aviation, is currently supporting a design study on a cryo gyro. Various types of gyros are under study. Kearfott, for example, is developing superconducting body-mounted free gyros and rate gyros. The cryogenic gyro works on the principle that a superconducting sphere can be suspended by a magnetic field, thus eliminating conventional bearings. When the chamber containing the sphere is evacuated, a Kearfott engineer points out, air drag is eliminated and any rotation imparted to the sphere will continue indefinitely. Texas Instruments is under contract from Rome Air Development Center to develop a sensitive fixed reference frame by using a magnetic field locked inside

Cryogenic Electronics Background

Cryogenic electronics is the technology of very low temperature (below 125K) electronics. The primary phenomenon which many cryogenic devices utilize is that of superconductivity, a metal or compound's complete loss of resistivity when cooled below its transition temperature near absolute zero. Many pure metals (usually poor conductors at room temperature), compounds and alloys display superconducting properties, although their individual constituents may not be superconducting by themselves.

Transition temperatures of superconductors can be reduced by externally applied or internal magnetic fields. For sufficiently large fields, exceeding a critical field, a superconductor can be driven out of the superconducting and into the normal, or resistive state. The critical field becomes larger as absolute zero temperature is approached.

This "quenching" of superconductivity by sufficiently high fields was employed five years ago by the late Dudley Buck, then a young graduate student, in his original concept of the cryotron. The cryotron consisted of a wire control made of a superconductor with a relatively high critical field wrapped around a core or gate superconductor with a lower field. Currents passing through the control set up fields which are sufficient to push the gate into its normal state. Thus, Buck had a switch which, placed in series with another cryotron, gate of one to control of the other, formed a multivibrator. Logic functions using cryotrons were demonstrated.

To increase the speed of the device which is limited by the switching time and the ratio of self inductance of the control to the normal state resistance of the gate, researchers progressed from Buck's original wire-wound cryotron to the thin film device now receiving careful attention.

This device, and other superconductive vacuum-deposited thin film cryogenic devices, have these potential advantages for space applications cited by Martin Co.:

• Thermal and chemical decomposition are virtually non-existent at cryogenic temperatures.

• Large complexes of circuitry of very small size with high reliability can be made.

• Insensitivity to shock and vibration is inherent because components consist of thin superimposed films with the entire circuit being a solid mass.

• Deposition of film components permits circuit redundancy and self organization which would allow the circuit to bypass defective components.

• Large number of components with the potential for large memory units with short access time permit storage of many complex computational programs, thus requiring a minimum of inputs from an operator or outside source.

Critics of superconductive film circuits point to cryotron switching time (1 microsecond is the estimated maximum expected), which is slow next to a phase-locked oscillator or Esaki diode, the difficulties in controlling film deposition and the need to cool the circuits with liquid helium. Proponents cite some of the advantages itemized above and the possible low cost of making 1,000 cryotrons in a single vacuum operation.

Success with the cryotron has stimulated interest in other cryogenic devices both superconducting and non-superconducting. Non-superconducting devices using cryogenic environments include infrared detectors and photoconductors from which thermal noise is practically eliminated at these reduced temperatures, and Masers which have very low noise temperatures when cooled to liquid helium temperatures.

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A. M. Bruning, Engineer-In-Charge, Advanced Development Group
Age: 33
B.E., Johns Hopkins, 1949
M.S., Mathematics, University of Pittsburgh, 1956
Specialties: Arc Heated Aerodynamic and Thermodynamic Test Facilities, MHD Research Facilities
Years with Westinghouse: 8

W. J. Walker, Engineer-In-Charge, Aviation Facilities Group
Age: 42
B.S.M.E., University of Southern California, 1949
Specialties: Wind Tunnels, Sonic Fatigue Test Facilities, Hardened Base Equipment, Launchers
Years with Westinghouse: 11

R. A. Feranchak
Age: 29
B.S.E.E., Youngstown College, 1952
Specialties: Arc Heated Aerodynamic and Thermodynamic Test Facilities, Explosive Forming, Rotating Equipment Test Stands
Years with Westinghouse: 7

R. F. Leepa
Age: 29
B.S.E.E., Lafayette College, 1953
Specialties: Military Power Plants, Radar Antenna Drives
Years with Westinghouse: 6

P. J. Hawkshaw
Age: 36
B.S.E.E., Catholic University, 1950
Specialties: Continuous-Flow and Hot Shot Wind Tunnels, Explosive Forming
Years with Westinghouse: 9

J. McDonald
Age: 43
A.B., Chemistry, Engineering, Physics, University of California, 1938
Specialties: Arc Chamber and MHD Generator Development
Years with Westinghouse: 13

H. C. Lee
Age: 40
B.S.E.E., Chiao Tung University (Shanghai), 1942
M.S., Engineering, Cornell University, 1949
Ph.D., Cornell University, 1951
Specialties: Arc Chamber and MHD Generator Development
Years with Westinghouse: 2

H. A. Zollinger
Age: 30
B.S.E.E., Michigan College of Mining and Technology, 1951
M.S.E.E., University of Pittsburgh, 1958
Specialties: Drive Systems for Loaders, Elevators, Erectors and Launchers
Years with Westinghouse: 9

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the superconducting sphere. Present efforts according to RADC are directed toward devising a cryogenic method for measuring extremely small magnetic fields.

• **Accelerometers (superconducting)** which should be highly accurate and sensitive over a wide range (from 10^{-7} g up to ½ g) and which are expected to be small in size.

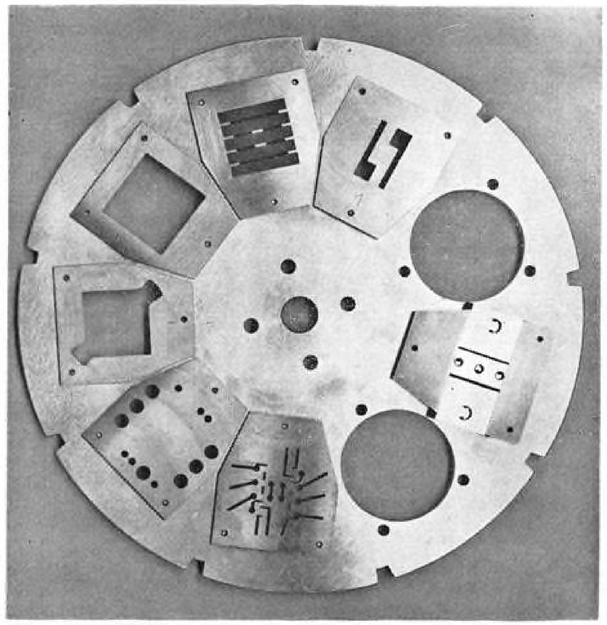
• **Vertical indicator** for satellites, which will provide direct reading of position, in research and development at Kearfott. A dual vector device, it will indicate two positions in space, one based on the radius vector from the earth's center to the satellite, the other a vector perpendicular to this. The indicating mechanism, still proprietary, is superconducting.

• **Bolometers (superconducting)** extremely sensitive to radiation, and possibly responsive in the far infrared region. These devices will utilize the extreme sensitivity of a superconductor to an externally applied fold and should be excellent radiation indicators.

• **Microwave mixers (superconducting)**, which should be low-noise devices capable of operating up to 1 kmc. Nonlinear mixing is obtained by transition from the superconducting to the normal state. Besides groups indicated in the chart, Arthur Little is investigating the response of superconductors to very high frequency fields under a contract from Air Force Cambridge Research Center in connection with the latter's interest in a microwave mixer.

• **Antennas (superconducting)**, which should have excellent frequency pickup because of low radiation to circuit resistance. The antenna would consist of a simple superconducting tank circuit with a small coil inserted in series with one element in the tank and brought outside the shielding. The coil would be extremely sensitive to radiation and would couple energy into the loop.

• **Electromagnets (superconducting)**, capable of providing stable magnetic fields for Masers and at the same time consuming little power, occupying insignificant space and contributing negligible weight to a device (AW Feb. 15 p. 76). These are in development primarily in conjunction with Maser work at Airborne Instruments, Hughes, Jet Propulsion Laboratory and Lincoln Laboratory. Main objective is to find superconductors with high critical fields (opposite requirement of a cryotron) and capable of being fabricated into wire. Under contract to Lincoln Laboratory, Battelle Memorial Institute is investigating a niobium-tin compound and if this material can be formed into wire it should provide



VAPORIZING NITROGEN in dewar flask at the Martin Co. (left) produces 77K temperatures for tests of vacuum-deposited specimens. Circular holder and necessary masks for depositing film flip flop at Space Technology Laboratories, Inc. (right) are shown half true size.

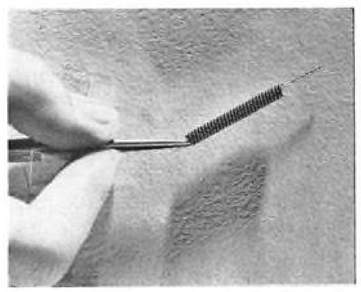
critical fields four times those of niobium.

• **Masers,** capable of operating in the millimeter wave region or with larger gain-bandwidth products or better ranges of frequencies. Among the more exotic types is a cyclotron resonance Maser in the planning stage at Lincoln Laboratory. It will use semiconductors as active materials, will be tunable and possibly work from millimeter to infrared regions.

• **Super-cooled parametric amplifiers,** normally capable of noise figures of about 1 db. at room temperature, which can provide even more sensitive performance rivaling Masers because of the reduction in thermal noise when cooled to liquid nitrogen temperatures.

• **Superconducting computer elements,** including thin film cryotrons. Shift registers and memories have been or are being developed at RCA, IBM and Arthur Little.

• **Non-super conducting** computing elements, such as CRYOSAR (low-temperature–CRYO Switching by Avalanche Recombination) developed at Lincoln Laboratory. CRYOSAR is a two-terminal computer element whose operation is based on impact ionization in semiconductors at liquid heilum temperatures. Its operation, similar to that of a gas discharge tube, involves abrupt changes in resistance produced by voltage across a semiconductor. CRYOSAR memory elements are possible.



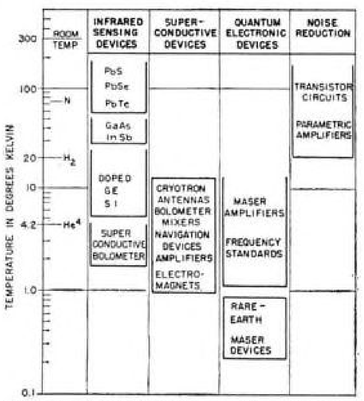
FIN TUBING made by Air Products for miniature heat exchangers used in cooling infrared crystals to liquid nitrogen temperatures. Gas enters tubing at one end, exhausts at other after passing through throttling section held to 77K. Tubing contained inside small cylinder with infrared crystal mounted at end is placed inside vacuum-insulated dewar fitted with window or lens.

Other Projects

Other cryogenic components and devices in varying stages of research or development are ferrite isolators and ferrite limiters (Airborne Instruments Laboratory), superconducting tranformers and transmission lines (IBM), superconducting cavities (Hughes), microwave superconducting switches (RCA and Hughes), harmonic generators (Hughes), low-temperature photoconductors (RCA and Kearfott), infrared detectors (Westinghouse, WADD, Hughes) and reversing switches (National Research Council).

Besides these special cryogenic devices, standard components may be made with new and improved properties when used at cryogenic temperatures, according to W. C. Dunlap, Jr., head of the solid state research group at Bendix Research Laboratories. Allowable voltages applied to rectifiers and capacitors, he says, may be increased greatly because the thermal factors in breakdown are sharply reduced. Unique, small-size resistors are possible in such systems, he says.

Along these lines, RADC is conducting a cryogenic program aimed at more immediate use of avionic equipment cooled to liquid nitrogen temperatures. By operating avionic equipment at lower temperatures and not allowing



LOW TEMPERATURE operating environments of infrared, superconducting and quantum electronic cryogenic devices as well as special cooled transistors and paramps are indicated in chart.

large temperature fluctuations, RADC engineers expect to obtain improved performance and better reliability than possible at room temperatures.

The preservative effect of low temperatures, Dunlap adds, might prevent deterioration of avionic components.

Materials Studies

The importance of materials in cryogenic electronics is indicated by the groups among the 44 questioned which are studying materials. The number breaks down as follows: superconducting materials—23; semiconductors—2; and paramagnetic materials—3.

In superconductors, the prime materials of cryogenic electronics, many groups report efforts to find new superconductors, to raise transition temperatures of known alloys or to find new materials with higher transition temperatures (for higher temperature operation); to find metals or alloys with sharp superconducting transitions; to obtain pure materials with low critical magnetic fields (for thin film cryotrons) or impure materials with high critical fields (for electromagnets).

Among the superconducting materials and the laboratories where they are studied are niobium and its compounds, bismuth-mercury, and vanadium compounds (Kearfott); niobium aluminide, rhenium nitride and zirconium zincide (Bell Telephone Laboratories); tin, lead, mercury, nickel and tantalum (MIT); niobium, tin, aluminum and zinc alloys (Rutgers University); and thallium (Physical Technical Federal Institute).

Cooling Mechanisms

Nine of the organizations questioned are working on cooling mechanisms for cryogenic electronics. Ohio State University, for instance, is examining unconventional cooling mechanisms under contract to RADC. The effects being studied include some considered inefficient by present standards, but which supply logistic advantages of simplicity, reliability and convenience in handling and use of non-strategic materials, RADC says. Ohio State is studying magnetothermal and endothermal chemical reaction effects.

If superconductors can be found with transition temperatures near the higher temperature of liquid hydrogen (20.4K), cooling problems may be eased for superconducting devices. To date the highest reported transition temperature is for niobium-tin (about 19K). One scientist suggests eventual use of liquid neon (27.2K) refrigerating systems although the cost could prove prohibitive.

Air Products, Inc., a manufacturer of cryogenic systems for cooling electronic devices, is urging avionics people to design 20 to 40K systems for airborne ap-

plications. The reason for this, the company points out, is the significant increase of refrigeration, and the saving of power and size due to Carnot cycle efficiency at these elevated temperatures.

Other points brought out by the results of the survey are:

• **Government agencies** are supporting at least a portion of the cryogenic research and development at 29 of the 44 organizations questioned.

• **Sponsoring government agencies** include Wright Air Development Division, Rome Air Development Center, Air Force Cambridge Research Center, Air Force Office of Scientific Research, Office of Naval Research, Navy Bureau of Ships, Army Signal Corps, Department of Defense, Army Ballistic Missile Agency, National Science Foundation, National Bureau of Standards and the National Aeronautics and Space Administration.

• **Total annual company** or laboratory investment in cryogenic electronics plus the annual amount of government money received for this purpose was reported by 24 of the 44 groups as previously indicated. The 24 reporting organizations appear to be a reasonable cross-section of the total sample in terms of program and organization size.

• **Principal problems** which remain to be solved to permit more widespread application of cryogenic devices reported by survey participants (with several indicating more than one) fall into these general categories: size, weight, reliability of refrigerating systems and dewars (19); more extensive range of materials (5); better understanding and knowledge of materials (6); reproducibility (4); scarcity of helium (2); need for logic circuitry (1); better materials handling (1); miscellaneous (4); and no answer (14).

• **Responses to the question:** Do you foresee the use of cryogenic electronic equipment in aircraft, missiles or space vehicles?—were "yes" (25), "no" (1), "possibly" (3), "questionable" (1), "not in a position to know" (1), and "no answer" (14).

Some of the individual cryogenic electronic research programs are:

• **Stevens Institute of Technology**—Scientists are investigating multiple films of superconducting and normal metals; thin normal films on superconducting base and ferromagnetic superconductors.

• **RCA**—In addition to device work, this company is studying superconductive metals and alloys, including transition metal compounds. Objectives are to study factors affecting the kinetics of the transition between normal and superconducting states using suitable materials, and to explore intermetallic compounds and compound alloys for new superconductors.

• **Rutgers University**—Dr. Bernard Serin is studying properties of dilute superconductive alloys. He is interested in the effect of electron scattering on superconducting properties and on the isotropy of a superconducting energy gap. He is also investigating effects of alloying on the normal phase of the same metals.

