Aviation Week

Including Space Technology

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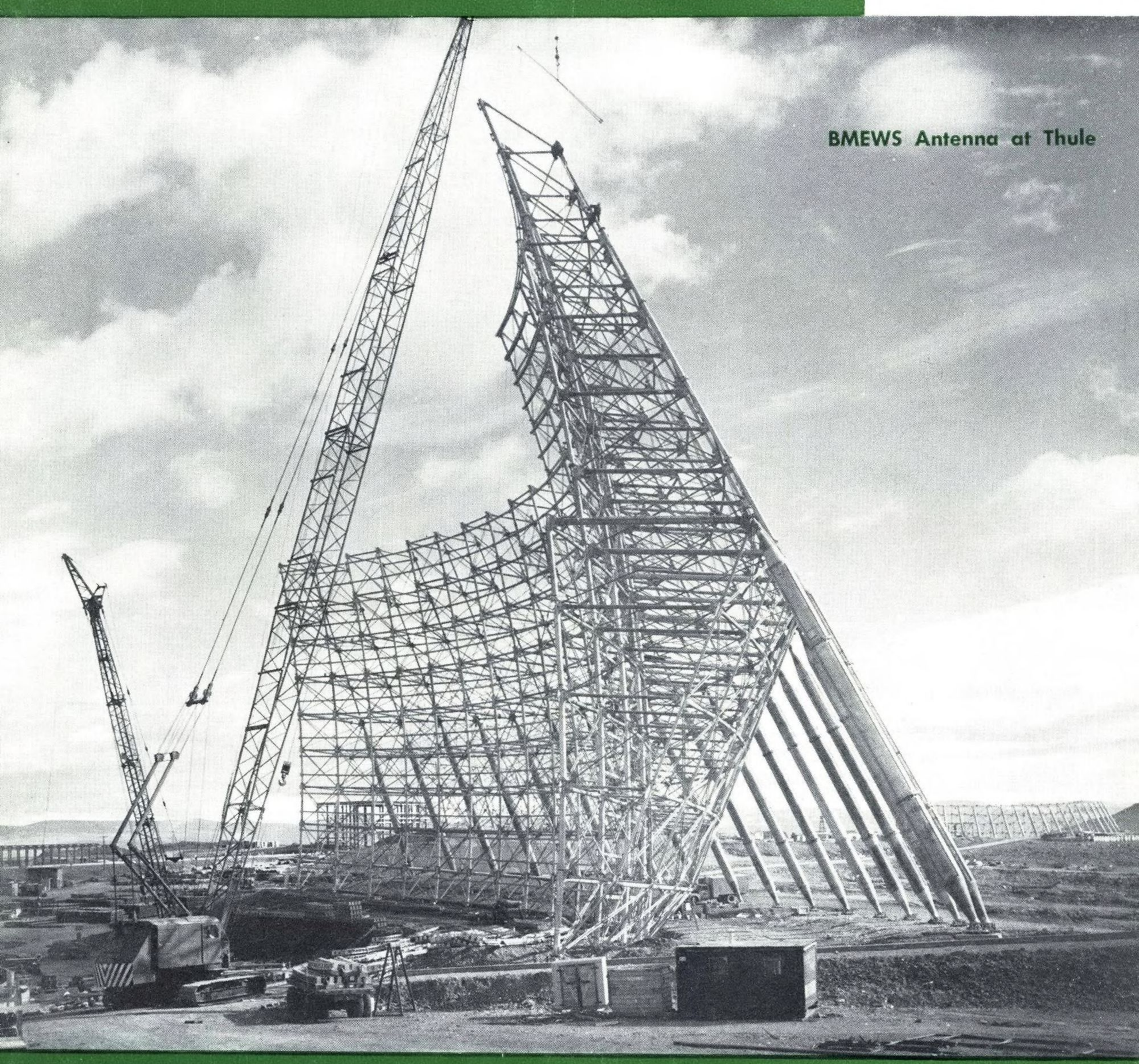
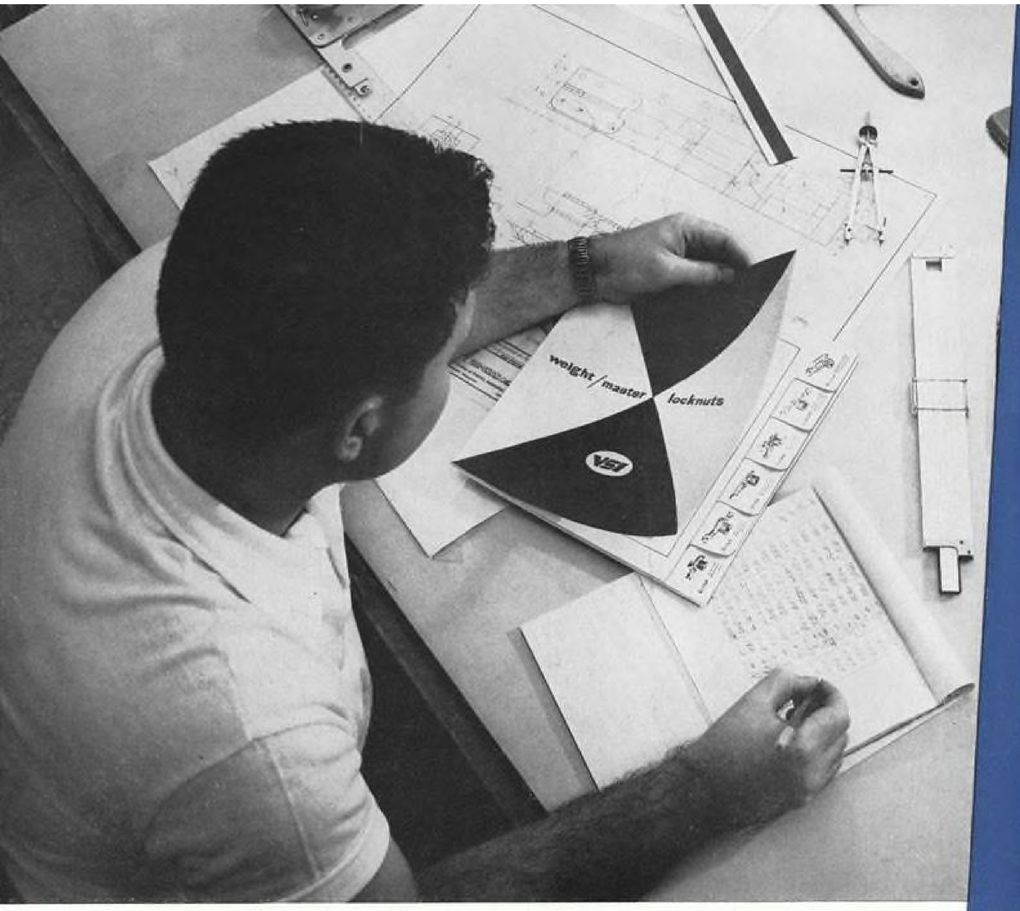
September 28, 1959

Space Spurs Molectronics Activities



BMEWS Antenna at Thule

Report on Interplanetary Strategic Systems



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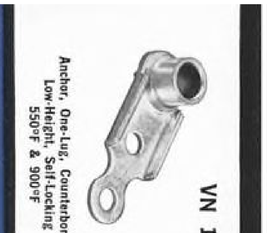
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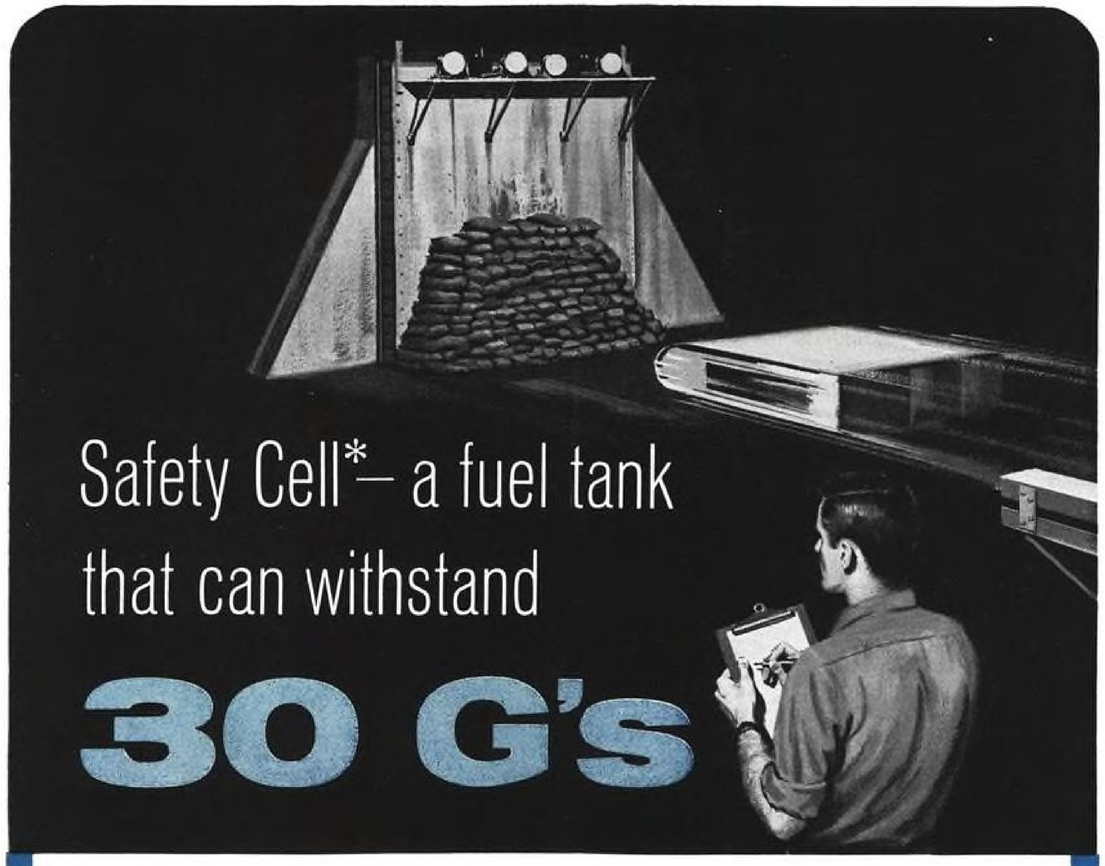

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AVIATION CALENDAR

Oct. 4—Jet Age Air Fair, Bradley Field, Windsor Locks, Conn. Exhibits and flying demonstrations.

Oct. 5-7—Seventh Anglo-American Aeronautics Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.

Oct. 5-7—Fifth National Communications Symposium, Hotel Utica, Utica, N. Y. Sponsor: Institute of Radio Engineers' Professional Group on Communications.

Oct. 5-8—81st General Conference, National Guard Assn. of the United States, Hilton Hotel, San Antonio, Tex.