• **Sperry Gyroscope Co.**—Surface Armament Division is studying basic properties of thin films, 20 to 50 angstroms in thickness, and investigating microwave response, current distribution and switching properties of films. Also testing of Silsbee's hypothesis of conditions under which superconductivity can exist is under way. K-band amplifiers with 15 to 18% bandwidths are expected to evolve.

Researching Cryogenics

Other Sperry divisions or Sperry Rand Corp. divisions are researching cryogenics for infrared and gyroscopic devices (Marine Division); for broad-band millimeter wave sources including amplifiers, oscillators and detectors in 30 to 300 kmc. range (Electronic Tube Division); for microwave devices perhaps using superconducting circuits and cooled dielectrics in countermeasures applications (Countermeasures Division) and for new kinds of sensing devices (Sperry Microwave Electronics Co.).

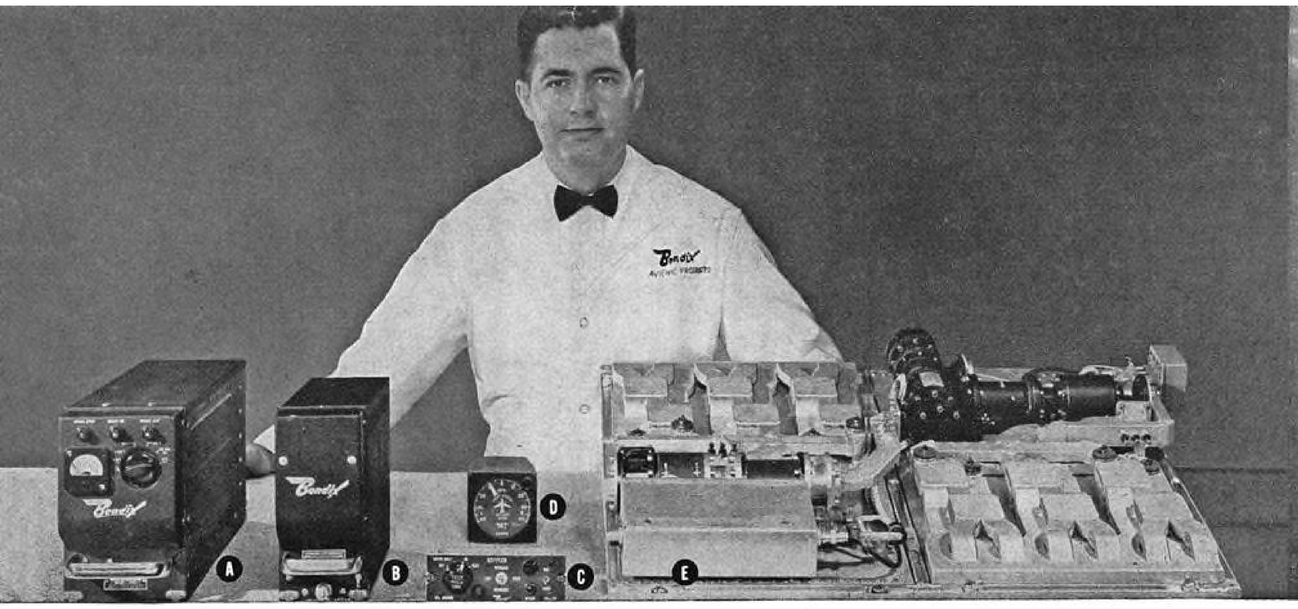
• **Hughes Aircraft**—Firm is working on cryogenic systems for use with infrared detectors, and more recently with Masers and parametric amplifiers. Hughes is now mass producing open-loop nitrogen gas systems capable of cooling an infrared detector down to 80K from ambient in less than three seconds. A method of making heat exchanger tubing with fins as thin as 0.0008 in. thus permitting highly efficient heat exchange has been developed.

Hughes is developing closed-loop systems including liquid helium for application to infrared detectors, and metal, liquid-helium dewars which the company says should be smaller and more rugged than commonly used glass dewars.

A liquid nitrogen transfer cooling system is now going into production for an airborne weapon system, and a prototype liquid helium system is being prepared for a flight test program to be carried out in the spring of 1960.

Organizations participating in the AVIATION WEEK survey were:

Aeronutronic, a division of Ford Motor Co.; Air Force Cambridge Research Center; Airborne Instruments Laboratory, Inc., a division of Cutler-Hammer Inc.; Air Products, Inc.; Arthur D. Little, Inc.; Autonetics, a division of North American Aviation, Inc.; Battelle Memorial Institute; Bell Telephone Laboratories; Burroughs Corp.; Car-



The Bendix DRA-12 Doppler Navigation System, pictured above, weighs only 61 pounds. (A) Tracker Unit—½ ATR package completely transistorized for greater reliability; (B) Transmitter-Receiver—short ⅜ ATR package requiring only single microwave connection (plus cabling) with antenna; (C) Control Unit—designed to RTCA-SC-46 specifications for installation in aircraft panel; (D) Indicator—standard, integrally-lighted instrument showing ground speeds up to 999 knots; (E) Antenna —four-beam planar array measuring only 3½" at thickest point.

United Air Lines selected the Bendix Doppler Navigation System for its new DC-8 Jet Mainliner fleet operating between California and Hawaii. Bendix Doppler will greatly increase operational efficiency over this long over-water route by reducing in-flight time and lowering fuel consumption.

BENDIX DOPPLER NAVIGATION SYSTEM

Years-ahead design anticipates airline performance needs... today and tomorrow

Built-in airline accuracy and reliability are the chief reasons why Bendix leads in commercial jetliner Doppler navigation. These essential qualities are the direct result of the advanced design and painstaking fabrication of the Bendix Doppler System, and they are the key factors that led United Airlines to select the Bendix system over all others.

Here are 10 reasons why Bendix Doppler is ahead today, and will be in the years to come:

1 The DRA-12 Bendix* Doppler Navigation System weighs only 61 lbs., and its companion CPA-24 Navigation Computer only 14 lbs.

2 Completely transistorized** for maximum reliability.

3 Employs fixed, passive, four-beam planar array antenna only 3½" at thickest point.

4 Utilizes FM/CW Doppler principle to give maximum efficiency at low power consumption.

5 High degree of accuracy in ground speed and drift angle information permanently maintained through use of digital computer techniques.

6 Coherent detection permits operation with signals more than 20 db below noise level.

7 Eliminates altitude holes through use of unique modulation method.

8 Maximum accessibility for maintenance achieved through use of plug-in computer circuit boards and sub-chassis construction.

9 Modulation system, computer elements, and other critical circuitry engineered for expansion into Mach 2 and Mach 3 aircraft.

10 Backed by full line of test equipment and complete maintenance training program.

Here is the Bendix Navigation Computer System, companion to the Doppler System on opposite page. This highly accurate system, weighing only 14 lbs., accepts ground speed and track information from Doppler System to continuously compute ground position relative to a selected track. This information is displayed as a direct readout in front of the pilot as distance to his destination and his position to the left or right of the selected track.

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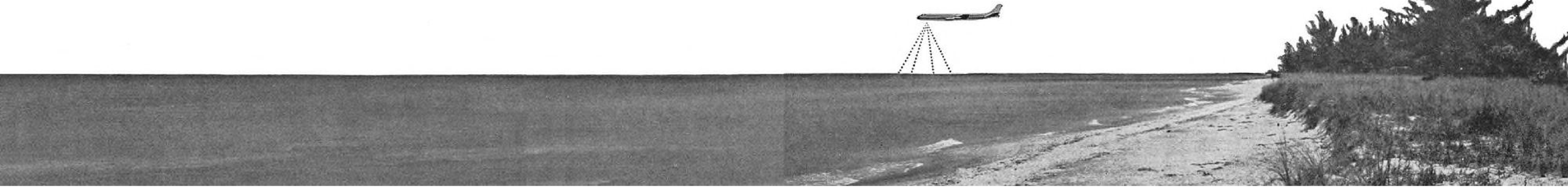


negie Institute of Technology; Convair, a division of General Dynamics Corp.; General Electric Co. Computer Laboratory, Palo Alto, Calif., and General Engineering Laboratory; Hughes Aircraft Co. (Electronics and Infrared Laboratories); International Business Machines Corp.; Jet Propulsion Laboratory of California Institute of Technology; Kearfott, division of General Precision, Inc.; Lincoln Laboratory of Massachusetts Institute of Technology; Louisiana State University, and the Martin Co. (Electronics and RIAS divisions).

Also, Massachusetts Institute of Technology (Electrical Engineering Computer Components); Minneapolis-Honeywell Regulator Co. (Aeronautical Division); National Bureau of Standards, Radio Standards Laboratory, Boulder, Colo.; New York University (College of Engineering); Ohio State University (Antenna Laboratory and Department of Chemistry); Pennsylvania State University (Cryogenic Laboratory); Purdue University (School of Electrical Engineering); Radio Corp. of America; Rome Air Development Center; Rutgers University (Physics Department); Space Technology Laboratories, Inc., (Physical Research Laboratory); Sperry Gyroscope Co. (Surface Armament, Marine, Electron Tube, and Countermeasures Divisions and the Sperry Microwave Electronics Co.); Stevens Institute of Technology (Department of Physics); U. S. Army Signal Research and Development Laboratory, Ft. Monmouth, N. J.; U. S. Naval Postgraduate School (Department of Physics), Monterey, Calif.; University of California (Los Alamos Scientific Laboratory); University of Kansas (Department of Chemical Engineering); University of Michigan (Solid-State Devices Laboratory of Electrical Engineering Department); University of North Carolina; Virginia Polytechnic Institute; Westinghouse Electric Corp. (Research division); and Wright Air Development Division.

In addition, three foreign laboratories participated in the survey. They are National Physical Laboratory, Teddington, Middlesex, England; National Research Council, Ottawa, Canada; and Physical-Technical Federal Institute, Braunschweig, Germany.

Information about cryogenic electronic research at several companies which did not participate in the survey but were mentioned here came from company spokesmen or sources outside the firms.

Bell Laboratories Employe Wins Annual Miniaturization Award

New York—David A. McLean of Bell Telephone Laboratories was named winner of the 1959 Miniaturization Awards Competition last week for his development of techniques for making tiny integrated circuits, consisting of capacitors, resistors and interconnections, all of tantalum, by the process of sputtering (AW Sept. 28, p. 73).

The annual competition is sponsored by Miniature Precision Bearings Inc., Keene, N. H.

AVIATION WEEK was one of 10 organizations or persons awarded Certificates of Excellence in the 1959 Miniaturization Awards Competition. AVIATION WEEK was selected for having made "significant contributions to miniaturization by seeking out, recognizing and reporting on significant achievements in this field. Because up-to-the-minute knowledge of new ideas of others is a powerful stimulant to the creative thinking of engineers and scientists, AVIATION WEEK has stimulated research and development in microcircuitry and molelectronics."

Other recipients of Certificates of Excellence include:

• **Dr. Jerome J. Tiemann,** General Electric Research Laboratory, for his contribution to the development of the tunnel diode.

• **Jack S. Kilby,** Texas Instruments, Inc., for his contribution to the development of complete solid-state circuits using a single crystal of semiconductor.

• **Pacific Semiconductors, Inc.,** for the development of microdiodes which occupy only 1/50th the space of a conventional semiconductor diode.

• **Mallory Battery Co.** and **Ruben Laboratories** for development of the world's smallest mercury battery, about the size of an aspirin tablet, which has long shelf life and can operate under extreme environmental conditions.

• **Col. Clarence H. Lewis,** headquarters Air Research and Development Command, and **Westinghouse Electric Corp.** for initiating the concept of molecular electronics and demonstrating its potentialities (AW Apr. 27, 1959, p. 54).

• **Eldon C. Hall, Massachusetts Institute of Technology Instrumentation Laboratory,** and **Samuel A. Francis,** Francis Associates, for the development of the welded-pack fabrication technique which made it possible to reduce the size of the Polaris inertial guidance digital computer to about one-quarter its former size and about one-half its previous weight (AW Aug. 24, p. 104).

• **General Electric Co.,** Miniature Lamp Department, for the development of the smallest 150 watt bulb ever made, which measures only one-half inch in diameter and features a "no-blackening" characteristic. Lamp was developed for use in wing tip of military jet aircraft.

• **Centralab,** the Electronics Division of Globe Union, Inc., for production of the smallest complete four-stage amplifier ever constructed. The hermetically sealed unit measures 0.53 in. in diameter and 0.23 in. thick.

• **Bendix Research Laboratories** for development of a miniature hydraulic cam motor, measuring only 1 in. in diameter and 1 in. long, which develops 0.3 hp., for use in space vehicle applications.

FILTER CENTER

▶ **Probing Upper Ionosphere**—Electron density of the upper atmosphere above the F-2 region will be studied with satellite payload and ground control equipment to be developed jointly by the Central Radio Propagation Laboratory of the National Bureau of Standards and Airborne Instruments Laboratory. The Propagation Laboratory will establish experimental constants and interpret data; AIL will design, develop and fabricate airborne and ground checkout hardware, ground display equipment.

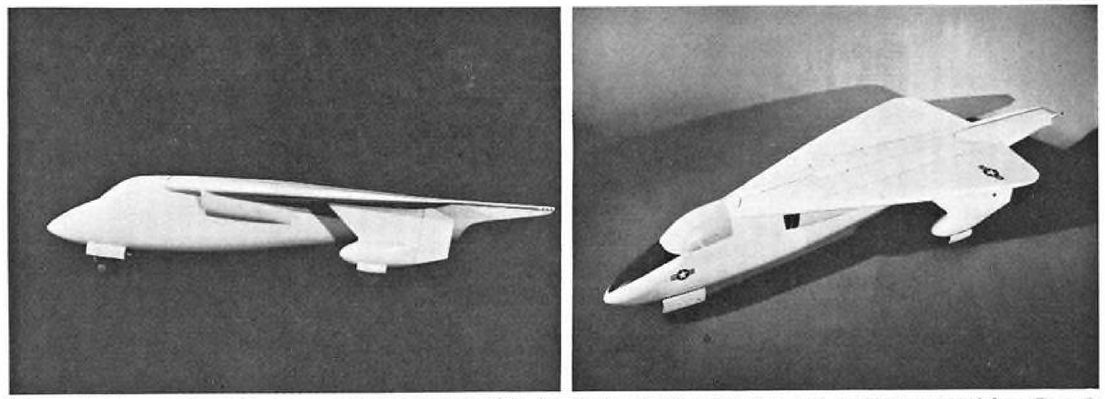
▶ **Space Guidance Team**—Team of former Army Ballistic Missile Agency scientists, perhaps 15 in number and headed by Dr. Frederick K. Mueller, previously deputy director of ABMA Guidance and Control Laboratory, will be the nucleus of Astro-Space Electronics Corp., Huntsville. The new firm, set up by Belock Instrument Corp., College Point, N. Y., will handle research, development and manufacture of guidance control systems and space vehicles.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

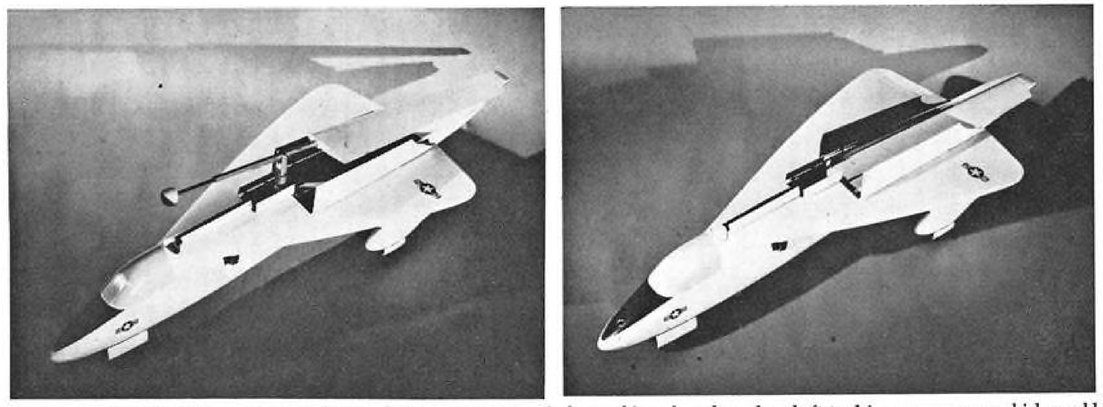
• **Ryan Electronics,** division of the Ryan Aeronautical Co., San Diego, has been awarded three contracts totaling more than $1.1 million by Sikorsky Aircraft for an additional quantity of AN/APN-97 radar navigation sets, spares and test equipment for use in Sikorsky's Navy helicopters.

• **Transval Electronics Corp.,** El Segundo, Calif., is to deliver two types of power supplies to activate ground support equipment for the Bomarc missile under a $600,000 contract from Boeing Airplane Co. Accelerated scheduling calls for delivery within six months.

• **Collins Radio Co.,** Cedar Rapids, Iowa, will produce airborne VHF communication and navigation equipment for the Air Force under a $1.1 million contract.

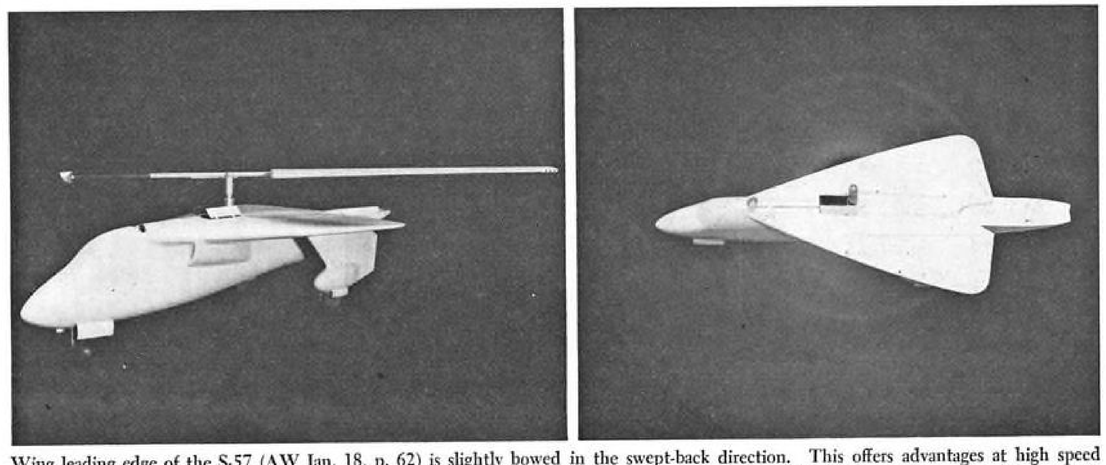


Sikorsky's S-57 proposal would use counterbalanced rotor blade for vertical takeoff and landing, and would be powered by a Pratt & Whitney J52 turbojet in horizontal high-speed flight. Rotor blade is housed longitudinally in fuselage during cruise phase.



Rotor would be powered by air diverted from turbojet to rotor system's free turbine, then through a shaft to drive a compressor which would send cold air to three jets at the tip of the rotor blade. USAF funded design, construction and test of wind tunnel model.

Sikorsky S-57 Jet VTOL Stores Rotor in Fuselage



Wing leading edge of the S-57 (AW Jan. 18, p. 62) is slightly bowed in the swept-back direction. This offers advantages at high speed and circumvents drag problems that are prone to occur in transonic vehicles at about Mach 1.1. The S-57 model showed uniform stability through the transonic range, Sikorsky says. USAF and Navy have studied the S-57 design concept.

SIKORSKY S-60, powered by two reciprocating engines, is the forerunner of a family of turbine-powered cranes which will be designed to carry payloads as great as 50 tons. Sikorsky's first turbine crane will be the S-64, due to fly this year.

Aviation Week Pilot Report:

S-60 Demonstrates Crane Feasibility

By Robert I. Stanfield

Stratford, Conn.—Sikorsky's S-60 flying crane test vehicle aptly demonstrates the vertical lift crane concept and potential—its cargo and personnel carrying techniques, and commercial and military capabilities.

Good visibility—coupled to its aft-facing pilot operation—simplifies loading and unloading.

Effectiveness of the S-60 was observed by this AVIATION WEEK pilot-editor flying first as a passenger in the 20-seat detachable, experimental "people pod" and then as an operator of the piston-driven, multi-engine Skycrane which cruises at 100 kt. and can haul a 5-ton payload.

The rotorcraft was built around existing components of the production S-56, including engines, hydromechanical clutches, gear and gear boxes, etc. Only the structure and cockpit are different. The development represents a Sikorsky investment of more than $2 million. Navy's Bureau of Aeronautics furnished bailed components (AW Apr. 20, 1959, p. 29).

Powerplants are two Pratt & Whitney R2800-54s, each generating 1,900 hp. normal rated and 2,100 hp. military rated at 2,700 rpm. Fuel grade is 115/145 octane. Empty weight is 19,613 lb.; maximum gross weight is 34,500 lb. Still-air range is 230 naut. mi.

The S-60 is the forerunner of a family of turbine-powered cranes designed by Sikorsky as universal tactical vehicles that will provide a maximum payload of up to 50 tons, maximum flexibility to transport any type of cargo and do any type of lifting, hauling or towing in the minimum time and at minimum cost.

First of these, Sikorsky's S-64, will

MOCKUP of Honest John rocket, with fins removed, is airlifted by S-60. The helicopter can haul a five-ton payload and cruise at 100 kt. Still-air range is 230 naut. mi.

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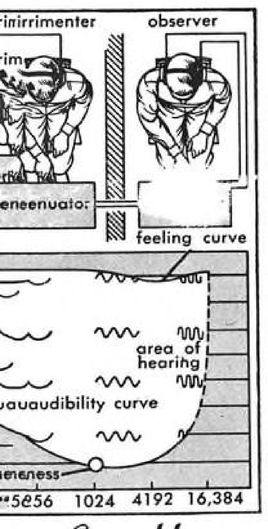

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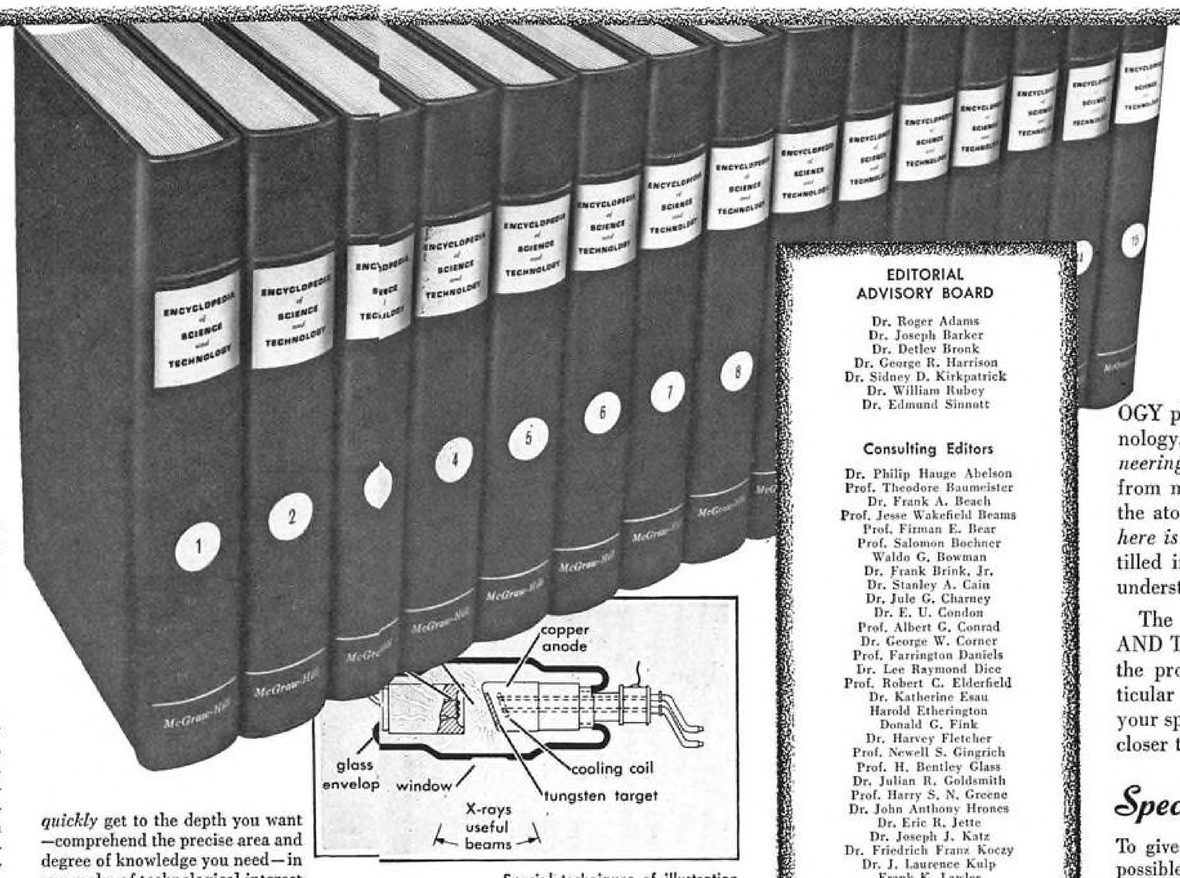

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be flying late this year. The S-64, which is expected to carry an 8-metric-ton payload (17,636.8 lb.)—with growth potential to 12 tons—will have the same design considerations as the S-60 except that the tail wheel will be eliminated in favor of a nose wheel. Gas turbines under consideration include the General Electric T64 and the Pratt & Whitney JFTD12A-1 (jet free turbine drive) military-rated at 4,050 shp.

Turbine-powered S-64, a short-haul, slow-speed vehicle, will cruise at 95 kt. at a maximum gross weight of 38,000 lb., AVIATION WEEK was told. Radius of action will be about 21.6 naut. mi. This conforms with German mission requirements and reflects the interest of Weserflug, West German company, in addition to U. S. Army and Navy interest generated by the S-60 test vehicle.

Sikorsky also has made a design study of a flying crane capable of carrying an 80,000-lb. payload, which the company feels may be a "solution to the transport of missiles." Such a helicopter would gross about 250,000 lb., have a 10-bladed rotor with diameter of about 160 ft., and be capable of tow loads approximating 180,000 lb. Powerplants would be mounted in multiples and thrust would be "equivalent to that of three ocean-going tugs."

Crane Concept

Crane concept, as demonstrated by the S-60, includes:

- **Carrying of any shape** or size load within the weight limitation of the machine: missiles, pod, vehicles, bridges, water buckets, etc.
- **Discharging and picking up** of loads faster than a cabin helicopter or even, says Sikorsky, than a truck: 60 sec. to discharge one load, take off, land over second load, hook up second load and take off.
- **Use of simple light-weight** isolators designed to provide vibration-free transportation—particularly applicable to delicate missiles or instrumented equipment suspended separately or in pods.
- **Pod transportation:** command posts, radio and radar posts, first aid stations, personnel transportation, construction shacks, etc.
- **Increased lifting capacity**—10% to 20%—by carrying loads close to fuselage and utilizing ground effect for takeoff (for large bulky loads normally suspended below a cabin helicopter).
- **Mine sweeping** along with streaming and retrieving gear from pods, and towing of various items from stalled land vehicles to ocean freighters.

Sikorsky S-60

Specifications and Performance:

Empty weight	19,613 lb.
Normal gross weight	31,200 lb.
Maximum gross weight	34,500 lb.
Cargo capacity	10,000 lb.
Fuel capacity	666 gal. (3,996 lb.)
Over-all length (blades unfolded)	87 ft. 11 in.
Over-all height:	
With tail rotor	21 ft. 8 in.
Without tail rotor, for carrier stowage	17 ft.
Vertical clearance (fuselage and ground)	7 ft. 8 in.
Gear tread	19 ft. 9 in.
Rotor diameter	72 ft.
Blade chord	23.6 in.
Rotor rpm.	185
Maximum speed (sea level)	113 kt.
Normal cruise speed	100 kt.
Hovering ceiling (IGE)	6,800 ft.
Range (still air)	230 naut. mi.

Cargo Hookups

The S-60 test vehicle, N807, fully grossed with about 4,000 lb. of fuel, plus pilots, weighs approximately 25,000 lb. Fuselage is cut away (from that of the S-56) to provide maximum ground clearance. Vertical clearance between fuselage and ground is 7 ft. 8 in., allowing the aircraft to hover over most loads (that of the S-64 will be 9 ft. 4 in.). Cargo hookups can be made without interference from rotor downwash and static electricity hazards. The aircraft also has taxi capability with load attached and is capable of emergency landings without jettisoning load.

Landing gear is similar to that of the production S-56, but incorporates large diameter main wheels to provide reasonable landing-taxi characteristics in rough, unprepared areas. It is mounted on the S-56 wing and nacelle structure. Use of a tail gear in the test vehicle was dictated by the location of the main gear—forward of the aircraft center of gravity.

Loads may be secured to a series of hard points on the underside of the fuselage and the wing, via snap-on adjustable cables. No special slings are required and kneeling of the main gear (6 in., which may be extended to 10-12 in.) allows the helicopter to squat down over the load. Cargo operation is in full view of the pilot at all times.

Experimental passenger pod, in which the flight was made by this pilot, weighs about 1,700 lb. empty and was ballasted with 4,000 lb. of lead shot to weigh it down. It measures 8 x 16 ft. It was attached to the S-60 by four suspension cables at each corner; rubber bungees eliminated any contact with fuselage.

Sikorsky is experimenting with varied absorbers of vertical movement and vibration, including bungee "clusters" of three bungees each for each suspension cable. Nylon cord also has been

used as a shock absorber. During this flight company was testing four air absorbers used with Cadillac automobiles.

The S-60, plus pod and passengers, grossed about 31,000 lb. at takeoff. Outside air temperature at the Stratford plant was 0C. Wind was from the west at 30 kt., with gusts to 40 kt.

Pod Flight

The pod is a "trailer-type" of vehicle, with an almost continuous expanse of glass windows. There are two doors on each side, plus one in the rear, facing the tail gear. Four airline-type seats also face aft; 16 bucket-type canvas seats are arranged in two rows of eight, back-to-back, in the center of the pod. Visibility to all areas is excellent.

Noise level is fairly high once the two piston engines fired up, though we didn't have to shout to be heard. Taxiing was smooth; there was no discomfort while moving out to run-up position.

Flight in the pod was made from a hover to several circuits of the plant at an altitude of 2,000 ft. where, with no insulation in the experimental pod, it was slightly frosty. There was little jouncing evident and, despite the strong wind, a minimum of vibration was apparent. Air was choppy, and the pod rode well with the helicopter through the rough air. Initial test flight with this type of absorber did produce a noticeable side-sway and side-to-side shake.

S-60 does not provide for jettisoning of loads on the hard points. This, of course, is comparable to carrying a load internally in a cabin-type aircraft. Some pilots have felt that the ability to jettison would be a desirable feature and also feel that while the practiced method of supporting cargo on four cables is completely adequate, additional cables could be used to eliminate all swaying.

Pilots with only checkout experience have had little difficulty in making successful pickups and drops, according to Sikorsky. Precise operation, with the good visibility offered by the crane, poses no problem.

During flight from the cockpit, this AVIATION WEEK pilot was accompanied by John F. Porth, company test pilot. The cockpit is suspended below the main part of the fuselage. The pilot, who sits on the left, is provided with a swivel seat and two sets of controls; swiveling about, he can operate the aircraft facing rearwards with cargo and landing site in full view. The copilot is provided with conventional forward-facing controls. (Turbine-powered S-64, by comparison, will have a fixed seat to the rear.)