Oct. 5-9—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

Oct. 6—12th Annual Airport Development & Operations Conference, Hotel Onondaga, Syracuse, N. Y. Sponsor: Bureau of Aviation, New York State Department of Commerce.

Oct. 6-8—12th Annual Meeting, National Business Aircraft Assn., Hotel Leamington, Minneapolis, Minn.

Oct. 6-8—Radio Interference Reduction and Electronic Compatibility Conference, Museum of Science and Industry, Chicago, Ill. Conducted by Armour Research Foundation in cooperation with Institute of Radio Engineers' Professional Group on Radio Frequency Interference. (Classified session on Oct. 8.)

Oct. 6-8—National Airports Conference, Norman, Okla. Sponsors: American Assn. of Airport Executives and the University of Oklahoma, in cooperation with FAA.

Oct. 6-8—Industry-Military Quality Control Management Symposium, Oklahoma City Air Materiel Area, Tinker AFB, Okla.

Oct. 6-9—International Symposium on High-Temperature Technology, Asilomar Conference Grounds, Monterey Peninsula, Calif. Sponsor: Stanford Research Institute.

Oct. 7—Fall Meeting, Underwater Ord-

(Continued on page 6)

AVIATION WEEK Including Space Technology

September 28, 1959

Vol. 71, No. 13

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AVIATION CALENDAR

(Continued from page 5)

nance Division, American Ordnance Assn., National Academy of Science, Washington, D. C.

Oct. 7-8—Second Advanced Propulsion Systems Symposium, New England Mutual Hall, Boston, Mass. Sponsors: Air Force Office of Scientific Research; Avco-Everett Research Laboratory.

Oct. 7-9—Sixth National Symposium on Vacuum Technology, American Vacuum Society, Sheraton Hotel, Philadelphia, Pa.

Oct. 7-9—Special Research and Development Conference, American Management Assn., Biltmore Hotel, New York.

Oct. 7-10—Fourth Annual National Meeting, Air Traffic Control Assn., Biltmore Hotel, Oklahoma City, Okla.

Oct. 7-10—Semiannual Convention, American Society of Tool Engineers, St. Louis.

Oct. 8-10—Society of Experimental Test Pilots' Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif. Third Annual Awards Banquet, Oct. 10.

Oct. 11-16—Third Pacific Area National Meeting, American Society for Testing Materials, Sheraton-Palace Hotel, San Francisco, Calif.

Oct. 11-16—Fall General Meeting, American Institute of Electrical Engineers, Hotel Morrison, Chicago, Ill.

Oct. 12-14—14th Annual National Convention and Logistics Forum, National Defense Transportation Assn., Olympic Hotel, Seattle, Wash.

Oct. 12-14—Annual Meeting, National Association of State Aviation Officials, Mark Hopkins Hotel, San Francisco, Calif.

Oct. 12-14—15th National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 12-16—15th Annual General Meeting of IATA, Imperial Hotel, Tokyo, Japan.

Oct. 12-16—NASA's 1959 Inspection, Langley Research Center, Hampton, Va.

Oct. 13-15—Seventh Annual Air Safety Forum, Hotel Shoreland, Chicago, Ill. Sponsor: Air Line Pilots Assn.

Oct. 14-15—1959 Science and Industry Conference and Exhibit, Conference Bldg., Balboa Park, San Diego, Calif. Sponsor: San Diego County Industries Assn., in cooperation with the Small Business Administration and Department of Defense.

Oct. 14-23—"William Tell II" Seventh World-Wide Interceptor Weapons Meet, Tyndall AFB, Panama City, Fla. Host: Air Defense Command.

Oct. 19-20—15th Annual Convention, Magnesium Assn., Hotel Roosevelt, New York.

Oct. 19-23—47th National Safety Congress, National Safety Council, Conrad Hilton Hotel, Chicago, Ill.

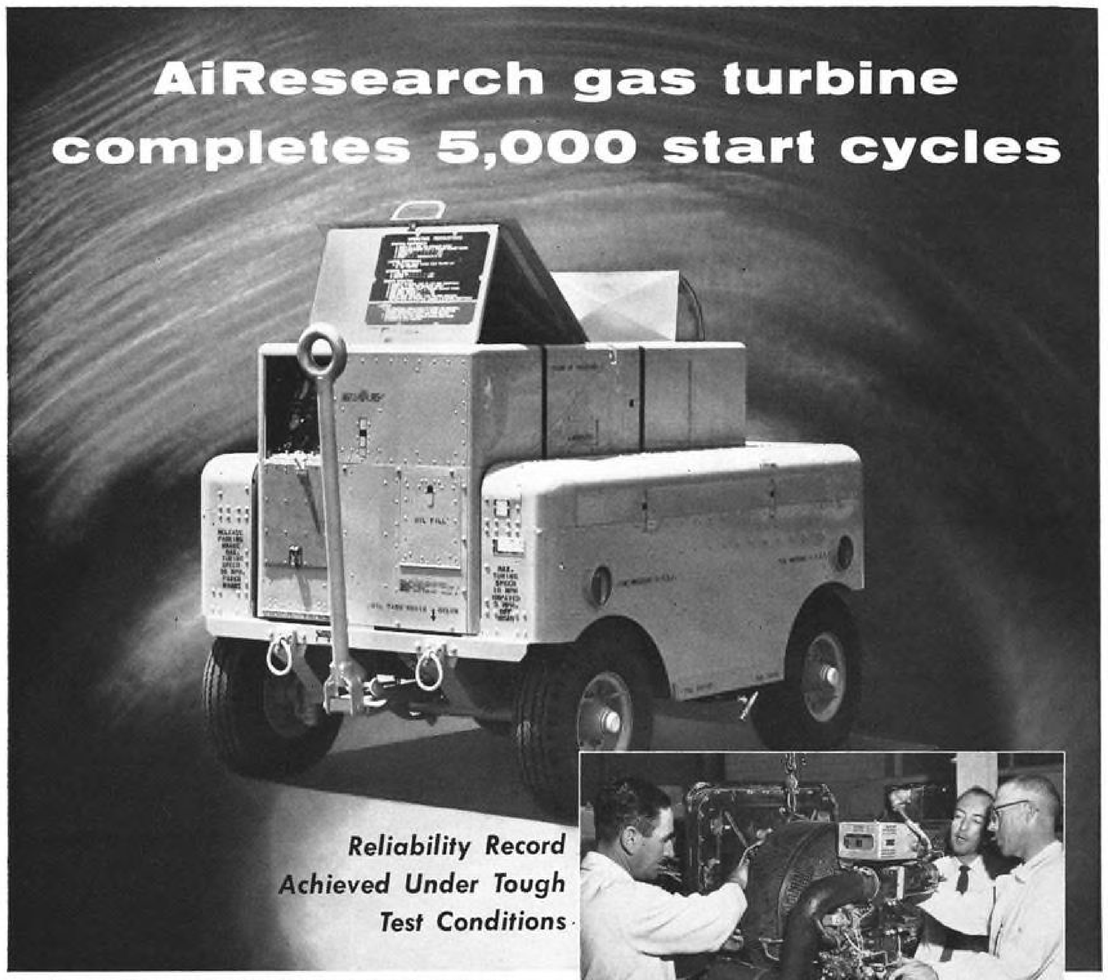
Oct. 19-25—Annual Meeting, Aircraft Owners and Pilots Assn., Galt Ocean Mile Hotel, Fort Lauderdale, Fla.

Oct. 20-21—Conference on Hypervelocity Projection Techniques, University of Denver, Denver, Colo.

Oct. 20-22—Tenth National Conference on Standards, American Standards Assn., Sheraton-Cadillac Hotel, Detroit, Mich.

Oct. 21-23—1959 Annual Meeting, Society for Experimental Stress Analysis, Pick Fort Shelby Hotel, Detroit, Mich.

AiResearch gas turbine completes 5,000 start cycles



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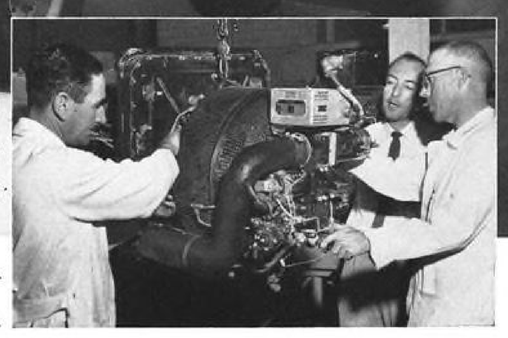

Air Force trailer-mounted MA-1A starter cart with improved AiResearch GTC 85-20 gas turbine unit.

AiResearch engineers inspecting improved AiResearch GTC 85-20 gas turbine unit after successful 5,000 start cycle test.

A world performance record for small gas turbine reliability has been established by this improved AiResearch GTC 85-20 unit . . . 5,000 start cycles. During each start cycle the turbine was brought to peak load twice, with a shut down time of only five minutes. This is equivalent to two main engine starts per cycle.

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Pneumatic power source for the Air Force's trailer-mounted MA-1A starter cart, the engine was torn down under supervision of Air Force personnel from Wright Air Development Center. It is now undergoing further tests upwards of 10,000 start cycles.

This intense product improvement in gas turbine reliability is matched only by AiResearch versatility. The world's largest manufacturer of lightweight turbomachinery, AiResearch has designed, developed and produced more than 8,500 gas turbines of all types vital to military and commercial ground support as well as auxiliary and prime power applications. Your inquiries are invited.