Two jump seats are provided for additional crew. Two landing lights, one spot and one flood-type, are located on the bottom of the cockpit with 360 deg. scope to ensure good visibility at night. Standard instrumentation is provided for both pilots; only altimeter, tachometer and manifold pressure gage is provided for rearward seat. Basic ASE (automatic stabilization equipment) is installed, monitoring pitch, roll and yaw with provisions for altitude and tether controls. Two large rear-view mirrors also are mounted adjacent to each pilot.

The big crane, looking somewhat like a praying mantis, was taxied easily to run-up position where magnetos were checked at 30 in. manifold pressure and 2,200 rpm. Automatic stabilization equipment was engaged before takeoff. The S-60 was "clean," pod having been removed, and a mockup of the Honest John surface-to-surface missile, on trailer, was readied for pick-up. Missile-trailer configuration weighed about 600 lb.

Flight Characteristics

S-60 was lifted off at 30 in. and 2,650 rpm., feet off rudder pedals, and was hovered at 15 ft. Stability was pronounced. With manifold pressure reduced to 31 in., the aircraft could almost hold position "hands off." Climb-out from hover was made at 45 in. and 2,600 rpm., airspeed indicating 70 kt., best single-engine speed. Rate of climb was 2,000 fpm.

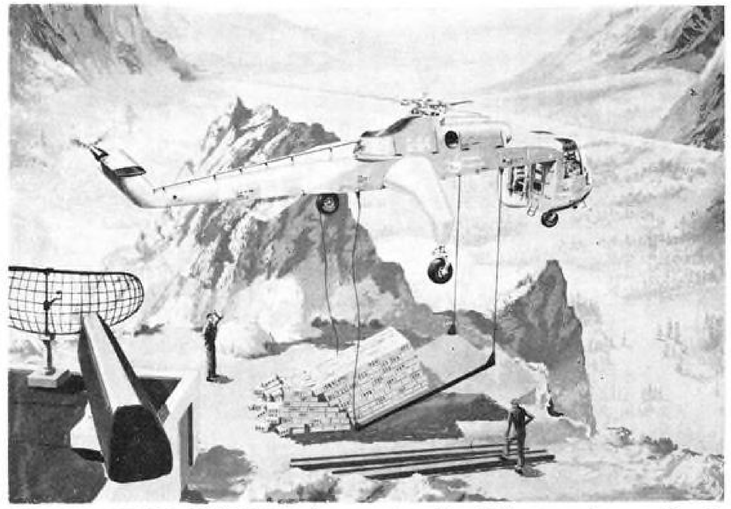
Again, the only heading was held in the climb; there was no need to touch the rudder pedals.

The rotorcraft normally cruises at 100 kt. During level flight at 2,000 ft., power to 28 in. and 2,600 rpm., the S-60 indicated 80 kt. Despite choppy air, the helicopter was able to maintain "hands-off" flight for brief periods. With power reduced to 22 in. and holding 2,600 rpm., descent of 1,500 fpm. was made at 80 kt. indicated.

Moving into the strong wind, for pick-up of the Honest John mockup, the pilot's seat was swiveled about. Collective pitch lever went around with the seat.

In this instance the right-seat pilot flew the helicopter while the cyclic stick was removed and inserted into an aft position, ahead of the now rear-ward facing pilot. There is a small formation stick to the right of the aft-facing pilot, which is coupled into the ASE, and which has proven satisfactory during tests, but was not operable during this flight.

The S-60 was brought deftly over the missile-on-trailer; while "sitting" over the load the brake was put on to keep the tail from swinging. A small crew hooked up to the four "end" points of the trailer within one minute. Loads are secured in the vicinity of the center of gravity; roll inputs due to swaying



SIKORSKY ARTIST'S CONCEPTION shows a twin-turbine S-64 using a dump truck technique to supply an isolated construction site. The S-64 will carry an eight-ton payload.

S-60 CAN LOWER its cargo hook from a hovering position, winch up a tree with its cargo hoist and fly away, or it can drag trees along the ground in a towing operation.

are at a minimum. Stability of the S-60 was pronounced during this short flight—particularly with use of the ASE—after which the aircraft was landed and the missile-trailer speedily detached.

With the use of snap-on adjustable cables, any type of load may be readily secured to the S-60. In a production version (the S-64) adjustable cables would be built into the aircraft, incorporated into a shade-roller type arrangement to simplify further cargo loading and unloading.

Hydraulic Hoist

The crane also is provided with a hydraulically operated hoist and a hook that can either be manually operated from the ground or electrically operated from the cockpit. The hoist is located directly under the main gear box at approximately the center of gravity of the S-60. Hydraulic winch is continually being modified to assure maximum reliability.

The S-60 has been on static tow (anchored to ground) and has held 12,000 lb. of tension with excess power for maneuvering. The 12,000 lb. gives aircraft about a 12-deg. nose-down condition.

Winch installed in the helicopter is designed for towing operations up to 30,000 lb. of tow load.

The rotorcraft was first flown on Mar. 25, 1959. Cargos that were carried or towed included bridges, fuel tanks, bulldozers, lumber, trucks, water buckets (500 gal.), radio control shacks, automobiles, trees, and 16 S-58 helicopters airlifted from Stratford to Sikorsky's Bridgeport, Conn., plant. As a minesweeper the S-60 has streamed out 600 ft. of cable and minesweeping gear during a Navy demonstration.

Hypersonic Tunnel Exceeds 12,000 mph.

Hypersonic wind tunnel capable of speeds in excess of 12,000 mph. and temperatures greater than 14,000F is in operation at Stanford University's Aeronautical Engineering Laboratory.

Financed by six aircraft firms—Convair Division of General Dynamics Corp., Douglas Aircraft Co., Hughes Aircraft Co., Lockheed Aircraft Corp., North American Aviation, Inc., and Northrop Corp.—the tunnel's research program is supported under contracts with the Air Force Arnold Engineering Development Center, Tullahoma, Tenn.

A bank of 138 capacitors stores up electrical energy sufficient to supply power for a 200,000-watt-sec. spark which boosts arc chamber pressure to 20,000 psi. Vacuum tank pressure is reduced to one-millionth atmospheric pressure prior to each "shot" which lasts 0.025 sec.

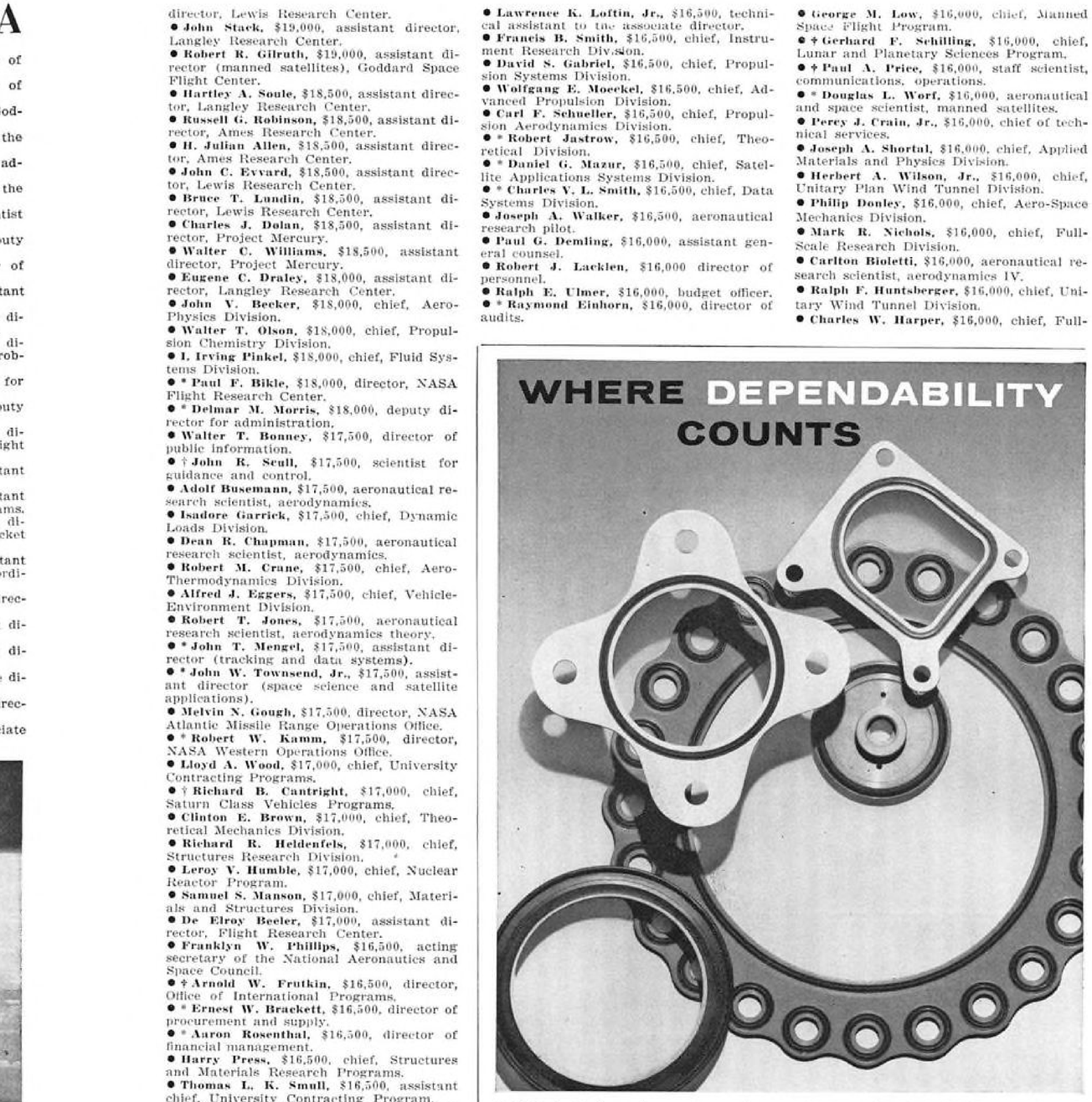
Special Salaries Reported by NASA

Washington—Following is a list of positions established by the National Aeronautics and Space Administration under Subsection (2), Section 203(B) of the National Aeronautics and Space Act of 1958 authorizing appointment of scientific, engineering and administrative personnel at salaries above normal civil service levels.

The section provides that the NASA administrator "may appoint and fix the compensation (up to a limit of $19,000 a year or up to a limit of $21,000 a year for a maximum of 10 positions) of not more than 260 of the scientific, engineering and administrative personnel of the Administration." It adds that "to the extent the administrator deems such action necessary to recruit specially qualified scientific and engineering talent, he may establish the entrance grade for scientific and engineering personnel without previous service in the federal government at a level up to two grades higher than the grade provided for such personnel under . . . the Classification Act of 1949. . . ." List was provided the House Committee on Science and Astronautics by NASA:

- **Richard E. Horner,** $21,000, associate administrator.
- **Ira H. Abbott,** $21,000, director of advanced research programs.
- **Abe Silverstein,** $21,000, director of space flight programs.
- **Homer J. Stewart,** $21,000, director of program planning and evaluation.
- **John A. Johnson,** $20,000, general counsel.
- **Henry J. E. Reid,** $20,000, director of NASA Langley Research Center.
- **Smith J. DeFrance,** $20,000, director of NASA Ames Research Center.
- **Edward R. Sharp,** $20,000, director of Lewis Research Center.
- **Harry J. Goett,** $20,000, director of Goddard Space Flight Center.
- **John P. Hagen,** $19,000, director of the Office for the U. N. Conference.
- **James P. Gleason,** $19,000, assistant administrator for congressional relations.
- **John F. Victory,** $19,000, assistant to the administrator.
- **Addison M. Rothrock,** $19,000, scientist for propulsion.
- † **Nicholas E. Golovin,** $19,000, deputy associate administrator.
- * **Albert E. Seipert,** $19,000, director of business administration.
- † **Emerson W. Conlon,** $19,000, assistant director of research (powerplants).
- **Milton B. Ames, Jr.,** $19,000, deputy director of advanced research programs.
- **Richard V. Rhode,** $19,000, assistant director of research (aircraft operating problems, structures and materials).
- * **Clark T. Randt,** $19,000, scientist for space medicine research.
- * **Homer E. Newell, Jr.,** $19,000, deputy director of space flight programs.
- **Newell D. Sanders,** $19,000, assistant director for applications and manned flight programs.
- **Edmund C. Buckley,** $19,000, assistant director for space flight operations.
- **Edgar M. Cortright,** $19,000, assistant director for lunar and planetary programs.
- **Morton J. Stoller,** $19,000, assistant director for satellite and sounding rocket programs.
- **DeMarquis D. Wyatt,** $19,000, assistant director for program planning and coordination.
- * **Abraham Hyatt,** $19,000, deputy director of launch vehicle programs.
- * **Milton W. Rosen,** $19,000, assistant director for vehicles.
- * **Elliott Mitchell,** $19,000, assistant director for propulsion.
- **Floyd L. Thompson,** $19,000, associate director, Langley Research Center.
- **John F. Parsons,** $19,000, associate director, Ames Research Center.
- **Eugene J. Manganiello,** $19,000, associate director, Lewis Research Center.
- **John Stack,** $19,000, assistant director, Langley Research Center.
- **Robert R. Gilruth,** $19,000, assistant director (manned satellites), Goddard Space Flight Center.
- **Hartley A. Soule,** $18,500, assistant director, Langley Research Center.
- **Russell G. Robinson,** $18,500, assistant director, Ames Research Center.
- **H. Julian Allen,** $18,500, assistant director, Ames Research Center.
- **John C. Evvard,** $18,500, assistant director, Lewis Research Center.
- **Bruce T. Lundin,** $18,500, assistant director, Lewis Research Center.
- **Charles J. Dolan,** $18,500, assistant director, Project Mercury.
- **Walter C. Williams,** $18,500, assistant director, Project Mercury.
- **Eugene C. Draley,** $18,000, assistant director, Langley Research Center.
- **John V. Becker,** $18,000, chief, Aero-Physics Division.
- **Walter T. Olson,** $18,000, chief, Propulsion Chemistry Division.
- **I. Irving Pinkel,** $18,000, chief, Fluid Systems Division.
- * **Paul F. Bikle,** $18,000, director, NASA Flight Research Center.
- * **Delmar M. Morris,** $18,000, deputy director for administration.
- **Walter T. Bonney,** $17,500, director of public information.
- † **John R. Seull,** $17,500, scientist for guidance and control.
- **Adolf Busemann,** $17,500, aeronautical research scientist, aerodynamics.
- **Isadore Garrick,** $17,500, chief, Dynamic Loads Division.
- **Dean R. Chapman,** $17,500, aeronautical research scientist, aerodynamics.
- **Robert M. Crane,** $17,500, chief, Aero-Thermodynamics Division.
- **Alfred J. Eggers,** $17,500, chief, Vehicle-Environment Division.
- **Robert T. Jones,** $17,500, aeronautical research scientist, aerodynamics theory.
- * **John T. Mengel,** $17,500, assistant director (tracking and data systems).
- * **John W. Townsend, Jr.,** $17,500, assistant director (space science and satellite applications).
- **Melvin N. Gough,** $17,500, director, NASA Atlantic Missile Range Operations Office.
- * **Robert W. Kamm,** $17,500, director, NASA Western Operations Office.
- **Lloyd A. Wood,** $17,000, chief, University Contracting Programs.
- † **Richard B. Cantright,** $17,000, chief, Saturn Class Vehicles Programs.
- **Clinton E. Brown,** $17,000, chief, Theoretical Mechanics Division.
- **Richard R. Heldenfels,** $17,000, chief, Structures Research Division.
- **Leroy V. Humble,** $17,000, chief, Nuclear Reactor Program.
- **Samuel S. Manson,** $17,000, chief, Materials and Structures Division.
- **De Elroy Beeler,** $17,000, assistant director, Flight Research Center.
- **Franklyn W. Phillips,** $16,500, acting secretary of the National Aeronautics and Space Council.
- † **Arnold W. Frutkin,** $16,500, director, Office of International Programs.
- * **Ernest W. Brackett,** $16,500, director of procurement and supply.
- * **Aaron Rosenthal,** $16,500, director of financial management.
- **Harry Press,** $16,500, chief, Structures and Materials Research Programs.
- **Thomas L. K. Smull,** $16,500, assistant chief, University Contracting Program.
- **William H. Woodward,** $16,500, chief, Powerplants Research Programs.
- **Ernest O. Pearson, $16,500,** chief, Aerodynamic and Flight Mechanics Research Programs.
- * **J. Allen Crocker,** $16,500 chief, Lunar and Planetary Program Coordination.
- **Francis B. Smith,** $16,500, chief, Instru-Programs
- * **John F. Clark,** $16,500, chief, Geophysics Programs.
- † **Oran W. Nicks,** $16,500, staff scientist, Lunar Flight Systems.
- **John L. Sloop,** $16,500, technical assistant to the director of Space Flight Programs.
- **Lawrence K. Loftin, Jr.,** $16,500, technical assistant to the associate director.
- **Francis B. Smith,** $16,500, chief, Instrument Research Division.
- **David S. Gabriel,** $16,500, chief, Propulsion Systems Division.
- **Wolfgang E. Moeckel,** $16,500, chief, Advanced Propulsion Division.
- **Carl F. Schueller,** $16,500, chief, Propulsion Aerodynamics Division.
- * **Robert Jastrow,** $16,500, chief, Theoretical Division.
- * **Daniel G. Mazur,** $16,500, chief, Satellite Applications Systems Division.
- * **Charles V. L. Smith,** $16,500, chief, Data Systems Division.
- **Joseph A. Walker,** $16,500, aeronautical research pilot.
- **Paul G. Demling,** $16,000, assistant general counsel.
- **Robert J. Lacklen,** $16,000 director of personnel.
- **Ralph E. Ulmer,** $16,000, budget officer.
- * **Raymond Einhorn,** $16,000, director of audits.
- **George M. Low,** $16,000, chief, Manned Space Flight Program.
- † **Gerhard F. Schilling,** $16,000, chief, Lunar and Planetary Sciences Program.
- † **Paul A. Price,** $16,000, staff scientist, communications, operations.
- * **Douglas L. Worf,** $16,000, aeronautical and space scientist, manned satellites.
- **Percy J. Crain, Jr.,** $16,000, chief of technical services.
- **Joseph A. Shortal,** $16,000, chief, Applied Materials and Physics Division.
- **Herbert A. Wilson, Jr.,** $16,000, chief, Unitary Plan Wind Tunnel Division.
- **Philip Donley,** $16,000, chief, Aero-Space Mechanics Division.
- **Mark R. Nichols,** $16,000, chief, Full-Scale Research Division.
- **Carlton Bioletti,** $16,000, aeronautical research scientist, aerodynamics IV.
- **Ralph F. Huntsberger,** $16,000, chief, Unitary Wind Tunnel Division.
- **Charles W. Harper,** $16,000, chief, Full-