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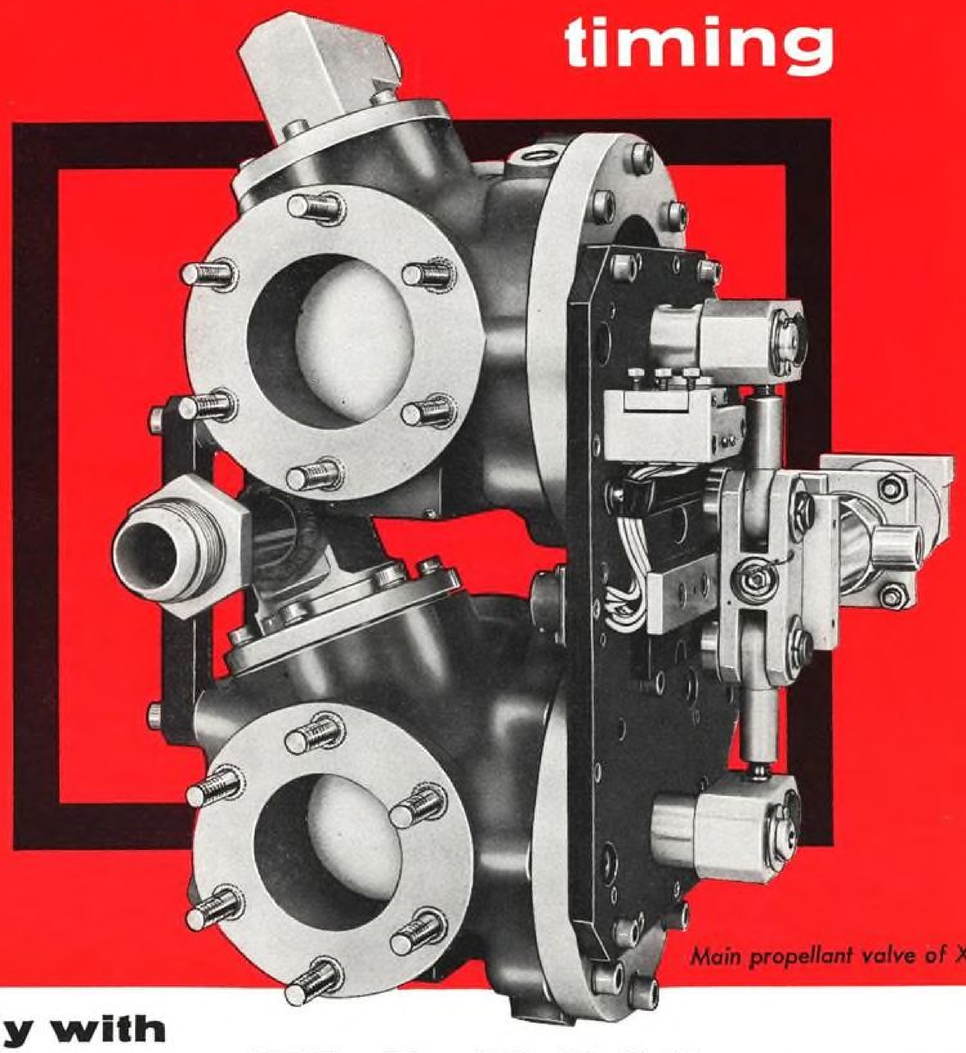

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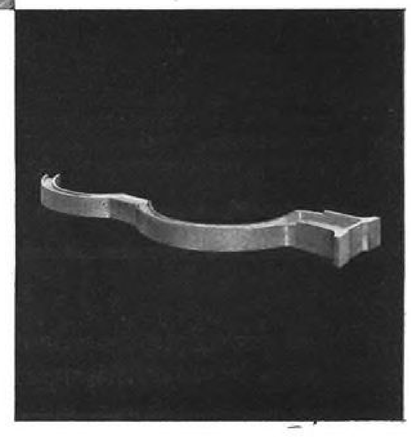

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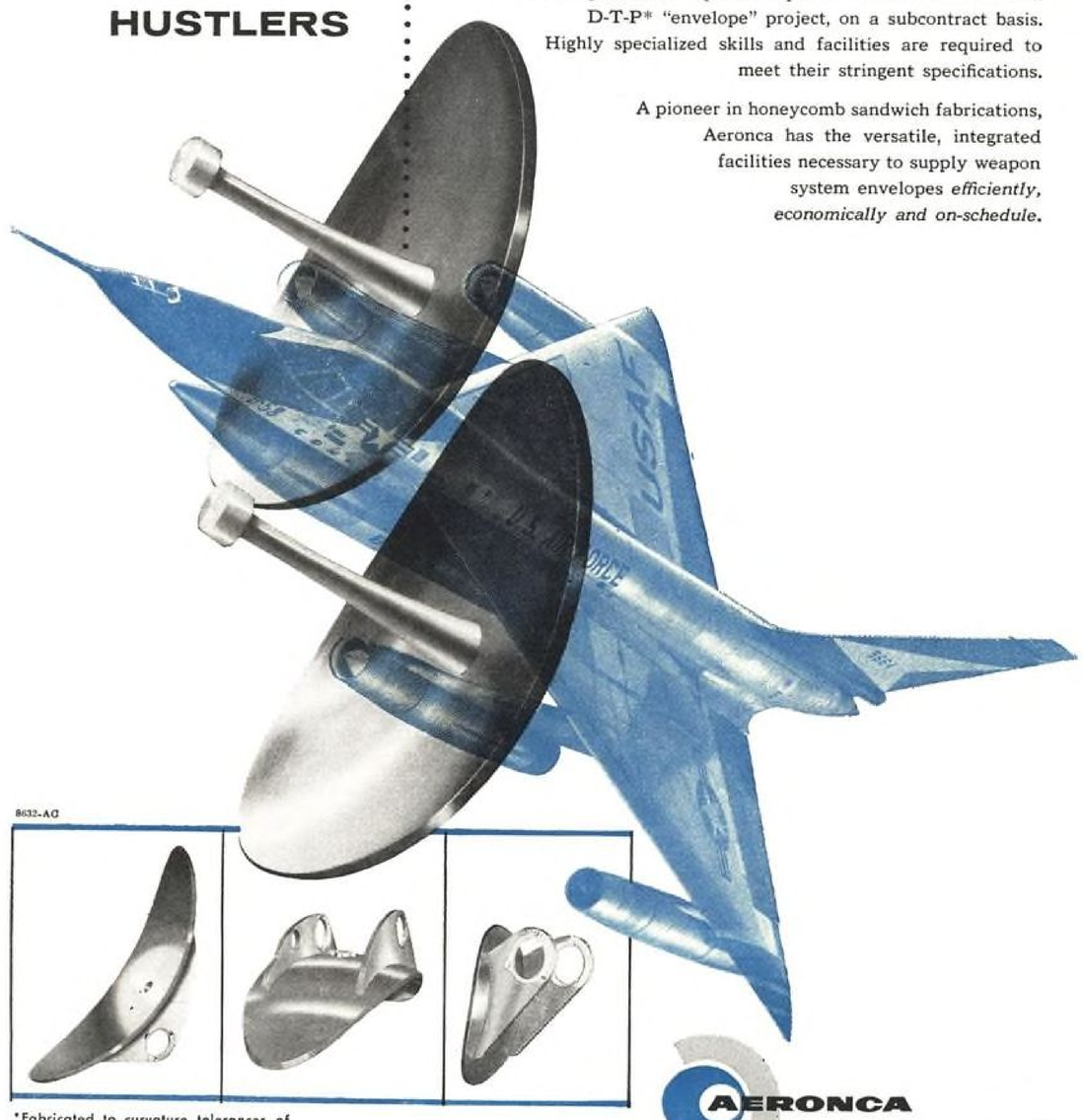

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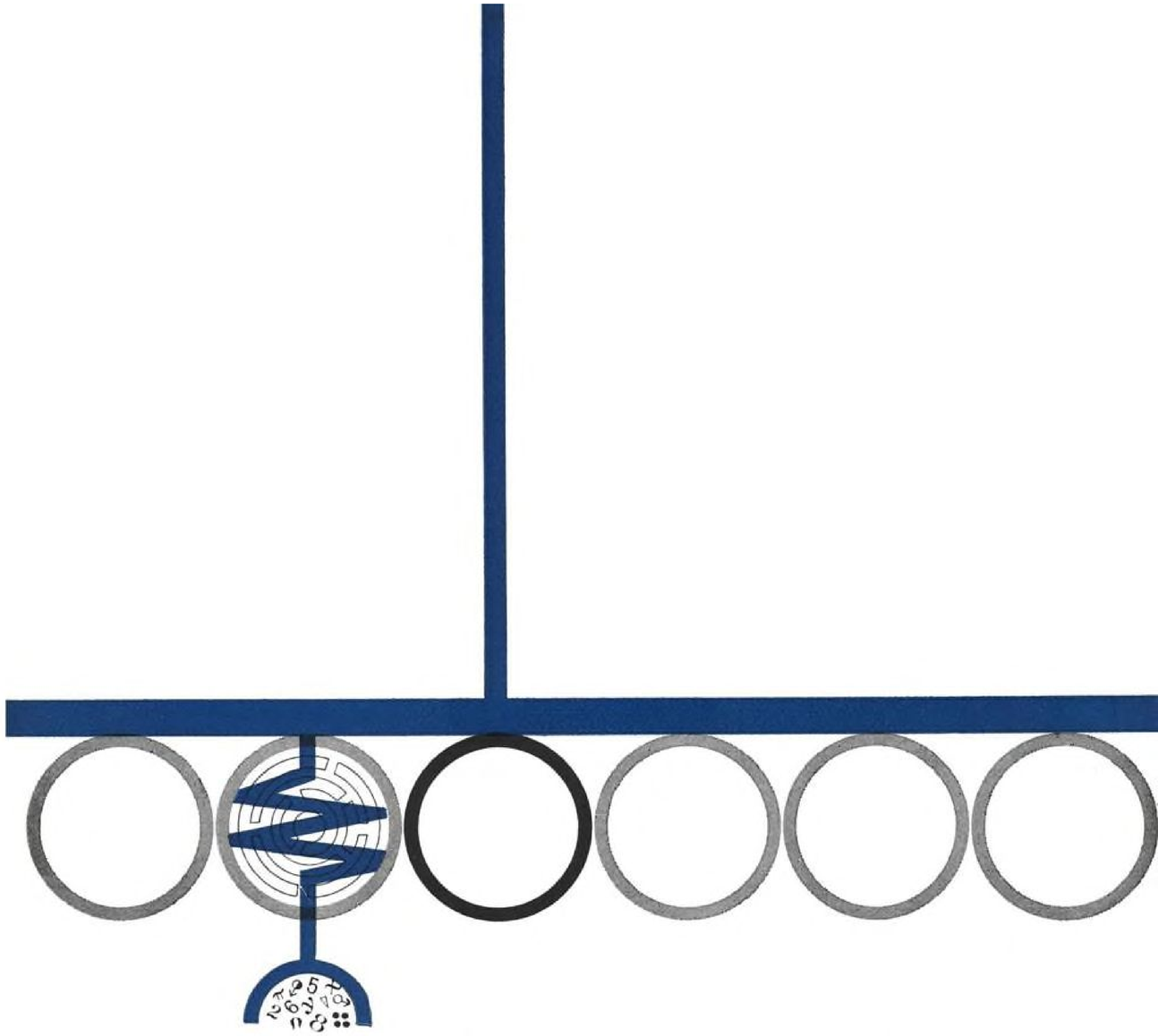