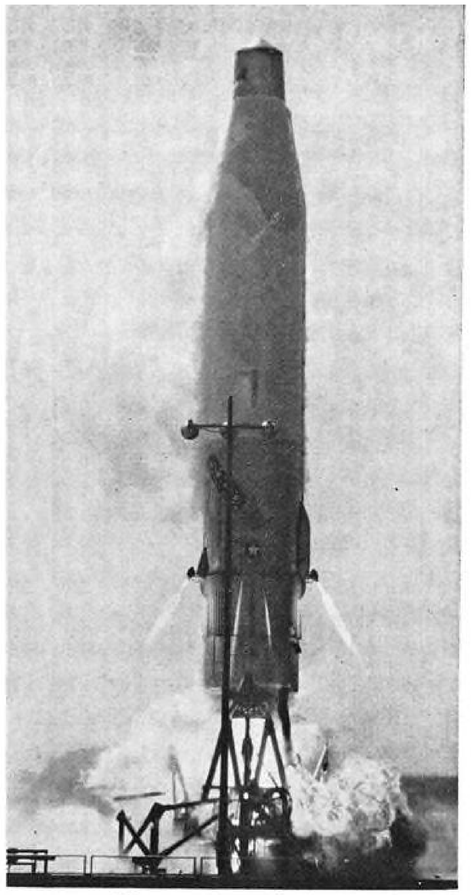
*—From other government agencies.
†—From industry or universities.



Bell Studies Airframe Cooling Structures

Bell Aircraft Corp. will develop insulated double-wall cooling structures to prevent overheating of space vehicles during re-entry, under a $1.4 million follow-on USAF contract. The structure also could be used for high-speed vehicles traveling in the atmosphere. Basically, the structure consists of an outer wall radiation shield and an inner wall, separated by a layer of thermal insulation. Outer wall is made of small panels. Inner wall incorporates tubes through which liquid circulates to cool the airframe.

Scale and Systems Research Division.
- **Jesse H. Hall,** $16,000, chief, Instrument and Computing Research Division.
- **Oscar W. Schey,** $16,000, chief of technical services.
- † **James H. Chamberlin,** $16,000, chief, Engineering Division.
- **Maxime A. Faget,** $16,000, chief, Flight System Division.
- **Charles W. Mathews,** $16,000, chief, Operations Division.
- **Paul E. Purser,** $16,000, special assistant to the director, Project Mercury.
- **William K. Ritter,** $16,000, associate chief, Satellite Application Systems Division.
- † **Gordon F. MacDonald,** $16,000, staff scientist, planetary sciences analysis.
- **Harry H. Gorman,** $16,000, assistant director for administration.
- **William J. Underwood,** $15,500, assistant to the chairman and secretary to the Civilian-Military Liaison Committee.
- * **Wesley L. Hjornevik,** $15,500, deputy director of business administration.
- **Harvey H. Brown,** $15,500, assistant chief, Structures and Materials Research Programs.
- **Boyd C. Myers II,** $15,500, technical assistant to the director for research management.
- † **William C. Cooley,** $15,500, chief, Advanced Technology Program.
- † **Wallace L. Ikard,** $15,500, staff scientist, telemetry and instrumentation.
- **A. O. Tischler,** $15,500, chief, Large Engine Rocket Program.
- **Harold B. Finger,** $15,500, chief, Nuclear Engines Programs.
- **Eldon W. Hall,** $15,500, chief analysis and requirements (Propulsion Programs).
- **Thomas A. Harris,** $15,500, research assistant for cooperative projects.
- **John C. Houbolt,** $15,500, assistant chief, Dynamic Loads Division.
- **Samuel Katzoff,** $15,500, assistant chief, Applied Materials and Physics Division.
- **Paul R. Hill,** $15,500, assistant chief, Applied Materials and Physics Division.
- **William H. Phillips,** $15,500, aeronautical research scientist, stability and control.
- **John P. Reeder,** $15,500, aeronautical research pilot.
- **William J. O'Sullivan,** $15,500, aeronautical research scientist, aerodynamics.
- **Charles H. Zimmerman,** $15,500, assistant chief, Aero-Space Mechanics Division.
- **Eugene S. Love,** $15,500, assistant chief, Aero-Physics Division.
- **Axel T. Mattson,** $15,500, assistant chief, Full-Scale Research Division.
- **Paul Kuhn,** $15,500, assistant chief, Structures Research Division.
- **John B. Parkinson,** $15,500, aeronautical research scientist, aerodynamics.
- **George B. Graves,** $15,500, aeronautical research scientist, instruments S-IX.
- **James A. White,** $15,500, chief, Instrumentation Division.
- **Donald H. Wood,** $15,500, technical assistant to the associate director.
- **Alvin Seiff,** $15,500, aeronautical research scientist, aerodynamics.
- **Max A. Heaslet,** $15,500, aeronautical research scientist, aerodyanmics theory.
- **Victor I. Stevens, Jr.,** $15,500, assistant chief, Aero-Thermodynamics Division.
- **Lawrence A. Clousing,** $15,500, assistant chief, Full-Scale and Systems Division.
- **Glen Goodwin,** $15,500, aeronautical research scientist, aerodynamics.
- **Steven E. Belsley,** $15,500, aeronautical research scientist, aerodynamics.
- **C. Mervin Ault,** $15,500, aeronautical research scientist, propulsion systems materials.
- **Henry C. Barnett,** $15,500, assistant to the director.
- **Edmund E. Bison,** $15,500, assistant chief, Fluid Systems Division.
- **Irving A. Johnson,** $15,500, assistant chief, Fluid Systems Division.
- **John C. Sanders,** $15,500, aeronautical research scientist, propulsion control theory.
- **Charles A. Herrmann,** $15,500, associate chief of technical services.
- * **N. Whitney Matthews,** $15,500 chief, Payload Systems Division.
- **Thomas A. Toll,** $15,500, chief, Research Division.
- **Frederick J. Bailey, Jr.,** $15,500, technical assistant to the director, NASA Atlantic



Operational Atlas Fired

First operational Atlas is launched from Vandenberg AFB, Calif., by SAC. Missile carries Mk. II heat-sink re-entry vehicle.

Missile Range Operations Office.
- **David H. Newby,** $15,500, director of technical services.
- **Clotaire Wood,** $15,000, technical assistant to the deputy administrator.
- * **Robert G. Nunn, Jr.,** $15,000, assistant general counsel.
- * **Walter D. Sohier,** $15,000, assistant general counsel.
- * **Gerald D. O'Brien,** $15,000, assistant general counsel for patent matters.
- * **Robert L. King,** $15,000, special assistant to the administrator.
- † **David H. Keyser,** $15,000, chief congressional liaison officer.
- **Robert L. Bell,** $15,000, security director.
- **Bernard Maggin,** $15,000, aeronautical research scientist, stability and control.
- **Ralph W. May, Jr.,** $15,000, aeronautical research scientist, aerodynamics.
- **Warren J. North,** $15,000, staff scientist, manned satellites.
- **Leonard Jaffe,** $15,000, chief, Communications Satellite Program.
- **Albert E. von Doenhoff,** $15,000, staff scientist, spacecraft technology.
- * **J. Kenneth Sterrett,** $15,000, staff scientist, computers and celestial mechanics.
- **John H. Disher,** $15,000, staff scientist, advanced manned systems.
- * **Nancy G. Roman,** $15,000, chief, Astronomy and Astrophysics Programs.
- **Morris Tepper,** $15,000, chief, Meteorological Satellite Programs.
- **Fred D. Kochendorfer,** $15,000, chief scientist, planetary and interplanetary flight.
- † **James E. O'Neill,** $15,000, space and aeronautical scientist, nuclear propulsion.
- * **Samuel Snyder,** $15,000, chief, Scout Class Vehicle Programs.
- * **Harry Harrison,** $15,000, chief, Space Propulsion Programs.
- **Howard B. Edwards,** $15,000, assistant chief, Instrument Research Division.
- **Clifford H. Nelson,** $15,000, aeronautical research scientist, instruments.
- **Roger A. Anderson,** $15,000, aeronautical research scientist, structures.
- **Arthur A. Regier,** $15,000, assistant chief, Dynamic Loads Division.
- **David G. Stone,** $15,000, aeronautical research scientist, stability and control.
- **Macon C. Ellis, Jr.,** $15,000, aeronautical research scientist, aerodynamics.
- **Joseph C. Thibodaux, Jr.,** $15,000, aeronautical research scientist, aerodynamics.
- **John Dimeff,** $15,000, assistant chief, Instrumentation Research Division.
- **Andre G. Buck,** $15,000, chief, Engineering Services Division.
- **J. Howard Childs,** $15,000, aeronautical research scientist, combustion.
- **Ambrose Ginsberg,** $15,000, aeronautical research scientist, compressors and turbines.
- **Robert R. Godman,** $15,000, assistant chief, Propulsion and Aerodynamics Division.
- **Simon Ostrach,** $15,000, aeronautical research scientist, aerodynamics theory.
- **Isadore Warshawsky,** $15,000, aeronautical research scientist, instruments.
- **Aaron S. Boksenbom,** $15,000, aeronautical research scientist, propulsion control theory.
- **Stephen H. Maslen,** $15,000, aeronautical research scientist, aerodynamics theory.
- **Beverly G. Gulick,** $15,000, chief, Facilities Engineering Division.
- **Edmund R. Jonash,** $15,000, aeronautical research scientist, rocket propulsion.
- **Hugh M. Henneberry,** $15,000, aeronautical research scientist, flight systems analysis.
- * **Leslie H. Meredith,** $15,000, chief, Space Sciences Division.
- * **C. A. Schroeder,** $15,000, chief, Tracking Systems Division.
- **N. Phillip Miller,** $15,000, chief, Construction Engineering Division.
- **Michael J. Vaccaro,** $15,000, business manager.
- † **Nelson W. Spencer,** $15,000, space and aeronautical scientist, physics of atmosphere X.
- **Robert L. Krieger,** $15,000, chief, NASA Wallops Station.
- **Hubert M. Drake,** $15,000, assistant chief, Research Division.
- **Gerald M. Truszynski,** $15,000, chief, Instrumentation Division.
- **Stanley P. Butchardt,** $15,000, aeronautical research pilot.
- **Joseph Weil,** $15,000, aeronautical research scientist, stability and control.
- * **Leland B. Mebine,** $14,500, chief, technical program analysis.
- * **Alfred S. Hodgson,** $14,500, director of management analysis.
- † **Robert F. Fellows,** $14,500, chief, Chemical Aeronomy Program.
- * **John A. O'Keefe,** $14,500, assistant chief, Theoretical Division.
- * **John C. Lindsay,** $14,500, associate chief, Space Science Division.
- * **Leopold Winkler,** $14,500, associate chief, Payload Systems Division.
- * **William G. Stroud,** $14,500, space and aeronautical scientist, meteorology.
- * **James E. Kupperian, Jr.,** $14,000, space and aeronautical scientist, astronomy.
- * **Herman E. La Gow,** $14,000, space and aeronautical scientist, physics of atmosphere.
- * **Karl R. Medrow,** $14,000, space and aeronautical scientist, space research instrumentation.
- * **J. Carl Seddon,** $14,000, space and aeronautical scientist, ionosphere.
- * **J. W. Siry,** $14,000, staff scientist, data systems planning.
- * **Robert J. Mackey,** $14,000, space and aeronautical scientist, instrumentation.
- * **Robert J. Coates,** $14,000, space and aeronautical scientist, radio frequency systems.
- † **Robert G. Kelly,** $14,000, machine programing mathematician.
- **Merland L. Moseson,** $14,000, space and aeronautical scientist, systems integration S-IX.

* — From other government agencies.
† — From industry or universities.

Lockheed Expands Abroad as Partner

By Richard Sweeney

Los Angeles—Lockheed Aircraft International, Inc., is setting a broad industry pattern in furnishing U.S. technical know-how and cash in joint ventures with foreign companies to produce hardware or services.

LAI teams with existing foreign companies or firms organized especially for the particular enterprise. LAI takes an equity position only if money is needed and the entire proposition meets strict business standards.

When the company was established in April, 1959, as a wholly-owned subsidiary of Lockheed Aircraft Corp., it was assured of capital for equity in foreign activities. No limits were set, with each deal to be handled individually. Since all Lockheed funds come from the same corporate pool, Lockheed Aircraft International management presents proposals to the parent firm, and judgments are made at that level.

Although LAI's corporate management is accountable for its profit and loss at the end of the fiscal year, ultimate responsibility is to account to Lockheed Aircraft Corp., which answers directly to the latter's stockholders.

Foreign Efforts

All divisions of Lockheed Aircraft Corp. are active in foreign markets. But LAI has a different position in foreign efforts (over and above capital investment) than the Lockheed divisions, in that efforts are directed to:

- **Seek fields where activities** can make use of the entire spectrum of capabilities existing within the parent corporation and its divisions, and yield a profit.
- **Handle certain foreign** interests which Lockheed has had for some time.
- **Serve as a medium of exchange** for technical knowledge between Lockheed and foreign companies.
- **Assist divisions** of the parent corporation in foreign sales promotion of their products or services.

Advisory Services

LAI is intended to offer technical and advisory services in engineering, manufacturing, material control, purchasing, managerial training and long-range economic planning in fields where the parent firm has capabilities, plus the financial support and guidance inherent in taking an equity position.