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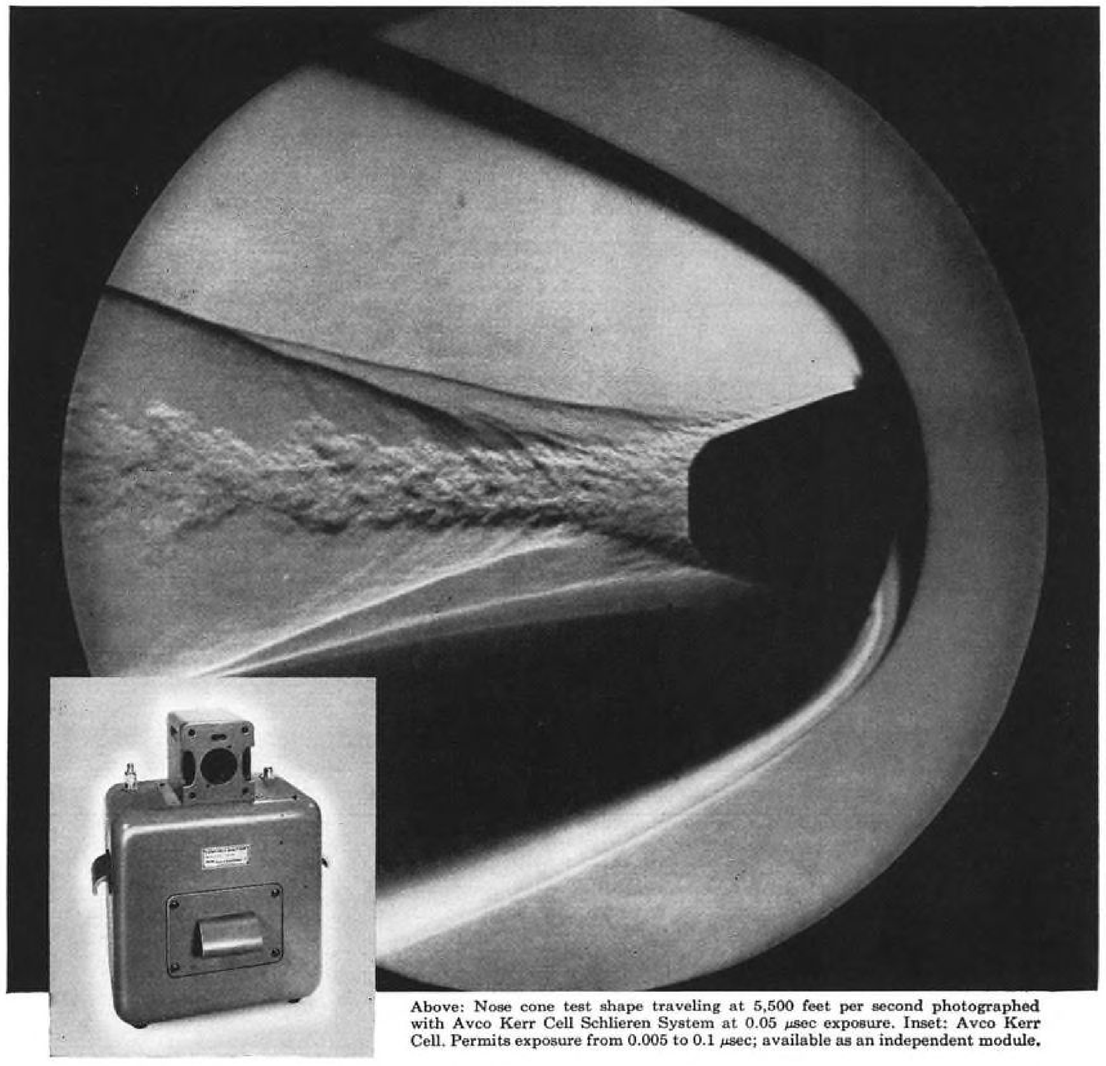

Above: Nose cone test shape traveling at 5,500 feet per second photographed with Avco Kerr Cell Schlieren System at 0.05 μsec exposure. Inset: Avco Kerr Cell. Permits exposure from 0.005 to 0.1 μsec; available as an independent module.

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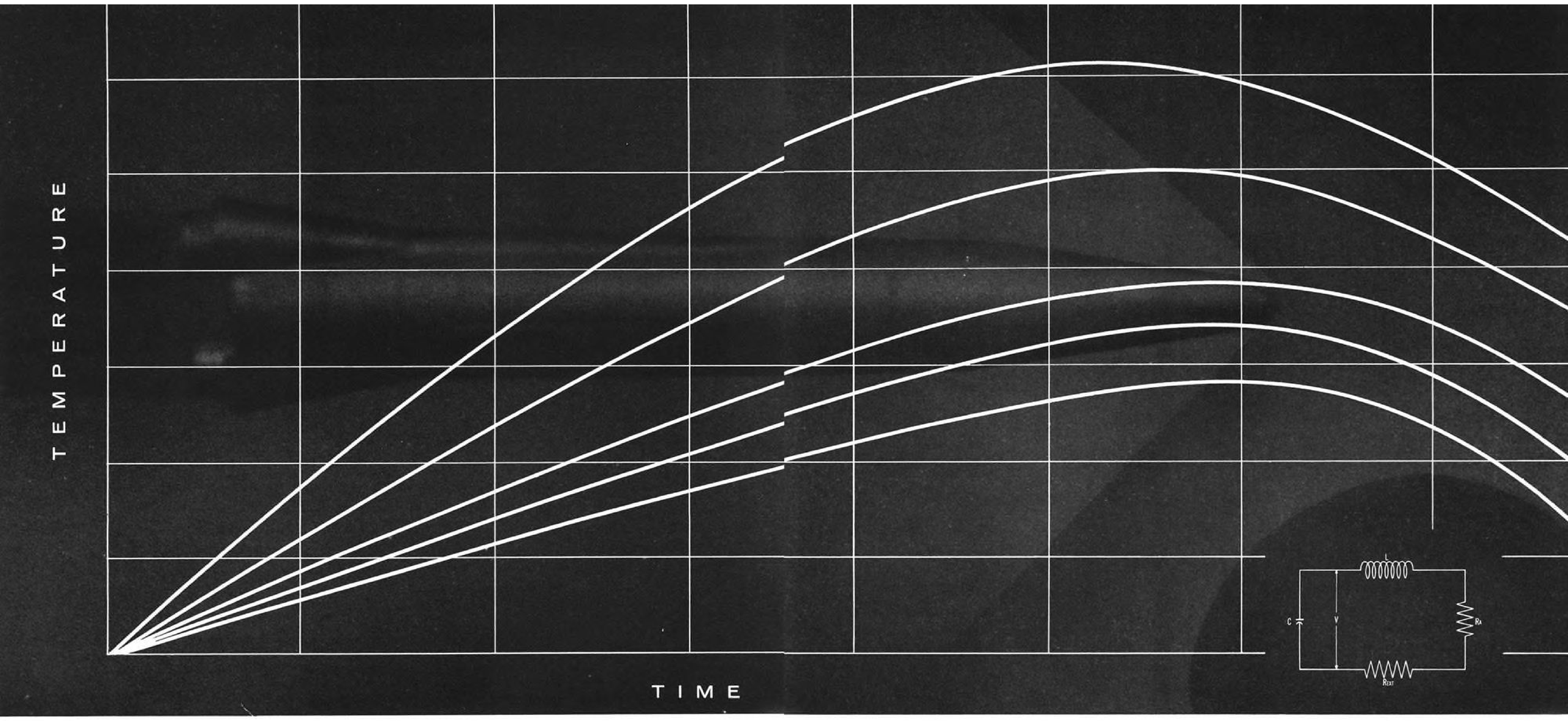

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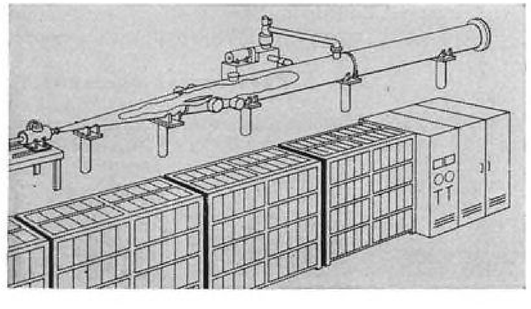

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September 28, 1959

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COVER: First photo of Air Force's Ballistic Missile Early Warning System surveillance radar antenna, recently installed near Thule, Greenland, shows tremendous size of the antenna, which measures approximately 400 ft. wide, stands 165 ft. high, and weighs 1,500 tons. The BMEWS radars are expected to have range of 2,500 to 3,000 mi. Similar BMEWS installation will be made near Fairbanks, Alaska, and in Scotland. For additional photos, see p. 90.

PICTURE CREDITS

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78,988 copies of this issue printed

EDITORIAL

Space Programs Changing

The decisive action in the Pentagon last week in sharply defining space weapon system development and mission responsibilities is a welcome change from the indecision and compromise that has characterized the top levels of the Pentagon for most of this year. Defense Secretary McElroy's action in assigning the Air Force the major space mission and transferring space weapon systems development from the Advanced Research Projects Agency to the military services that will operate them is a major step in the long sought for goal of clearly defined authority and responsibility in the military space program.

Although the decisions were announced by Secretary McElroy with the approval of the Joint Chiefs of Staff, we suspect that major credit for their sharp definition and technical logic must go to Herbert York, Defense Department director of research and engineering. And we also suspect that these decisions are but the first in a series planned by York and his advisers aimed at untangling the technical red tape that has impeded progress in this area so badly during the past few years.

We hope the McElroy-York decisions will be followed soon by equally decisive action toward welding a closer and more effective liaison between the military space program and the activities of the National Aeronautics and Space Administration. The inadequacy of the current Pentagon-NASA liaison groups was clearly defined by all persons concerned in the Senate hearings conducted last spring by Sen. Stuart Symington (D.-Mo.) and it is obvious that, with the areas of space responsibility more sharply defined within the Pentagon, the time is now ripe to tackle this inter-agency problem with greater possibilities of effective solution.

Future of ARPA

The military space decisions also shed considerable light on the future of ARPA. The original purpose in creating ARPA, if indeed there was one beyond its public relations effect, appeared to be as a method of resolving the inter-service disputes over development of new weapon systems that cut across the traditional service missions. These included the anti-missile defense system and space weapon systems. However, it was soon apparent that ARPA under the aggressive leadership of Roy Johnson was off on a more ambitious course and was charting its course to develop into a "fifth operating service" by taking over all advanced weapon system development for all of the other services. The basic fallacy of this position, where ARPA would research and develop new weapon systems and then turn them over to a using service when they approached operational status, was soon apparent, as it would have created a dangerous gap in bringing a weapon system from the development to combat-readiness stage.

Ever since ARPA made its "fifth service" intentions clear, there has been a concerted effort, partially stimulated by valid technical considerations and partially by plain rivalry from other military empires, to either abolish ARPA or radically shift its role in the Pentagon. According to Roy Johnson, he has assurances from the Secretary of Defense that ARPA will not be abolished, but the recent space decisions make it clear that its role is being radically altered. ARPA apparently will emerge as a relatively small technical group of "out in the blue" advanced thinkers organizing basic state-of-the-art research in fields of eventual military interest. It would appear that there is a permanent place for a group with this purpose functioning at a high level of the Pentagon and free from the traditional Pentagon demands that all research authorized must promise an immediate military hardware development.

The other aspects of the McElroy-York decisions appear to be technically logical although there are bound to be anguished cries from those in the Army and Navy who were busily building space weapon empires of their own. We expect they will get little sympathy on Capitol Hill or from the American public. The days when either Congress or the taxpaying public would support this type of inter-service empire building have long passed. We predict these decisions and any of similar decisive nature to follow will be widely applauded by Congress and the public.