A financial interest does not, however, necessarily mean LAI furnishes all of these services. Nor is it necessary for LAI to assume an equity position in a foreign enterprise to furnish all or part of these services.

In addition to offering technical services involved in new product development in foreign nations, LAI also could act as agent for service divisions of Lockheed Aircraft Corp., such as Lockheed Air Terminal (airport development and management) and Lockheed Air Service (contract maintenance for foreign aircraft fleets or help in setting up maintenance systems to be operated by foreign personnel).

World Activities

Parts of the world and fields where LAI has been active since its founding have been:

- **Brazil**—LAI electronic and radar technicians have completed instructing Brazilian air force personnel in functional operation of advanced equipment.
- **Argentina**—LAI is exploring the possibility of joining with an Argentine company to form an aircraft manufacturing firm there.
- **Turkey**—LAI is in negotiation with THY, the Turkish airline, for establishment of a maintenance center at Istanbul.
- **India**—LAI has been asked to submit a proposal for design of a commercial feeder-class transport and a separate proposal for its manufacture in India, for local use in that country.
- **Thailand and Indonesia**—LAI is discussing details of possible assistance for national air programs in both countries.
- **Japan**—LAI represents Lockheed interests in manufacture of the P2V-7 and forthcoming production of the R-104J in Japan. This cognizance is a carryover from earlier years when the association began with Lockheed Aircraft Service Overseas in T-33 maintenance and production.
- **Italy**—LAI has negotiated an agreement with Macchi whereby a light utility plane will be produced in Italy, and LAI has purchased a substantial amount of stock of Aeronautica Macchi, S. A.
- **Mexico**—Lockheed Aircraft Corp. formed a partnership with Mexican interests in 1958, with the initial project being the manufacture in Mexico of a light utility airplane designed to operate from the rough, short airstrips at high altitudes which predominate throughout Mexico and South America. This is the same airplane which will be built in Italy by Macchi. When LAI was formed, Lockheed Aircraft Corp. transferred to its stock in the Mexican concern—Lockheed-Azcarate S. A.—which has a majority of Mexican interests represented by Abelardo Rodriguez, former president of Mexico, and Juan F. Azcarate, Mexican aeronautical pioneer and engineer.

Technical Experts

In line with its various missions, LAI has technical experts in each of its fields of interest, who carefully scrutinize prospective deals to assess the over-all requirements plus the return which may be expected on any investment.

LAI's technical staff includes experts in aeronautical engineering, manufacturing, facilities (including construction), sales, accounting, purchasing and planning.

LAI also uses services of persons familiar with the nation where it is contemplating entering business. They make contributions concerning legal and political aspects involved in doing business in the particular nation, since each foreign government usually has its own strict rules on how much outside capital may be invested and who must hold how much of a majority interest. Usually, these persons also know the proper contacts for foreign negotiations, and the required protocol.

When LAI is forming a new enterprise, there are additional factors which enter the considerations, such as the possibility of giving some business to one of the divisions of the parent corporation. LAI technical staff is too small to accomplish detail engineering on particular projects when this is necessary, therefore, this usually is subcontracted by LAI and its foreign partner to one of the Lockheed Aircraft Corp. divisions.

Plane Market

The small utility airplane to be built in Mexico (and Italy) is an example. Lockheed-Azcarate knew there was a market for this type of airplane, but the firm was not established to start from scratch in design, flight test and production. Therefore, the design, flight test and certification of the aircraft, design and construction of tooling were subcontracted to Lockheed Georgia Division.

Georgia Division contracted, for a given price and according to Lockheed-Azcarate specifications, to deliver complete and approved production drawings and specifications to be used in Mexico, an FAA-approved type cer-

tificate, the prototype airplanes, and supporting material to the Mexican firm. Georgia Division retains no inherent or residual rights in design whatsoever.

Conditions under which LAI and its foreign partners may place business with the divisions of Lockheed Aircraft Corp. vary, and include:

- **Where more than one division** is capable of doing a job, bids from each may be taken before the contract is placed. Thus, California and Georgia Divisions may both bid on the same airplane design proposal.
- **Contract may be given** to a particular division where personnel and facilities are more readily available to do the job, all other aspects being equal.
- **Where only one division** has the capability to do the job, or where one division is in a better position to do the job by virtue of its past experience in specific areas of a general field, the contract may be placed directly.

Divisional Relations

Relations between LAI and the divisions of Lockheed Corp. are relatively fluid, and work both ways—Lockheed divisions may bring business directly to LAI, or indicate to LAI where a possible opening exists in which LAI might be interested, as well as receiving business from LAI.

During foreign negotiations LAI can act directly as a sales agent for the products of Lockheed Aircraft Corp. divisions, but only when the division specifically asks LAI to do so. However, this does not prevent LAI from gathering sales leads for the various divisions' products and notifying the division regarding prospects. Here, a division may ask that LAI act as its agent and try to sell the product, or may take over the sales activity itself.

LAI would be paid for its work when acting on behalf of Lockheed divisions, but there is no set fee and each case is negotiated separately with the division involved. There could be cases where LAI actually would make no profit from this activity, and some where LAI might not even recover its expenses or ask for them.

How LAI and a foreign partner get together is flexible. LAI may approach a foreign company or the latter may approach LAI. Nor is it impossible for individuals to join in a foreign country and approach LAI with a feasible idea. Or, LAI may see a possible deal and search out individuals to form the foreign company part of the enterprise.

J. Kenneth Hull has been president of LAI since its start, assuming the post from the presidency of Lockheed Aircraft Service, a job he held from the formation of that organization in 1947.

Vice presidents of LAI who came from LAS are J. W. Clutter, W. D. Hammond and P. M. Willcox. W. Scott McGilvray, former Lockheed Aircraft Corp. international development manager, also is an LAI vice president.

In 1953, Lockheed Aircraft Service (Overseas) started a program of technical assistance with Kawasaki Aircraft Co., Ltd., at Gifu, Japan, to provide skills required to overhaul Japan-based U.S. military jet aircraft. Kawasaki was able to do the job unassisted within one year. In 1954, Lockheed helped Kawasaki set up a jet engine overhaul facility, and the assistance was completed in 18 months.

In 1955, Lockheed helped Kawasaki set up for production of T-33 jet trainer aircraft, including construction of complete manufacturing facilities, training 1,500 Japanese workers, plus providing management training and technical assistance.

Key Figure

Hull was a key figure in setting up this T-33 production, his work involving technical and legal negotiations as well as establishing the manufacturing facility.

In 1958, Lockheed contracted to provide technical assistance for Kawasaki and Shin Meiwa Industries, Ltd., for manufacture of P2V-7 anti-submarine patrol planes, with Kawasaki as prime contractor and Shin Meiwa as major subcontractor.

Since previous dealings between Japan and Lockheed had involved Hull and his staff when an agreement was signed last month for production of F-104J Starfighters in Japan, this contract was placed under the cognizance of LAI which Hull now headed. The agreement between LAI and Mitsubishi Heavy-Industries Reorganized, Ltd., is the one exception to the pattern of F-104 foreign program management, which usually rests with California Division of Lockheed Aircraft Corp.

New Offerings

Arcs Industries, Inc., Bellmore, N. Y., engaged in the manufacture of electronic and mechanical components, subassemblies and special devices for use in the missile and computer fields; a subsidiary provides engineering, manufacturing and research services. Offering is 100,000 shares of common stock, for public sale at $3.75 per share. Proceeds will be used to discharge certain indebtedness; for advances to the subsidiary; to purchase additional equipment; for working capital.

Keystone Electronics Company, Inc., Newark, N. J., organized (under Delaware law) Jan. 8, 1960; on Jan. 30 it acquired all the outstanding stock of The Keystone Electronics Co. (a Connecticut corporation), engaged in the manufacture and sale of quartz crystals and through a New Jersey subsidiary engaged in the manufacture and sale of special purpose electron tubes. Offering is 200,000 shares of common stock; 133,334 shares to be offered for public sale for the account of the company, and 66,666 outstanding shares by the holders thereof. The offering to be made at $3 per share; present book value of outstanding shares is estimated at $.89 per share. Proceeds of the sale of the 133,334 shares will be used for additional equipment and inventory; for research and development; balance for working capital purposes.

International Rectifier Corp., El Segundo, Calif., engaged in the development, manufacture and sale of semiconductor devices. Offering is 120,000 shares of common stock; 60,000 shares to be offered for public sale for the account of the company, and 60,000 outstanding shares by the present holder thereof; offering price and underwriting terms to be supplied by amendment. Proceeds of the company's sale of 60,000 shares will be used for equipment for the manufacture of new products; for carrying of increased inventories of finished products; for additional capital investments in foreign companies; balance will be added to working capital to finance expanded operations.

Burnell & Co., Inc., Pelham Manor, N. Y., engaged in the design, manufacture and sale of electronic components known as filters or filter networks and conductors or coils. Offering is 200,000 shares of common stock, for public sale at $3 per share; an additional 10,000 shares will be offered pursuant to the company's restricted stock option plan. Proceeds will be used to pay the company's $100,000 bank loan; for the manufacture of magnetic amplifiers and the establishment of a new crystal filter division; for the purchase of new automatic winding and testing and production equipment; balance will be added to working capital.

Collins Radio Co., Cedar Rapids, Iowa, engaged in the design, development, manufacture and sale of specialized radio communications equipment. Offering is $12,000,000 of convertible subordinated debentures, due 1980, for public sale; interest and conversion rates, public offering price and underwriting terms to be supplied by amendment. Proceeds will be added to general funds and will be used as needed.

Tool Research and Engineering Corp., Beverly Hills, Calif., organized in June, 1959, is the successor (by statutory merger in August, 1959) to three California corporations. Company is principally engaged in the design and fabrication of production tooling; the development and construction of high precision machinery, automation machinery, ground support equipment and ground handling equipment; in project design and engineering; the production of stainless steel honeycomb core for aircraft and missile programs. Offering is 350,000 shares of common stock for public sale; offering price and underwriting terms to be supplied by amendment.

In February, 1960, the company contracted to acquire all the outstanding stock of Hillgren Manufacturing Co. and 76% of the outstanding stock of Western Lock Mfg. Co. Aggregate price of the stock is $5,014,035; $3,635,000 payable in cash and $1,379,035 payable in company notes. Of the proceeds of the sale $3,635,000 will be used to pay the cash portion of the purchase price; remainder of the proceeds will be added to working capital. Sellers of the stock are G. & A. Management Co., Carl A. Hillgren, Alice R. Hillgren and Carl C. Hillgren, trustee.

Systron-Donner Corp., Concord, Calif., engaged in the research and development, design, manufacture and sale of electronic and electromechanical instruments and systems. Offering is 442,700 shares of capital stock for public sale; offering price and underwriting terms to be supplied by amendment.

Under an agreement dated January, 1960, the company will acquire all of the outstanding capital stock of Donner Scientific Co. in exchange for the 442,700 shares of the company's stock; said shares will be delivered to the present owner of all of Donner's outstanding stock, who will cause the shares to be delivered to the underwriters for public distribution.

Servonics, Inc., Alexandria, Va., engaged in the design, development, manufacture and sale of certain electronic and electromechanical systems, instruments and components. Offering is 76,600 shares of common stock, for subscription by common stockholders at the rate of one new share for each five shares held; record date and subscription price to be supplied by amendment. Offering also includes warrants for the purchase of 24,000 common shares, and the shares issuable upon exercise of the warrants, which warrants were issued in connection with a stock offering in April, 1959. Proceeds will be used to retire bank note indebtedness of $100,000; for the purchase of additional machinery, equipment and facilities to expand the company's manufacturing and engineering capability

to provide additional working capital to finance government and other contracts; to finance the initial payments on land for a future plant site; balance for general corporate purposes.

General Instrument Corp., Newark, N. J., engaged in the manufacture of electronic components and end products. Offering is 200,000 shares of common stock for public sale; offering price and underwriting terms to be supplied by amendment. Proceeds will be used to repay $3,000,000 of bank borrowings; balance will be added to working capital.

Magnasync Corp., North Hollywood, Calif., engaged in the manufacture and sale of electronic equipment and related precision products. Offering is 200,000 shares of capital stock, for public sale at $5 per share. Proceeds will be used to repay interim loans; for expansion of laboratory facilities and personnel for research and development; to increase plant production facilities, etc.

Universal - Cyclops Steel Corp., Bridgeville, Pa., engaged in the production of specialty steels. Offering is 200,000 shares of common capital stock for public sale; offering price and underwriting terms to be supplied by amendment. Proceeds will be added to the company's current funds which will be used as needed for future plant expansion and improvements.

Riddle Last-Quarter Loss Down From 1958

Washington—Riddle Airlines, Inc., under new management since October, reported net losses for the last three months of 1959 were $47,353 as compared with a net loss of $347,320 for the same period of 1958.

A comparative profit and loss statement issued by the carrier shows that Riddle's scheduled freight and charter operations produced revenues of $1,577,079 for the airline as compared with operating revenues of $2,808,460, including $910,673 realized from military Logair contracts, during the fourth quarter of 1958.

Expiration of the airline's military contract last June was reflected in the fourth quarter figures which recorded a drop in revenue miles flown from 2,928,458 for the 1958 fourth quarter to only 1,238,993 for the last three months of 1959. Available ton miles offered by Riddle in the same quarter dropped from 19.3 million to 8.8 million.

Operating expenses of the carrier, reflecting both a reduction in available ton miles offered and tighter cost control methods, reduced Riddle's operating expenses from a total of $2,042,371 in the fourth quarter of 1958 to $1,741,208 or the same period of last year.

In a report to company stockholders, President Robert M. Hewitt pointed out that Riddle hopes to bid successfully on Logair contracts that will be announced by the military by July 1. He estimated that if the airline had retained its Logair contracts through last year, Riddle would have earned a net profit for the fourth quarter of between $150,000 and $200,000.

Acquisitions And Mergers

Consolidated Diesel Electric Corp. has acquired control of Ultradyne, Inc., Albuquerque, N. M., producer of pressure transducers, through a stock transaction.

Bowmar Instrument Corp., Ft. Wayne, Ind., has acquired Applied Dynamics, Ann Arbor, Mich., manufacturer in the computer field, and will operate the acquisition as an independent company.

Ionics, Inc., Cambridge, Mass., has purchased all assets of Electron Arc, Inc., Lynn, Mass., and will operate the electrical equipment manufacturing company as a division. Ionics uses Electron Arc silicon rectifier power supplies in its commercial electric membrane plants for desalting brackish water.

Telex, Inc., St. Paul, Minn., has acquired a 25% interest in Electro-Logic Corp., Venice, Calif., producer of digital-indicating voltmeter and other instruments.

H. K. Porter & Cie S. A., international subsidiary of H. K. Porter Co., Pittsburgh, has acquired 51% of the stock of King Aircraft Corp., Ltd., Glasgow, Scotland, supplier of aircraft engine and airframe accessories including fasteners, clamps and couplings.

Financial Briefs

Cessna Aircraft's recently purchased minority interest in French aircraft builder Max Holste (AW Feb. 15, p. 33) amounts to 49%. Cessna's European sales organizations will continue to control sales promotion while Holste, under license agreements, will handle any European manufacturing. If Cessna decides to build the Max Holste Super Broussard feeder liner in the U.S., the aircraft's Bastan turboprops will be built under license by Continental. Continental holds U.S. license rights for all Turbomeca engines.

American Metal Products Co. net income for the year ended Dec. 31 was $1,938,992 or $1.40 a share on an average of 1,377,777 common shares compared with 1958 earnings of $1,647,522 or $1.21 a share on an average of 1,330,025 common shares outstanding. Sales in 1959 totaled $57,385,535, compared with 1958 net sales of $46,397,963.

B. F. Goodrich Co. net sales for 1959 totaled $771,591,342, an increase of 10.7% over 1958 sales of $697,296,556. Net earnings for 1959 were $37,580,186 or $4.18 a share, compared with $35,457,421 or $3.95 a share the year before.

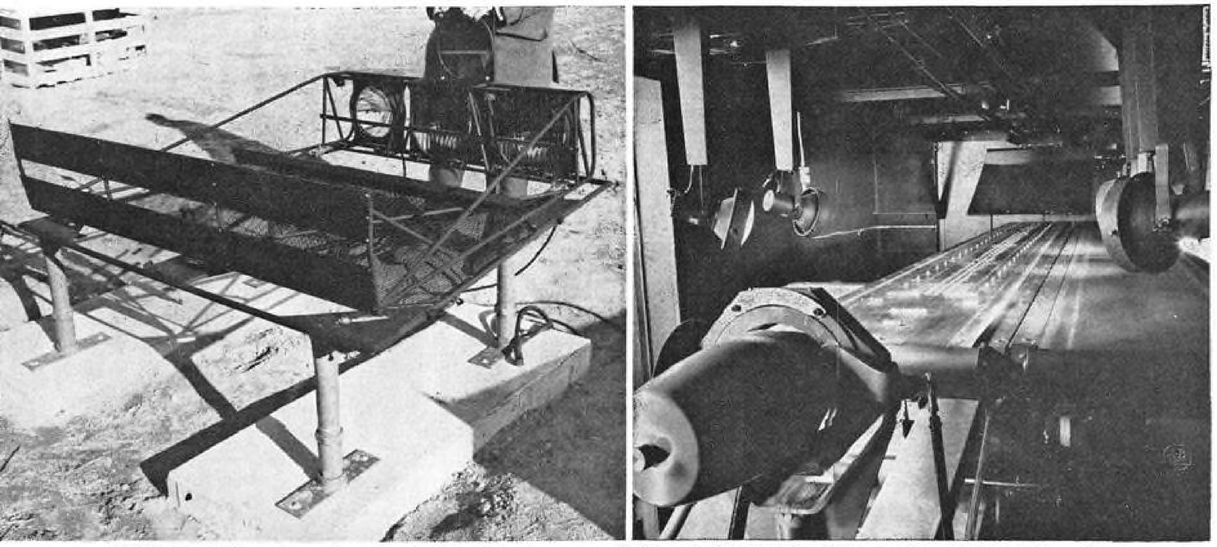
Speer Carbon Co., St. Marys, Pa., reported record net sales of $23,525,268 for 1959. Sales for the previous year were $18,338,899. Net income of the company, which manufactures carbon, graphite and ceramic products and electronic components for the missile, electrochemical, electrometallurgical, nuclear and automotive industries, was $1,970,817 or $2.20 a common share for 1959, compared with $1,176,034 or $1.30 a common share in 1958.

North American Aviation expects to exceed $1 billion in sales in Fiscal 1960, J. H. Kindelberger, board chairman, said at the company's annual meeting. The company had sales of more than $1 billion in 1959 and 1957. Current backlog, however, has dropped to $695 million, from $765 million a year ago. In the last fiscal year 43% of North American's sales were from missiles, electromechanical and electronic products, rocket engines, nuclear reactors and architectural metals compared with 33% in the previous year.

Thompson Ramo Wooldridge sales for the year ended Dec. 31 totaled a record $417,748,953 compared with $340,621,767 in 1958. Total sales in the missile, space and electronics field were $167,153,000, an 87% increase over the 1958 figure, $89,382,000. Net income in 1959 was $9,743,918 or $3.02 a share on 3,119,503 common shares, compared with $8,979,232 or $2.86 a share on 3,024,983 shares in 1958.

O. K. Electronics Corp. is merging with Thermal Controls, Inc. The companies, both of Nutley, N. J., will operate under the name Thermal Controls, manufacturing thermal time delay relays, high vacuum fuses and other thermal devices.

Garrett Corp. sales for the half year ended Dec. 31 totaled a record $107,824,000 compared with $81,727,000 on Dec. 31, 1958. Net earnings were $2,703,000 compared with $1,241,000 for the previous year's first half. Garrett has formed a subsidiary company, Garrett (Japan), Ltd.



CRADLE holds three lamps for red and white glide slope system (left). At right is Dalto flight simulator (AW Feb. 1, p. 93).

FAA Evaluating Variety of Landing Aids

By Robert H. Cook

Atlantic City, N. J.—Federal Aviation Agency is moving rapidly toward its goal of an all-weather landing system through round-the-clock testing of runway and approach area hardware at the National Aviation Facilities Experimental Center here.

Installed along the first 2,000 ft. of NAFEC's 13-31 instrument landing system runway are five different versions of visual glide slope aids and five new runway lighting systems. Center project officers hope they will make a significant contribution toward elimination of such hazards as the "black hole" at touchdown in both fair and foul weather.

NAFEC feels the evaluation program is particularly significant because it is providing FAA with its first opportunity to engage in "live" testing of the hardware with military, commercial and general aviation pilots.

Pilot comments on the various landing aid configurations currently are being compiled, primarily on the basis of questionnaires filled in by each participant, and the experimental center expects to submit an interim report on the status of the program to FAA's Bureau of Research and Development within the next few weeks.

While much is expected from eventual adoption of some of the systems under evaluation, NAFEC cautions that they will not be cure-alls and that they will fit into an all-weather landing system that will still rely heavily upon radar, ILS systems and some automatic landing systems also undergoing tests at the center. Project officials point out that such items as the visual glide slope indicators being tested could prove valuable as backup reference to ILS systems or could provide the first practical landing aids at small airports having neither ILS nor radar facilities.

Weather is a major problem in the flight test program, and project pilots stay on an alert status, ready to fly at the appearance of the below minimum conditions which provide best test information. NAFEC hopes it can speed up evaluations by installing special windshields in test aircraft to simulate adverse weather conditions. One suggestion has been to install double-pane windshields filled with a water and clay solution with controllable interior lights to simulate varying visual conditions.

Using a Configuration A approach light system, NAFEC's 10,000 ft. ILS runway is equipped to test the following runway lighting systems:

- **Fluorescent runway edge** floodlights.
- **Incandescent runway edge** floodlights, scheduled for installation this month.
- **Three configurations** of narrow-gage runway lighting systems which form parallel tracks for a distance of 2,000 ft. down the runway from the threshold.
- **Centerline runway** and taxiway lights.

Installed along the sides of the first 1,000 ft. of runway are several systems of visual glide path aids which generally work on the principle of aligning different colors of light to coincide with a glide slope angle of 2.5 deg. They include:

- **Tri-color**, using yellow, green and red lights.
- **Amber**, combining green and amber.
- **Red and white**, also known as the Calvert and Royal Aircraft Establishment (RAE) system.
- **Double Bar** with amber and white lights.
- **Mirror system** with amber and green similar to the old system used on aircraft carriers.

During a series of touch and go landings made in almost ideal weather and observed by AVIATION WEEK, the test aircraft radioed instructions for various lighting configurations, all of which were easily identified from an altitude of about 1,250 ft. and a distance of four miles. Narrow gage systems displayed gave a particularly clear touchdown target, with the only problem encountered being a necessity to vary light intensities. NAFEC feels more extensive evaluation will be needed to arrive at a light level acceptable to a majority of users.

Fluorescent runway edge lighting, using eight-foot-long tube lamps in raised metal troughs to form an almost continuous bar of light along the runway edge, aided in outlining the touchdown area from a distance, but this system has the disadvantage of a constant brilliance that cannot be controlled during actual touchdown. NAFEC plans to test a similar installation this month with controllable quartz lamps of high intensity.

Various types of narrow gage systems tested seem to function equally well on a unit comparison basis, and the final decision on which system should be adopted depends primarily on the cost of installation.

Systems installed at NAFEC are similar in that they consist of a series of lights arranged to form bars flanking the centerline of the runway and spaced 100 ft. apart for a distance of 2,000 ft. from the threshold. Spacing between the two parallel series of bars has been designed for gages of 35, 40 and 60 ft., divided by the runway centerline lights. Hardware used in the different configurations includes the Elfaca flush-mounted type—tested last year by the Air Force at Dow AFB, Me., and March AFB, Calif., and recently installed at New York International Airport (AW Feb. 29, p. 87)—smaller MC-2 semi-flush units and a semi-flush pancake light system, which also is used for runway centerline guidance and on high-speed turnoffs.

Rugged construction of the Elfacas, manufactured by Structural Concrete Products Corp., is well suited for landing areas which must handle heavy aircraft such as the Boeing B-52 test aircraft used at Dow AFB, Me., or the new commercial jet transports landing at Idlewild, but FAA estimates indicate the cost of installing them might be prohibitive at many airports. Bureau of Research and Development estimates the cost of installing each Elfaca for NAFEC was about $2,700.

Lighting Costs

FAA figures indicate that the same lighting configuration can be duplicated with MC-2 semi-flush lights made by the Multi Electric Corp. at a cost on new runways of $500 per unit. Designed to Air Force specifications, the MC-2 is basically an 18 in. deep steel can containing a suspended lamp shining through a prism lens.

From the standpoint of both installation and maintenance costs, the General Electric pancake fixtures appear most economical. FAA estimates a complete installation cost per unit of $100 for this type.

Entire unit is housed in a six inch diameter disk rising one half inch above the runway surface.

Installation requires only the drilling of a one inch recess for the pancake body in concrete, with the special nylon-coated electrical wiring placed in a one inch deep trench running along the runway surface. Unit recess and wire trench are later sealed to the concrete with a special epoxy, or bonding agent. Pancake bulb shines from beneath a heavy metal strap that arches over the top of the unit and is held in place with two screws for easy replacement. FAA reports that NAFEC maintenance crews have been able to replace bulbs at the rate of 70 units per hour because of the fixture's simplicity of construction.

Pancakes now being used by NAFEC are equipped with 45, 25 and 10 watt bulbs, which FAA research directors say may soon be replaced with 200 watt high-intensity bulbs to provide better illumination. FAA tests indicate that the quartz type bulbs used in the pancake can be seen between 800 and 1,000 ft. away in daylight conditions with one-sixteenth of a mile visibility. Life expectancy of the bulbs is estimated at 1,000 hr. at full power.

Glide Slope Systems

Among the visual glide slope guidance aids displayed, the most easily identified and followed to the runway intersection appear to be the red and white and the double bar systems. Now being used at London Airport and by the Royal Air Force at Farnborough, England, the red and white works in much the same manner as a pin hole camera projecting two colors of light which the pilot must stay between in order to remain on the correct glide slope angle.

Basic unit of the system contains three lamps of 20,000 candlepower each, with a red filter over their top halves. They are mounted in the rear of a tubular steel cradle with the light rays shining through a forward aperture slit of about six inches. Units flank the runway in sets of three spaced 22 ft. apart.

Correct aircraft alignment with this system requires that the pilot see white in the front units and red in the rear at an altitude of about 1,250 ft. and distance of 4.8 mi. from touchdown. In practice, the object is to descend at an angle which will show two distinct colors at the same time. Descent below the proper glide path angle shows only white lights, while an angle which could lead to an overshoot of the touchdown area shows only red. Changing hue of the colors during descent permits a visual reference to judge the degree of necessary glide slope angle correction.

The Double Bar system uses the principle of lining up two separate color bars into one level combination of amber and white colors. Lights installed along Runway 13-31 are sealed beam types of 300 watt power each. About 500 ft. from the threshold, a battery of three white lights, 20 ft.

apart and mounted on 23.5 ft. high poles, flank each side of the runway at a distance of 120 ft. from the edge. A second battery of amber lights, on a level with the runway and in two groups of five each, flank the runway 500 ft. farther down from the threshold.

Total effect of this combination is that the white light bar can literally be used in the manner of an artificial horizon by visually keeping it in level alignment with the flanking amber color bars. Perfect coordination with the 2.5 deg. glide slope angle presents a solid color bar of amber-white-amber while an excessive angle reveals a white line above the amber.

The amber system is located 1,000 ft. from threshold on the left side of the runway. At this point, two batteries of seven 200 watt sealed beam units equipped with green filters are mounted on six-foot-high wooden frames installed parallel to each other and about 20 ft. apart. Sixty-six-feet farther down the runway is a four-foot-high wooden frame with four amber lights arranged in the form of a square.

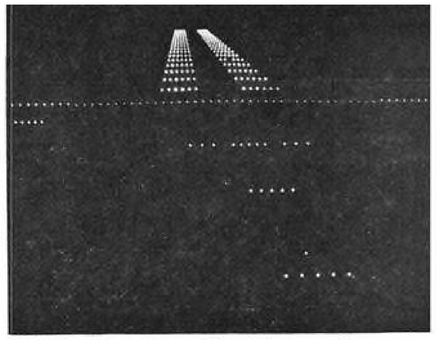
Proper flight alignment with this system requires a color view of an amber dot, or "meatball" as the system is nicknamed, in the middle of a green band. Approach above correct glide slope angle places the amber dot above the green bar. The full system appeared as a large green ball at a great distance during the flight observed by AVIATION WEEK, and intensity of the forward green lights made it difficult to observe the position of the amber color.

Color Combination

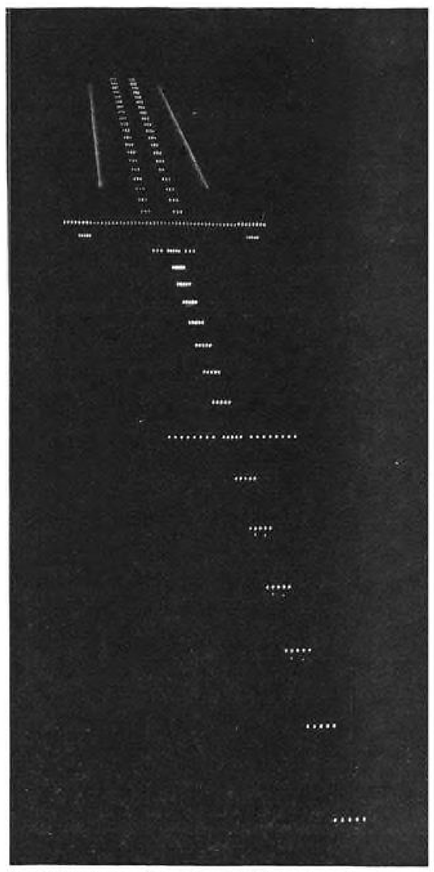
A combination of red, green and amber colors is used in the tri-color system, housed in two four-foot-high metal stands on each side of the runway 1,000 ft. from the threshold. Each stand contains an 18-in.-high projector with a five inch lens opening and a small electric motor which operates a flasher shutter at the rate of one movement a second. Stand mounted to the left of the runway has lamp angles one half a degree higher than the unit on the right to give the pilot a method of double checking his glide slope angle. If the aircraft landing is above the correct angle both lamps appear amber; if it is low, the lamps are red with the left unit turning this color first. Correct glide slope angle with no deviation produces a green color reading from both units.

Final visual glide path aid system undergoing current test and evaluation at NAFEC is the mirror system similar to the system used on aircraft carriers. About 1,000 ft. down the left side of the runway from the threshold. Center technicians have installed a horizontal battery of eight amber-colored lights mounted on a ground level concrete base. About 50 ft. distant, mounted on the back of a truck, is a mirror measuring four feet long and three feet wide.

Extending from each side of the truck are horizontal bars of six green lights each. Ground-positioned lights are focused into the mirror so that an amber colored band appears to center itself in the middle of a green bar when correct glide slope angle is being maintained.



AERIAL view of experimental approach lighting system as seen from 500 ft.



STANDARD Configuration A light system is combined with MC-2 narrow gage lighting, flanked by fluorescents at touchdown area.

WHO'S WHERE

(*Continued from page 23*)

Changes

William J. Conner, Jr., manager of defense and business planning, General Electric Co.'s Missile and Space Vehicle Department, Philadelphia, Pa. Also: **Edward A. Miller**, manager of the Discoverer program for the Missile and Space Vehicle Department.

Robert C. Little, assistant manager of customer service for Air Force aircraft, McDonnell Aircraft Corp., St. Louis, Mo. **William S. Ross** succeeds Mr. Little as chief test pilot and chief of flight operations.