Orderly Program Evolving

Meanwhile, there is sound evidence that we are passing through a significant but almost imperceptible change in our civilian space research program. This change is marked by the end of the helter-skelter, frantic welter of projects that were spawned in the officially indifferent days before Sputnik I or in the wailing wall period that followed it. Gradually, the fruits of the basically sound foundation planning that NASA and its related groups have done in the past year are beginning to ripen into a new and scientifically significant space research program. It will still be several years before these fruits are sufficiently ripe to pluck in the form of spectacular achievements, but already they are changing the character of our space program.

Bold imaginative planning and competent technical execution are still no guarantee of superiority in space research without adequate budgetary and public support over the long hard pull that lies between our present position and the unchallenged superiority that is our goal. The years just ahead are the most difficult for American technicians and the public. For, while the technicians are working hardest to provide a truly sound foundation for achievements in the future, the public is likely to become most impatient in its demand for spectacular shots immediately. It will take considerable effort by the leaders of our military and space programs to educate Congress and the public in this respect. And it will demand an equal effort by the Congress and American public to listen to these technical leaders and try to understand what they are saying.

—Robert Hotz

WHO'S WHERE

In the Front Office

Dr. W. R. G. Baker, chairman of the executive committee of the board of directors, Gulton Industries, Inc., Metuchen, N. J. Dr. Baker is president of Syracuse University Research Corp.

Milton Farber, vice president-basic research, Rocket Power, Inc., Redlands, Calif., a subsidiary of The Gabriel Co.

Daniel W. Ruple, vice president and general manager, Pacific Division, Titeflex, Inc., Springfield, Mass.

John W. Christensen and **Robert A. Gregg,** vice presidents, Space Recovery Systems, Inc., El Segundo, Calif.

Barry J. Shillito, executive vice president and general manager, Houston Fearless Corp., Los Angeles, Calif.

Berge Thomasian, vice president-manufacturing operations, Servonics, Inc., Alexandria, Va.

L. D. Dannenbaum, executive vice president, Nuclear Electronics Corp., Philadelphia, Pa.

William E. H. Reardon, vice president and sales manager, and **James H. Pierson,** vice president and personnel director, Electric Specialty Co., Stamford, Conn. Also: **Joseph J. Sousa,** chief engineer; **George C. Zimmerman,** director of manufacturing.

Joseph C. Worth, vice president and director of sales, U. S. Semiconductor Products, Phoenix, Ariz., a division of Topp Industries.

Paul H. Hammond, vice president and general manager, Beattie-Coleman, Inc., Anaheim, Calif., subsidiary of Coleman Engineering Company, Inc.

Walker C. Brownlee, administrative vice president, The Garrett Corp., Los Angeles.

Dr. Finn J. Larsen, vice president-research, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Edward W. Herold, vice president-research, Varian Associates, Palo Alto, Calif.

Martin L. Stevens, vice president-engineering, Precision Gears and Products, Inc., Paterson, N. J.

Tom Towers, director of the newly formed Los Angeles Sound Abatement Coordinating Committee, International Airport, Los Angeles, Calif. Mr. Towers is on leave of absence as aviation editor of the Los Angeles Examiner.

A. N. Christmas has been appointed Great Britain's Director of Guided Weapons, Research and Development (Techniques).

Jack A. Gertz, chief of the Federal Aviation Agency's Office of Public Affairs, Washington, D. C.

William B. Whitacre, vice president-flight, American Airlines, Inc., and **Walter W. Braznell,** assistant vice president.

Honors and Elections

Dr. Everett T. Welmers, director of plans and programs for Bell Aircraft Corp.'s Niagara Frontier Division, has joined the Department of Defense's Advanced Research Projects Agency to work on special space projects. Dr. Welmers is on a one-year leave of absence from Bell Aircraft.

(Continued on page 130)

INDUSTRY OBSERVER

► Next Discoverer polar orbit satellite is scheduled to be fired from Vandenberg AFB, Calif., this week. Aerial retrievement of a parachuted satellite nose capsule will be attempted again by a C-119 team from Hawaii equipped with trailing snag wires.

► **Tight Fiscal 1961 budget reins have forced Air Force to institute studies to see if there will be sufficient funds to support the WS-138A air-launched ballistic missile program, although USAF considers it one of its most important new projects. Final recommendation is expected in October.**

► Douglas Aircraft has narrowed the choice of WS-138A guidance subsystem contractors to General Electric and Nortronics, with other bidders being so advised in letters that went out last week. Douglas will make presentation to Air Force in about three weeks, indicating its preference between the two companies.

► **Final decision on whether to proceed rapidly with production of Nike Zeus anti-ICBM missile as proposed by Army may go to the White House. President's special science advisor, Dr. George Kistiakowsky, recently received briefing on Nike Zeus system from top-level Bell Telephone Laboratory officials. Other high Defense officials, including Gen. Laurence Kuter, head of the North American Air Defense Command, also have received recent Zeus briefing.**

► Watch for Canada to order turbine-powered helicopters within the near future. The Royal Canadian Navy is interested in the Kaman HU2K for anti-submarine use as an off-the-shelf aircraft able to operate from small ships. Canadian army wants an off-the-shelf turbine-powered, troop-carrying helicopter and Vertol's YHC-1A and Sikorsky's S-61 (HSS-2) are the prime contenders. What degree production of entire aircraft or of major components would be carried on in Canada will be a major factor in the decision.

► **Sperry Gyroscope will announce development of a lightweight automatic pilot selling for less than $4,000 for use on single and twin-engine business aircraft. Step will mark Sperry's first venture into the lightplane autopilot business and may be the forerunner of its entry into the lightplane instrument field.**

► Final plans for reorganization of USAF's Air Research and Development Command (AW Aug. 17, p. 25) are scheduled to be announced within the near future. Proposed plan was submitted to Air Force Secretary James H. Douglas by ARDC Commander Lt. Gen. Bernard A. Schriever.

► **Three additional cruisers being converted for guided missile service include the USS Chicago, USS Columbus and USS Albany. Emergency 750 kw. generators and associated equipment for conversion are being supplied by the Inet Division of Leach Relay Corp. under a $169,000 Navy contract.**

► Proposal encompassing design criteria and follow-on design for the Minuteman underground silo and control facilities has been submitted to USAF's Ballistic Missile Division by engineering firm of Roberts & Schaefer Co., Inc. Consultant to firm on proposal is Ralph M. Parsons Co., architects and engineers.

► **Watch for the Army and Marine Corps to open a joint competition within the next few months for design of a tactical VTOL aircraft.**

► Beech Aircraft reportedly plans to unveil its new six-seven place executive transport, Model 65, at the National Business Aircraft Assn. convention in Minneapolis beginning Oct. 6. The aircraft, civil counterpart of the L-23F, is a reworked Model G50 Twin-Bonanza. Principal differences include a new fuselage, which has downward hinged airstair door on the left side just aft of wing trailing edge, and a pilot compartment separated from the passenger compartment by sliding doors. Gross weight is up a few hundred pounds over the G50's 7,150 lb. Two 340 hp. Lycoming IGSO480-A1A6 engines with fuel injection will power the Model 65.

Washington Roundup

Disarmament Effects

As a followup to Soviet Premier Nikita Khrushchev's disarmament proposals before the United Nations, the Senate Foreign Relations Disarmament Subcommittee headed by Sen. Hubert Humphrey (D.-Minn.) has begun a study of the impact of arms control and disarmament agreements on the economy. Sen Humphrey said that he had suggested some time ago that the executive branch make the study, but that the Administration had shown "an apparent lack of interest."

Early in August, Senate Armed Services Committee asked Defense Department to report on defense expenditures listed by states as an initial step in evaluating the impact of armament spending on the economy.

NATO Air Defense Study

Problems of defending Western Europe against ballistic missiles and using surface-to-air missiles against manned aircraft will be exhaustively covered in a study initiated by the North Atlantic Treaty Organization. The study will last several months and will be conducted at NATO's Air Defense Technical Center at the Hague, Netherlands.

Cornell Aeronautical Laboratory has been retained as a special consultant in the study. The laboratory's principal function will be to design mathematical models to simulate the acquisition and interception of short- and medium-range ballistic missiles and aircraft in situations realistic for the present Western European situation. Interception vehicles of major interest in the study will be ground-launched missiles.

Defense Reorganization Plan

Senate Armed Services Committee will be called upon during the next session of Congress to consider a bill that would reorganize the Defense Department by converting Air Force, Army and Navy secretaries into undersecretaries of defense and give greater authority to the Defense Department director of research and engineering in coordinating research programs now being conducted by the three military departments. The reorganization bill was introduced by Sen. John Sherman Cooper (R.-Ky.) during the last days of a summer congressional session that included a number of proposals and demands for a tightening of the defense structure (see p. 39).

Reserve Promotions Criticized

Military reserve promotion practices were criticized last week in a report from the Senate Preparedness Investigating Subcommittee headed by Sen. Lyndon Johnson (D.-Tex.) which charged that reserve officer promotion criteria vary among the services and that there is a "seeming inconsistency" in the application of these criteria to certain officers. Report said promotion to flag and general rank should not be conferred exclusively as a reward for past military service but should take into consideration an officer's future usefulness and growth potential.

The Senate group also said that the services should have more uniform promotion standards and that these standards should be more uniformly applied, and it observed that "there appears to be a disturbing trend to utilize the reserve component as an instrumentality of some benefit for regular officers who resign their commissions to accept better paying jobs with industry."

Subcommittee noted an apparent need for more realistic definition and application of the term "best qualified" for promotion and said there is some evidence that promotions to general and admiral occasionally have been conferred without reference to the nation's needs, to any known military requirement or to the capability of the individual officer.

The report also noted that the services require reserve officers in the lower grades to adhere much more strictly to participation requirements than do officers in the higher grades.

Inspecting Soviet Transports

The three Soviet turbine-powered transports that flew the party of Soviet Premier Nikita Khrushchev to Washington and constitute the types that represent the backbone of Russian airline modernization plans were closely inspected last week during a special six-hour display period by a bevy of leading U.S. aviation officials. Major exceptions—U.S. airline officials, who someday will compete with Aeroflot and its aircraft, and representatives of aircraft manufacturers.

Their names were not among the lists provided Soviet officials by the State Department.

Three transports that carried the Khrushchev party here—the Il-18 turboprop, the Tu-114 turboprop and the Tu-104 turbojet—represent the bulk of the turbine aircraft Russia has in commercial service.

The Russians decided against putting the aircraft on public display during their 14-day stay at Andrews Air Force Base near Washington, but they did allow the State Department to send a few hundred carefully screened visitors out to view the planes. Representatives of the State Department, Defense Department, Civil Aeronautics Board and the Federal Aviation Agency studied the exteriors and interiors of the three planes in accordance with a State Department request to the Russians that "engineers and technicians" be permitted to look over the fleet. Obvious absence of airline or manufacturing technicians during the period of inspection was explained this way by one State Department spokesman: "It was a last minute deal, and we didn't have time to work out as comprehensive a list as we might have wished to do."