Frank R. Carvell, general manager-rocket motors, Aviation Products Division of B. F. Goodrich Co., Rialto, Calif.

James W. Salassi, director of marketing, B. H. Hadley, Inc., Pomona, Calif.

W. James Bischof, manager-instrument development group, Instrument Division of Bourns, Inc., Riverside, Calif. Also: **Stephen Hluchan**, sensor and materials engineer for the Instrument Division.

William C. House, director-systems management, Aerojet General Corp, Azusa, Calif.

Stan Burns, director of Engineering, Ground Support Division, American Electronics, Inc., El Monte, Calif.

Robert P. Wakerman, technical director, Military Programs Division, Allen B. Du Mont Laboratories, Inc., Clifton, N. J. The division has also appointed the following chief systems engineers: **Eric Herud**, reconnaissance systems; **Richard Petruzzelli**, data and display systems; **John De Bell**, radar systems; **Anthony Cuomo**, support systems; **Charles Benenson**, communications systems.

Robert G. Brown, director, Advanced Concepts Research and Development, AC Spark Plug Division of General Motors, Milwaukee, Wis. Also: **John E. Shultz**, head of a new group to develop and produce an inertial heading reference for aircraft.

Solomon Charp, manager of navigation and control electronic equipment, General Electric Co.'s Missile and Space Vehicle Department, Philadelphia, Pa.

H. G. MacKenzie, director-interline sales, American Airlines, Inc.

Michel Bergerac, international sales manager, Cannon Electric Co., Los Angeles.

Eddie Holohan, manager of military and international affairs, The Flying Tiger Line, with headquarters in Washington, D. C.

G. E. Putness, assistant chief engineer for administration, Convair Division of General Dynamics Corp., San Diego, Calif.

Dr. Howard A. Wilcox, director of research and engineering, Defense Systems Division, General Motors Corp., Detroit, Mich. Also: **Moreton Price**, director of sales, Defense Systems Division, with headquarters in Washington, D. C.

James E. Kirch, navigation section head, Motorola's Western Military Electronics Center, Phoenix, Ariz.

Dr. Maurice A. Meyer, director of the newly formed Advanced Development Division of Laboratory for Electronics, Inc., Boston, Mass.

analytical, systems, components engineers

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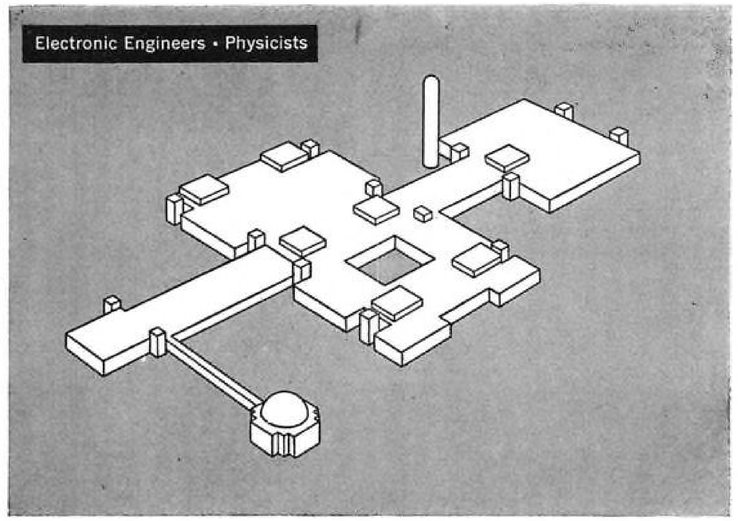

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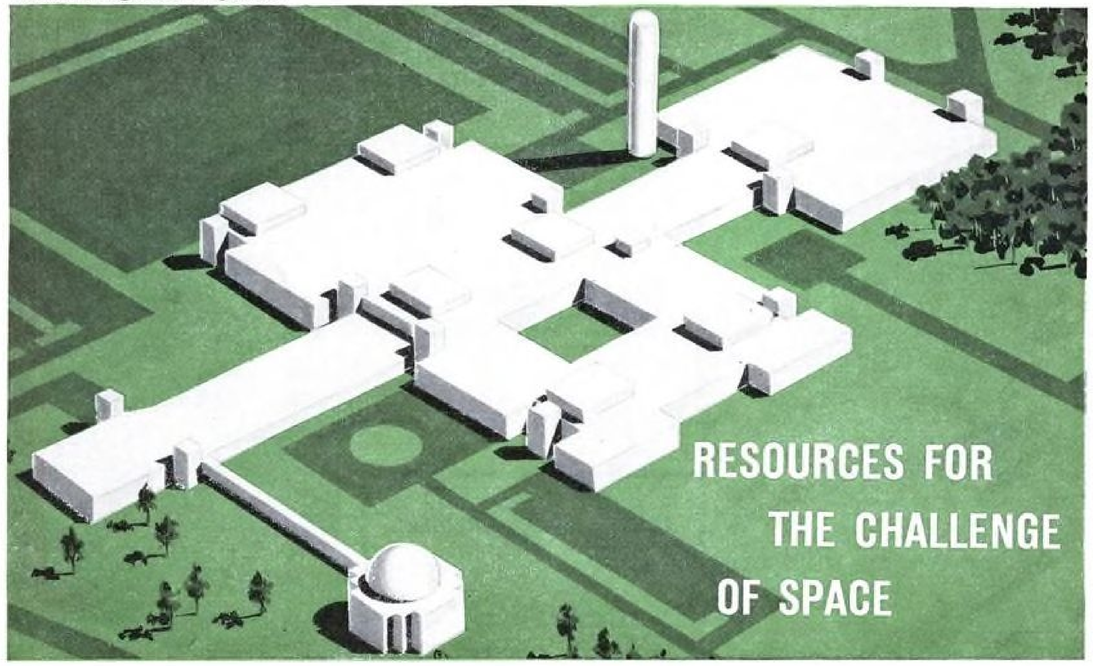

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* * *

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PROBLEMATICAL RECREATIONS 7

What are the last three digits of the number 7^{9999}?

—National Mathematics Magazine

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ANSWER TO LAST WEEK'S PROBLEM: Symbolize the first digits of the multiplier, multiplicand, and product respectively, and then conceiving of the two possible ways of forming the number of digits of product, multiplier, and multiplicand, namely: $m = n_1 + n_2$ or $n_1 + n_2 - 1$, one can see that each way can be satisfied in two possible ways. Hence the answer is no.

LITTON INDUSTRIES
Electronic Equipments Div.
Beverly Hills, California

LETTERS

SPABOAPOA Awards

Your Feb. 29 Letters (p. 102) contains one from Robert B. Bose titled "FAA/ALPA Disputes." This interesting letter generated the thought—why not a Society for the Preservation and Betterment of Airline Passengers of America (SPABOAPOA), to promote the passenger's point of view. Such an organization could bring pressure to bear on management to improve those areas of personal interest to the customer, such as:

Meeting the schedule.
Terminal facilities.
Airborne drinking.
Airborne eating.
Radarless aircraft.
Flight safety.
Indifferent personnel.
Unwarranted delays.

Such an organization would be non-profit and function on contributions from fellow passengers. It could make an award for "The Airline of the Month," and on an annual basis "A Magic Carpet Award" for the best airline of the year. And if appropriate, "The Flying Broomstick" for the worst. No payola please—only service.

Applications for membership in the SPABOAPOA should be addressed to:

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5312 Westpath Way
Washington 16, D. C.

Senior Pilots

Before he is submerged in a wave of letters from outraged airline pilots, let me support Robert Bose in the thoughts he offers in his very fine letter (AW Feb. 29, p. 102). He puts the problem in its real perspective.

Like Mr. Bose, I am not a pilot of any kind. But I do fly commercially with some frequency. I also like to live.

Without resources from dues-paying members to gather statistics, I still feel safe in saying that when a man reaches his sixties his physical capabilities are significantly less than those of a younger man. I'm still in my thirties, but I already notice with dismay a lessening of any physical capability you might name over those of only 10 years ago. Frankly, I don't like to trust my life to men only five years short of what is a mandatory retirement age in many other less demanding occupations, particularly when those men are handling high performance aircraft requiring keen physical agility and ability.

The ALPA argues (AW Feb. 29, p. 47) that there are no statistics to correlate age with accidents. Well, I don't care to become one of those statistics just to satisfy ALPA's demands. Didn't the ALPA recently criticize the FAA for failing to take action that ALPA supported and ask if there would have to be fatal accidents before FAA action? But when FAA acts in this case before fatalities, ALPA cries no statistical proof!

Isn't it peculiar (I don't dare say funny about such a deadly serious matter) how nimble ALPA is with its arguments? The same story claims that "lightning-fast" reflexes are needed only in fighters. I seem to remember recent arguments that the hazards of jet flying, including the need for these same reflexes, supported demands for generous increases to already high salaries. Just a short while before that the same arguments were cited in demanding that something be done about air safety. (That outcry brought about the FAA which the ALPA now attacks so fiercely.)

We should take warning from the railroads. They have enviable passenger safety records. But haven't you noticed that in almost every train wreck with passenger fatalities it is the crack trains—the prima donnas? Who runs these? Why the senior engineers—real old timers whose physical ability has been eroded by time to the point that they are unable to handle a crisis. As in railroading, the senior pilots handle the choice runs—the ones with the high performance equipment demanding the most in alertness, dexterity, coordination, and strength in case of emergency.

Yes, Mr. Bose is right. The issue is clearly the interests of the flying public (unorganized and weak) against those of a small potent organization of pilots.

E. C. HIGHTOWER
Tonawanda, N. Y.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Employe Security

A recent article brought out the complaint that some states were not getting their share of the defense dollar; that California, specifically, got more than its just share.

I would like to comment on this from the standpoint of the employe. Contract cancellations in the missile/aircraft industry have come with little notice in the past, and will undoubtedly continue. Spreading out the contracts to various states, on a more or less equal basis, places the impact and hardship of contract cancellation squarely on the defense worker. When there is little or no industry in the area affected, the skilled worker must then move himself and family to a new area.

Thus, one of the best ways for a worker to increase his "job security," where his present employer may have to curtail his labor force severely, is to have "area security" where employers in the immediate area can help absorb any layoff. This is the situation in Southern California. Layoffs, when dictated by our defense requirements, become less of a hardship on the employe when he is not forced to move his residence.

But consider the situation of the worker (this includes engineers) where there is no "area security." He is horrified by any news of possible contract cancellation, yet because of his isolation he has probably become less efficient, has been lulled into a false security that his job is a "career" appointment, and his entire company's effort has become dulled by the lack of a vigorous, intelligent approach by its labor force; the complacent attitude brings the inevitable cancellation closer to reality.

Competition is needed by the military to get the best product. Spreading out the work would help solve unemployment in many states, but would it develop a healthy industry? Perhaps some of our missiles would be more successful if they had been developed in a competitive environment.

ROBERT FISHER
Canoga Park, Calif.

Defense Organization

Your excellent editorial (AW Feb. 15, p. 21) ought to be read by all Americans. However, I think you should repeat the two basic issues here, and clarify the second, as follows:

"*First*, are we utilizing the full technical, industrial, military and economic capacity of this country to attain a military posture of unquestionable and undebatable superiority that will enable us to continue to provide world leadership? To this we regretfully conclude the answer at present is "No."

"*Second*, are we organizing our defense program around the basic requirements for continued survival as a free nation in the face of the Communist challenge or are we organizing it around arbitrary fiscal limits? Again the answer appears to be a sad "No."

Are we organizing it around arbitrary fiscal limits? Yes.

CARL E. HEYL
Engineer
Bethpage, N. Y.

Robot Tank

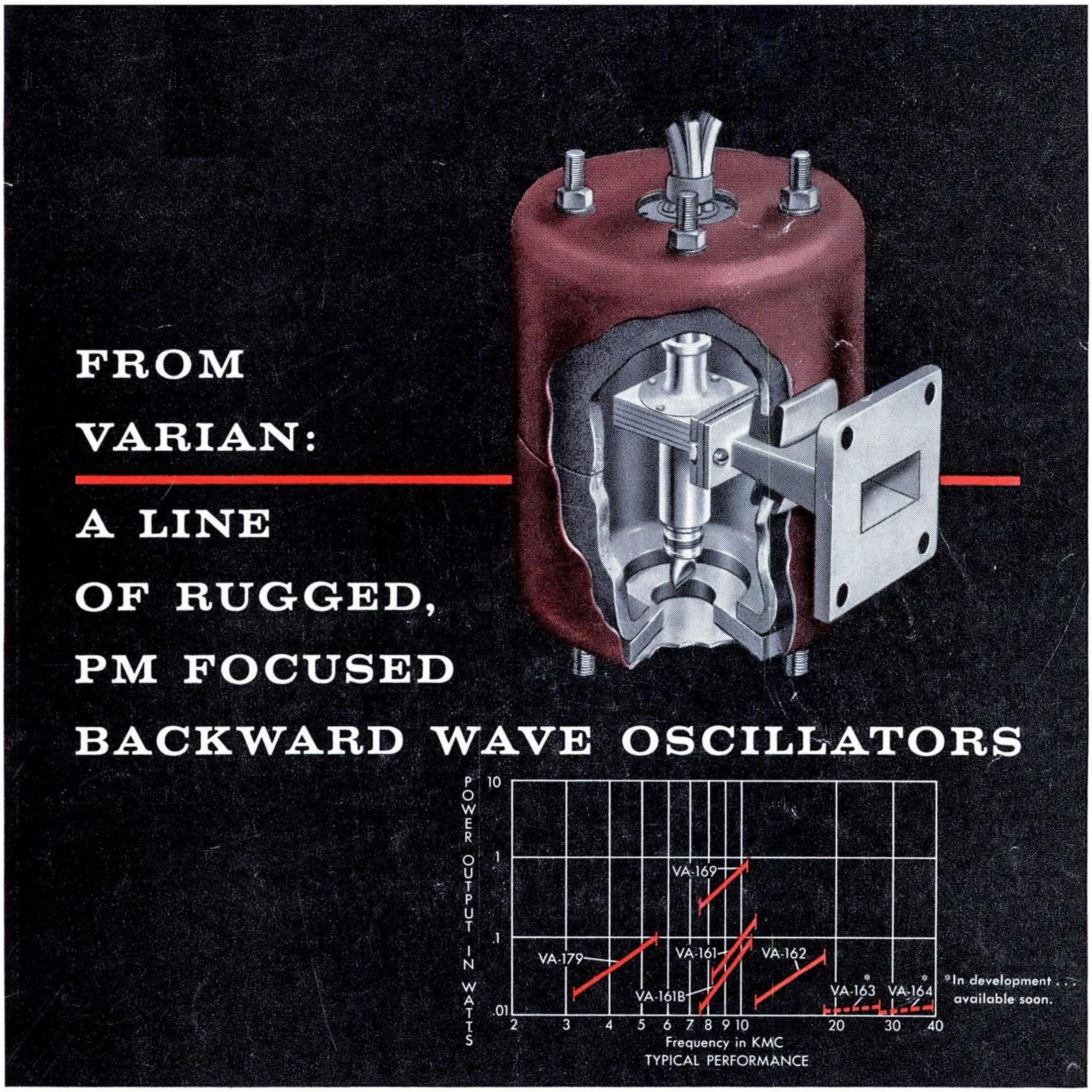
Our attention has been invited to your Jan. 18 issue, and particularly to the Space Technology article entitled "USSR Moon Robot Shot Tests Foreseen" on pp. 28 and 29. The diagram on p. 29 is captioned "New Soviet rocket may be used to launch robot tank 'laboratories' to moon's surface," and the diagram itself refers to "Caterpillar drive engine."

This letter is written to inform you that both "Caterpillar" and "Cat" are trademarks registered for our exclusive use in identifying products of our manufacture. And this certainly is not of our make.

We would suggest that in the future when making such reference, you could use "crawler treads," "track-type tracks," etc.

Please accept this in the spirit in which it is written. Ours are old and valued trademarks, and we continuously strive to protect them.

BURT POWELL
Advertising Manager
Caterpillar Tractor Co.
Peoria, Ill.



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