Khrushchev Baffled by Rocket

Meanwhile, Khrushchev expressed bafflement with modern science during the San Francisco portion of his U.S. tour. At the San Jose plant of International Business Machines, Khrushchev confessed that he did not understand electronic computers, and said he was reminded of the time Soviet scientists invited government leaders to see the first rocket Russia launched.

"Well," he said, "we went and looked at it. We looked at it from this side, from that side; we looked down upon it; we looked up at it. It must have been—we thought it was all very interesting indeed. But what the thing was, none of us knew."

—Washington staff

USAF Explores Strategic Space Plans

Broad requirements for operating weapons, vehicles beyond orbit of the moon are due by early next year.

Washington—Feasibility of strategic interplanetary systems is being explored by the Air Force in a broad study program, with industry members formulating technical problems that may be encountered and proposing basic solutions.

Interim progress report on the strategic interplanetary system analysis, officially designated Study Requirement 182, was recently made to the Air Research and Development Command. Final presentation under SR-182, scheduled to be made early next year, will project relatively firm, broad requirements for operating vehicles and weapons beyond the orbit of the moon. This implies a weapon system capability coupled with capability for interplanetary travel for strategic purposes.

At least three companies are conducting studies under contract to the Air Force on SR-182:

• **General Motors Corp.'s** Allison Division, Indianapolis, Ind. Cost of the project is estimated at approximately $265,000—with the Air Force standing a portion not to exceed more than about three-eighths of the costs, or about $100,000. Remainder of the costs will be borne by Allison.

• **Westinghouse Electric Corp.'s** Air Arm Division, Baltimore, Md. This contract totals about $85,000.

• **Douglas Aircraft Corp.**, Santa Monica, Calif. Contract is for approximately $255,000.

It is not yet known whether such a strategic interplanetary capability is feasible and should be developed. One premise under which the studies are progressing is that, if bases for scientific exploration on near planets are established, an obligation would evolve to protect them. Coupled with this is the philosophy that scientific findings on planetary bases may bring out a prime necessity of holding these stations.

Broad Approach

Because of the broad approach necessary to establish requirements for a strategic interplanetary system, practically no restrictions have been established to limit the proposals of the individual industry members making analyses under SR-182. Essentially, ARDC has an open mind on the subject and is receptive to all ideas.

Indications are that the study requirement will encompass the use of missiles, satellites, miscellaneous space vehicles, biological and chemical warfare capability, nuclear power for propulsion and other applications and use of the moon as an "in-base" even though the latter is being analyzed under other study requirement. The study requirements also probably will include consideration of microwave radiation to develop a ray capability to disintegrate vehicles in space. At least three industry companies which have specialized avionic capabilities are understood to be conducting studies in this field of research.

Analyses of other space requirements are being conducted simultaneously with those of the strategic interplanetary system. These include Study Requirement 192 relating to the use of the moon as a strategic military base, and Study Requirement 183 relating to establishment of a lunar observatory (AW April 27, p. 26).

Moon Dispute

Environmental conditions under SR-192, which encompasses the moon and cislunar space within its orbit, are in many respects similar to those being analyzed for the strategic interplanetary system under SR-182. There has been considerable disagreement of the value of using the moon as a military base, and undoubtedly this same disagreement will be carried over to use of the strategic interplanetary systems.

Some scientists have underplayed the military importance of moon bases and other operations on the planets. They feel that there has been an inordinate amount of discussion on the military importance of space efforts. They don't contend that there are no military applications in space but feel that accelerated efforts for establishment of military bases on the inner planets are not justified in view of the limitations and demands of the present state of the art and military problems.

Another contention is that there is doubt whether space vehicles can ever be weapon-carrying platforms with a reasonable probability that these weapons will be able to impact on a specific target. Considering lethality of present warheads, target misses of warheads coming in from space for earth impact could involve disastrous consequences.

Proponents of military systems are aware of these and many other objections to making use of space bases and space vehicles for military purposes but feel that this field of exploration must be probed not on the basis of known potentials alone but on the basis of all the unknowns which may turn out to have military significance, so long as international tensions exist on earth. There are too many unknowns, these observers feel, not to acknowledge the validity of this approach.

SR-192 Report

An interim progress report on proposals under Study Requirement 192 also was recently presented to ARDC. Final presentation is scheduled for January, 1960. Other government organizations interested in industry thinking in connection with these study requirements include Defense Department's Advanced Research Projects Agency, the National Aeronautics and Space Administration and Strategic Air Command.

Industry members performing analyses under SR-192 on a contractural basis for the Air Force include:

• **Aerojet-General Corp.** USAF will bear two-thirds of the cost of the project; Aerojet one-third.

• **Douglas Aircraft Corp.**

• **North American Aviation, Inc.**

A number of other industry members also are performing studies in this space regime under SR-192 and in preparation for development work which is almost certain to be generated in the future by military or civilian agencies.

Attainment of a true capability for a lunar base is generally targeted for about 10 years in the future. All industry members concerned with the study are aware of the tremendous economic factors involved as well as the very difficult design and operational problems.

Scientists generally agree that it will be a tremendous job to put any significant payload on the moon and also ensure a return capability.

Estimates, based on present day propulsion capabilities and without a requirement for a refueling in orbit, are that it would require a vehicle with gross weight of between 3 and 4 million lb. to land a single pound on the moon and bring it back to earth. Translation of this factor into cost of design, building and launching, landing on the moon and launching for return, means this effort easily would run into hundreds of millions of dollars.

The magnitude of the problem is indicated in estimates that it probably would require a 2,000 lb. payload to put a man and his supporting equipment on the moon. Added to this is the sizable multi-stage rocket that will be required for the return journey.

Ability to refuel en route to the moon would cut the takeoff gross of the launch vehicle considerably—perhaps to one-eighth or more—of that required without refueling.

With availability of nuclear power, coupled with ability to refuel, takeoff gross would be slashed even more drastically—perhaps to 1/100 the gross required without these advantages.

Refueling in space will involve precise and sensitive techniques. The refueling vehicle itself will have to be put into a satellite orbit for rendezvous with the lunar vehicle. A wide variety of proposals for simplifying refueling techniques is being studied by various industry members and government agencies, including ARDC's Ballistic Missile Division, the Army Ballistic Missile Agency and NASA. One plan involves a basic technique such as substituting the tanker's full fuel bays for empty tanks in the lunar vehicle.

Industry members feel that there is a distinct possibility that feasible and relatively realizable ideas are presented under Study Requirement 192, and that there will be a continuation of military support for successive contract phases leading to an initial capability to put equipment on the moon. NASA is considering similar proposals.

F-108 Canceled

Washington—Air Force last week terminated development of the North American F-108 Mach 3 interceptor but said it plans to continue development at a reduced level of the fire control system and GAR-9 air-to-air missile, both under development by Hughes Aircraft for the F-108. USAF officials said its bomber sister ship, North American's Mach 3 B-70, will be continued.

Cancellation of the F-108, on which the Air Force has spent approximately $150 million thus far, did not come as a surprise in view of recent predictions by Defense officials that major program cancellations would be needed to stay within a fixed defense budget next year (AW Aug. 17, p. 26; Sept. 14, p. 26).

Behind the action is a view in top Defense Department levels that by the time the F-108 could become operational, the major air threat will no longer come from manned aircraft.

Decision to continue the Hughes programs at a reduced level was based in part upon the desire to maintain a going capability in fire control and air-to-air missiles in the event it proves necessary to shift back to manned interceptors. There also is a possibility that the fire control system and/or GAR-9 might find use on the Convair F-106 or on an interceptor version of the Convair B-58 or even the B-70, observers speculate. The two programs have represented about 15% of Hughes' total effort.

USAF Gains Major Space Role In Transfer of ARPA Programs

Washington—Air Force will become the major military space system operator as Advanced Research Projects Agency transfers its programs to the services and gets out of the space system business on Defense Department order.

The Defense Department last week gave USAF future responsibility for development, production and operation of all military space boosters and transferred four military satellite systems to the services for development of the payloads and ground support equipment involved, a move predicted by AVIATION WEEK (Aug. 31, p. 32).

ARPA space work will decline through a "progressive and orderly" transfer of space projects to the services, and Herbert F. York, defense director of research and engineering, said the agency will "largely and eventually" get out of the space system field. ARPA, he said, will evolve as an agency devoted to advanced research in such areas as solid propellant chemistry, advanced missile defense and materials research.

Although the projects transferred last week are all in the development stage, they are indicative of the roles and missions the three services will have in space operations. The four satellite projects are:

• **Midas,** an infrared early warning satellite for ballistic missile defense, was shifted to the Air Force.

• **Samos,** the reconnaissance satellite system formerly designated Sentry, was transferred to the Air Force.

• **Transit,** navigation satellite system, will be developed and operated by the Navy.

• **Notus,** a family of communication satellites, was transferred to the Army.

Schedule for these transfers was not announced, but York said the shifts will be accomplished within the next year. These four projects were shifted to the services which were managing them for ARPA, but York said this rule will not necessarily apply to future transfers. He said the assignments were made by Defense Secretary Neil McElroy with the advice of the Joint Chiefs of Staff and scientific offices.

ARPA was established in February, 1958, to coordinate and manage advanced research projects, including the military space programs, and the agency's budget grew quickly to its present $455 million level for Fiscal 1960. Now, the big money projects are being transferred back to normal service channels and will take well over half the present ARPA budget with them.

York and ARPA Director Roy Johnson both insist that these shifts will not change the basic character of the agency. They said last week that most ARPA personnel are working on advanced research projects despite the heavy orientation of the budget toward space systems. Johnson said McElroy had assured him "as lately as last week" that ARPA will be a permanent part of the Defense Department. The agency will run its research programs with a broad view of the requirements of all the services.

Transfer of the space systems means they will be removed from the relatively secure shelter of the ARPA budget and will have to compete for development funds with other systems in the service budgets. Thus, they become subject to the economy waves which periodically result in the cancellation of military systems, similar to the demise of the F-108 last week (see box, left).

York and Johnson said this situation will be healthy since the space systems will have to prove themselves in direct competition with other systems the services may develop in the same area.

In a speech last week, Johnson said such systems as a maneuverable recoverable space vehicle or an effective missile defense system "could eat up the entire Defense research and development budget." He said these developments must compete on a dollar basis with other military systems in the three services.

Johnson told the Business Equipment Exposition that such developments should be assigned to individual services and that if they remain in an agency like ARPA "the services will continue to regard them as being additional and will continue to ask for all the old items." He also argued that advanced research should be divorced organizationally from weapon system development.

Assignment of the Air Force to develop, produce and operate all military space boosters means that the Army and Navy will be using USAF transportation to place their satellite systems in orbit.

It also means that Air Force will eventually take over the Saturn booster which the Army Ballistic Missile Agency is currently developing under ARPA direction. Details on this switch

have not yet been worked out, but the new situation will eventually put the Air Force in charge of the Saturn program, which is the Army agency's major space effort. New status for ABMA, either in the Defense Department or in National Aeronautics and Space Administration, may be established before Saturn is shifted to USAF.

Johnson said the move to transfer projects to the services was begun last spring when ARPA asked McElroy to get the Joint Chiefs' opinion on which services should get the programs.

ARPA is retaining Project Discoverer, a well established satellite program which includes recovery experiments. York said this project is involved more with development of space flight techniques than pure military objectives. It will be transferred eventually, however, presumably to the Air Force.

In the program shifts, Air Force will be responsible for the early warning and reconnaissance areas with Midas and Samos. Lockheed Aircraft Corp. is prime contractor on both these projects.

Navy got the navigation role with Transit. Navy has been the primary agent for ARPA on this project, but USAF also was working on it and some adjustments will be necessary. Applied Physics Laboratory of Johns Hopkins University is prime contractor. Navy tried to put a 265 lb. Transit test prototype in orbit this month, but failed when the third stage of the Thor Able launch vehicle malfunctioned.

Army's Role

Army's role is in the communications area with the Project Notus system. This is a satellite family which includes Task Courier, a 500 lb. delayed relay satellite being developed by a team including Philco Corp., Radiation, Inc., and the International Telephone & Telegraph Co. Polar communications in the Notus system will be provided by Task Steer real-time repeater satellites which will provide instantaneous relay of messages. General Electric Co. and Bendix Aviation Corp. are developing the Steer systems.

Army's Notus program will also include Task Decree, four real-time repeater satellites which will be in 24 hr. equatorial orbits and will hover in relation to fixed spots on the earth.

Booster programs under ARPA direction, and eventually slated for the Air Force, include Project Tribe, a program aimed at developing the propulsion, guidance and control aspects of advanced military space vehicles. Under Tribe, Task Agena is concerned with adapting the Bell Hustler liquid rocket engine for use as a second stage on Atlas and Thor boosters for Discoverer, Midas and other projects. Task Saturn covers the 1.5 million lb. thrust booster under development by ABMA and using eight clustered Rocketdyne H-1 liquid engines. First static test is scheduled for early next year, and flight test of the entire vehicle is scheduled to begin a year after static test begins.

Project Orion is an ARPA study conducted by General Atomics Division of General Dynamics Corp. on the feasibility of propelling a rocket by controlled nuclear explosions. This is another prospect for transfer to USAF.

Along with these booster and satellite programs, ARPA has the following projects under way:

• **Project Defender** is research in advanced defenses against such offensive threats as ballistic missile and space vehicles. This work is aimed at developing a defense for the period extending to about 1980 and is a step beyond the Nike Zeus and BMEWS systems.

• **Project Principia** is a solid propellant research program designed to increase specific impulse by 10-20% over present values. It includes development of basic chemical formulas and the means to use the new materials in solid propellants.

• **Project Pontus** is a basic materials research program. It is conducted entirely by U. S. universities and is aimed primarily at establishing materials laboratories at the schools involved. It covers research in high strength, high temperature and radiation-resistant materials, as well as work in the power conversion field.

• **Project Longsight** is a continuing series of studies and analyses of missile and space vehicle systems needed to meet future military requirements. Included are such unorthodox studies as GLIPAR, a project established in connection with Project Defender to encourage imaginative approaches to ballistic missile defense. Longsight also includes reviews of advanced research proposals submitted for DOD.

• **Project Shepherd** involves development of a satellite detection and tracking system, including a National Space Surveillance Control Center and a detection line across the southern U. S. to detect and track all satellites and other high-altitude vehicles flying across the country. Army and Navy are both heavily involved in this project.

• **Project Mrs. V** is to develop a maneuverable, recoverable space vehicle which probably will weigh over 20,000 lb. and can be ground or air-launched. This project is a logical extension of the USAF-NASA Dyna-Soar program and probably will become part of that project in later stages.

Soviets Report Lunar Probe Data

Washington—Moon has no magnetic field or radiation belt of charged particles, according to a preliminary reduction of data from the Soviet lunar probe (AW Sept. 21, p. 28) and reported by Tass news agency.

Other preliminary results and information concerning the lunar flight as detailed by the Soviets include:

• **Guidance system** was located in the last stage of the launching rocket and functioned only during the initial moments after launch when it was under power.

• **Last stage of the rocket** also hit the moon.

• **Moon is enveloped by either** a blanket or a belt of low energy ionized gases. A blanket of such particles would resemble an ionosphere.

• **Flight path of the instrument** container at moment of impact was inclined at 60 deg. to the moon's surface. The impact point was about 800 mi. directly north of the center of the visible surface of the moon. This is east of the Sea of Serenity close to the craters Aristylus, Archimedes and Autocyclus.

The Soviets pointed out that indications that there is no magnetic field on the moon support the thesis that the earth's magnetic field is created by a slow turning of its liquid center which acts essentially as a dynamo. It is believed in responsible circles that the moon does not have a liquid core.

The measurements which showed no radiation belt near the moon supported the magnetometer readings which are accurate to within 60 gammas, according to the Soviets.

Instrumentation in the second Russian cosmic rocket to measure the concentration of low energy ionized gases consisted of four traps containing positive particles. Current generated in these traps is an indication of the incidence of the gas particles which the Soviets reported to be less than 100 per cubic centimeter at some locations between the earth and the moon.

The recorded currents from these instruments increased sharply about 10,000 km. from the moon.

Commenting on the space probe, visiting Soviet Premier Nikita Khrushchev told Sen. Richard B. Russell (D.-Ga.), that: "They wanted to launch that rocket about a week earlier. . . . The rocket was prepared and put on the launching site. But when they started testing the apparatus, the equipment, they found that it wasn't working properly.

"Then they decided to take that rocket away and put a new one in its place, prepare and launch it. The first rocket was not launched. It will be tested and if needed we might launch it later on because it is still in its place. I can swear by the Bible that that is the fact."

U.S. Gears Space Plan to Cut Soviet Gap

By Evert Clark

Washington—U. S. space program has almost completed a transition that will carry it from pre-Sputnik and hastily conceived post-Sputnik projects into more solid efforts that are expected to close the gap in the race with the Soviet Union.

The nation still faces 12 to 18 months of waiting for Soviet surprises before it has the boosters to achieve the kind of range-payload combinations demonstrated by the recent Soviet lunar rocket. These surprises probably will include manned orbital flights.

In spite of spectacular Soviet achievements, significant gains made by the U.S. in the space sciences already exceed those made in the Soviet program—and this will be increasingly true in the future.

These are the views of leading officials in the U.S. space program, as indicated by an AVIATION WEEK survey.

Although these officials believe that funding of U.S. space efforts must continue upward if the goals they have set are to be achieved, they feel that the nation has succeeded in laying a broad, sound base for a space program that soon will begin to produce greater scientific, technical and economic payoffs than the Russian program. It also may be producing these benefits long after Soviet political emphasis has shifted to other technological areas.

Soviet Russia's current advantage is based upon stronger political motivation and, therefore, greater political and financial support, on good long-range planning and on a much earlier start on booster development.

U. S. Advantages

In contrast, the U.S. enjoys a number of advantages that are less often recognized, space officials say. Most of these are inherent in the nation's political, technical and economic systems, and they give these officials a surprisingly high degree of confidence despite Russia's current lead.

Because space exploration was an easy byproduct of the Soviet military ballistic missile program and because it offered such tremendous propaganda advantages, it was made a major instrument of national policy. Many observers believe that the Soviet government has established a specific goal for its space scientists—perhaps as limited as manned exploration of the moon or as far-reaching as manned exploration of Venus or Mars—and that every step thus far has been taken with that in mind.

Since the program is primarily dependent on political rather than scientific motives, it will not be as diversified scientifically and could lose its current high level of financial support if and when other political and propaganda goals become more attractive.

On the other hand, space officials say the U.S. program has been sold to Congress and the public primarily as a scientific program with secondary emphasis on the political implications. Although it took a political situation to solidify development of a space program, the U.S. already has laid a broader scientific base, and scientists have the strongest voice in selection of both missions and specific experiments, giving the program a greater flexibility and higher chance for payoffs. A condition of the U.S. approach is an obligation to the taxpayer to give him practical returns on his investment wherever possible. Examples of this are the considerable efforts being put into communication and navigation satellites, which will have perhaps more civil than military applications. Through this approach, space exploration will establish itself on its own merits and continue regardless of whether the strong political implications now attached to it continue or disappear.

U. S. science and industry is so much farther advanced in the technical "arts"—as exemplified by the ability of industrial technicians to mass produce reliable radio equipment in cleanly packaged form rather than build it on a one-time basis in a laboratory—that the gap with Russia will be closed rapidly for somewhat the same reasons that the U. S. caught up with a technologically more advanced opponent in World War II. No one doubts the Russian scientist's ability to understand the scientific findings quite as well as the U. S. scientist can, but the feeling is that U. S. technical resources are not only more vast but farther advanced—so that greater advantage can be taken of scientific ability.

Space Science Lead

The U. S. started earlier than Russia in the space sciences, and basic research rocket work dating from 1946 plus the deliberate effort made through most of the postwar period to develop a truly basic research program allowed for rapid advances on a broad scientific front. There seems to be little doubt among U. S. space scientists that this country's scientific contributions during the International Geophysical Year and since have been more worthwhile than Russia's, even though Russia has performed more spectacular feats and apparently is farther advanced in some areas, such as biomedical research for space.

The U. S. program is at an important milestone. National Aeronautics and Space Administration, which observes its first birthday this week, has one more IGY payload and two more satellite payloads inherited from Defense Department's Advanced Research Projects Agency to launch before it is well into what it can consider its own program. ARPA itself is in the process of shifting development of space systems to the military services (see p. 27).

NASA Administrator T. Keith Glennan says that his agency is not running into financial problems yet, but "we may." He continues to insist on a consistent level of funding instead of up-and-down financing and says NASA is "just beginning to understand what we will need in the years ahead, and its going to be more than we have now."

Aside from funding considerations, Deputy Administrator Hugh L. Dryden says that the scientific groundwork for the next two or three years of opera-

U. S. Space Shots

Washington—U. S. has successfully launched nine satellites and three space probes since Jan. 31, 1958. Two attempts to launch lunar probes and a number of satellite launching attempts failed.

Army Ballistic Missile Agency launched Explorer I in January, 1958, and Explorer III in March, 1958, under Defense Department direction before either the military or civilian space agencies had begun formal operation. Navy launched Vanguard I in March of 1958. Since then, three probes and three satellites have been launched under sponsorship of National Aeronautics and Space Administration and six satellites have been launched under sponsorship of Defense Department's Advanced Research Projects Agency. Divided by agency, they are:

• NASA—Vanguard II in February of 1959 and Vanguard III this month; Explorer VI last month; Pioneer I space probe in October of last year; Pioneer III in December of last year, and Pioneer VI in March of this year. Explorer VI and Pioneer I and III were Air Force Ballistic Missile Division-Space Technology Laboratories projects and Pioneer IV was an ABMA project.

• ARPA—Explorer IV in July of 1958; Atlas-Score in December of last year; Discoverers I in February of this year, II in April and V and VI last month; Explorer was an ABMA project; Atlas-Score was an Air Force and Army Signal Corps project and the Discoverers were AFBMD-STL projects.

Atlas Able IV Vehicle Destroyed

Cape Canaveral, Fla.—Plans by National Aeronautics and Space Administration to orbit a satellite around the moon in early October were severely crippled late last week when the Atlas Able IV launching vehicle exploded during a static test at the Air Force Missile Test Center here.

Loss of the vehicle also left in doubt whether the shot will be made at all this year. At the time of the explosion, officials said no backup vehicle had been prepared for the program.

The launching vehicle, which was to have placed a 370 lb. payload into orbit around the moon, included a Convair Atlas C booster, an Aerojet AJ10-101A liquid-propellant second-stage rocket with a thrust of about 7,500 lb. and an Allegeny Ballistic Laboratory X248 solid-propellant third-stage with a thrust of about 3,000 lb. Payload was not installed on the vehicle at the time of the explosion.

Cause of the explosion was not immediately known. There were no injuries to test personnel.

The Atlas Able IV lunar-orbit satellite had been scheduled for launch on Oct. 3, with alternate dates of Oct. 4, 5 and 6 in the event of technical delays.

The Able IV payload, which would have been the largest yet put into space by the U. S., had been scheduled to go into a near circular orbit, giving the satellite a 5,000 mi. radius from the moon's surface.

Deviation could have provided an elliptical orbit on the order of a 1,000 mi. perigee and 10,000 mi. apogee.

The payload also included a vernier and an injection rocket with multiple firing capability, the first time this had been incorporated into a U. S. space probe.

Life in orbit of the satellite had been expected to be indefinite. Data transmission capability in scanning the lunar surface was to have extended for approximately one year.

Regulation of the satellite's internal temperature was to have been accomplished through use of small "propeller blade" devices (AW Sept. 7, p. 29).

tion has been laid on the basis of dollars in hand. Lead time, however, continues to be a critical factor:

• **Procurement of existing boosters** involves a lag of roughly a year, except when a military backup vehicle becomes available or an occasional trade can be made with the services for a booster.

• **First really new booster** system developed from the beginning for space—the Vega—will not be ready for missions for some 12-18 months. Although Vega uses an Atlas, which was not specifically designed for space work, the vehicle takes maximum advantage of the Atlas' space capabilities. It will carry a high quality guidance system, modified from a military system, and large payloads—enough to match the recent Soviet lunar shot on a weight basis.

• **University research program** is off to a good start, but payoffs are some two years away.

• **Space sciences program** has a good backlog of work done by the services and others, but new payloads take approximately three years from the idea stage to a fully engineered version.

Inherited Projects

NASA still has two projects left over from the IGY or inherited—the Army Ballistic Missile Agency-IGY radiation satellite to be launched by a Juno II, and Tiros, a meteorological satellite transferred from ARPA. First Tiros will be launched around the first quarter of 1960 using a Thor Able modified to provide attitude control and a long coasting period. Second shot will use the first Thor Delta, a vehicle initiated by NASA.

The Explorer VI paddlewheel satellite launched last month represented the first payload initiated and funded by NASA after it was formed, although it had been proposed earlier. This and two related projects, the projected Atlas Able lunar orbiter and a Thor Able probe are the most ambitious that NASA has planned so far. All three projects were initiated by NASA, with Air Force's Ballistic Missile Division and Space Technology Laboratories, Inc., carrying them out.

NASA Progress

NASA progress in other areas includes:

• **Project Echo.** First launch of this 100-ft. aluminized inflatable sphere is due in the first half of 1960 using Thor Delta. Several vehicles will be launched over a two year period. Dates now are being studied to compress the schedule. This is a passive communications satellite with NASA's Jet Propulsion Laboratory, Bell Telephone Laboratories and Naval Research Laboratory participating. Information on how individuals with the proper equipment may experiment with Echo will be released soon.

• **Tiros follow-up.** This will be an earth-oriented satellite to be launched by Vega. NASA is attempting to design an earth-oriented, stable, multi-purpose payload that eventually would carry meteorological instrumentation plus piggyback experiments that could be kicked off the main satellite into their own orbits. Development of advanced meteorological equipment is under way. NASA's Goddard Space Flight Center is investigating infrared techniques, and invitations to bid on a satellite-borne radar are out. Use of a spectrometer also is currently being explored (AW Sept. 21, p. 23).

• **Plans for a geodetic satellite** carrying a flashing light are fairly firm. Launching, using a Thor Delta, is between one and two years away.

• **Primary guidance and control** efforts are in connection with the Vega and Centaur boosters. Advanced injection guidance is being developed for both. Centaur will use a Minneapolis-Honeywell inertial platform and a Librascope computer (AW Sept. 21, p. 84).

Ames Research Center is now writing specifications leading to the hardware portion of a program for control systems for earth-oriented geodetic and meteorological satellites and for space-oriented satellites to carry an orbiting telescope.

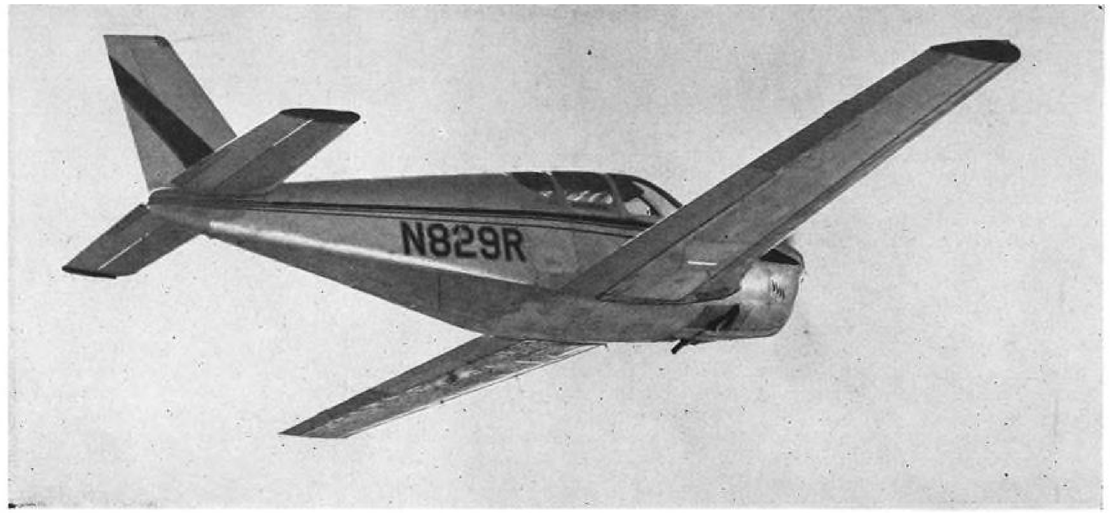
Lunar Program

Work on midcourse and terminal guidance is centering at JPL as part of a lunar program, and NASA has a study contract with ABMA for lunar soft landings which also includes some midcourse and terminal guidance studies.

• **Mercury man-in-space project** is progressing satisfactorily. Recent Big Joe shot (AW Sept. 14, p. 38) to check heating rate on the Mercury capsule was so successful that a backup shot has been canceled. Although the trajectory was not as planned, the flight gave about the right heating rates but for shorter periods. Capsule was recovered in good condition, and several independent recovery location methods agreed. NASA called it "very reassuring to the astronauts and to the operation and recovery group."

• **International cooperation** agreements to replace IGY agreements are being made. Negotiations are either completed or under way for 17 foreign tracking stations. The Scout solid-propellant rocket will be used to launch British satellites and has been offered to COSPAR countries. There is a joint program with Canada for sounding rockets and at least one satellite, and an agreement with Australia for sounding rocket launchings.

• **Work by all but 35%** of JPL's personnel is now funded by NASA. About 10% are doing NASA type work but are funded half by Army and half by USAF. About 25% are still working on Army's Sergeant missile, but this work is shifting to Sperry.



Beech Model 33 Makes First Flight

Beech Model 33, new four-place business plane, made its first flight at the Wichita, Kans., production facility. Airplane will cost about $20,000; note swept vertical tail which distinguishes the Model 33 from the Beech Bonanza. For ground view, see p. 126.

Early Atom Plane Development Urged by Joint Subcommittee

Washington—Flight of a nuclear-powered aircraft "as early as possible" and a possible shift in program responsibility from Defense Department to the Atomic Energy Commission has been recommended by the Research and Development Subcommittee of the Joint Committee on Atomic Energy.

Following the first public hearings (AW July 27, p. 25; Aug. 3, p. 32) since the nuclear aircraft program began 13 years ago, the subcommittee headed by Rep. Melvin Price (D.-Ill.) said: "It is in the national interest to achieve nuclear flight as early as possible, not only to meet stated military requirements but also to provide a boost to world confidence in America's scientific capabilities."

Since the program has been hobbled by changes in policy direction and lack of firm objectives, the report said future technical progress may require a shifting of primary responsibility for achievement of first flight from the Defense Department to the Atomic Energy Commission, "at least through the flight feasibility and demonstration stage."

Other subcommittee conclusions and recommendations contained in the report include:

• **"It is clear from the hearings** and the history of the Aircraft Nuclear Propulsion project since its inception in 1946, that there has been a lack of concrete objectives and target dates either for a ground test prototype propulsion system or for early flight." The report said such objectives and target dates are essential to provide clear guidelines for the R&D program and to give working scientists and engineers the incentives to reach their goals.

• **"Technical progress** in the program to date has been both positive and continuous. In general, technical objectives have been met on schedule.

• **"It is evident that early flight** with materials now on hand would provide a powerful stimulus toward early development of a fully operational military aircraft propelled by nuclear energy. Many problems associated with nuclear flight could be met and solved through such early flight with concurrent development of more advanced reactor cores to produce improved performance."

• **"In any programing effort** to achieve early nuclear flight utilizing available materials, there should be continued emphasis on the development of advanced materials so as to ensure a better performance and capability in the future. The recent technical advances made in the indirect cycle system appear most promising, and it is the feeling of the committee that every effort should be made to push ahead with the proposed experimental reactor program.

• **"The concept of coordinated** direction of the technical program between the Defense Department and AEC has, in general, worked well since the establishment of the joint office and should be reinforced by firmer top-level support from both agencies." The report said the Aircraft Nuclear Propulsion Office has more often than not been given responsibilities without delegation of the actual authority needed to carry them out effectively.

The committee suggested that Congress may wish to consider placing primary authority and responsibility for the ANP program with the AEC as a possible alternative to a joint effort. This recommendation was prompted by the Defense Department position that there is presently no general operating requirement for a nuclear-propelled aircraft.

The committee said that if program responsibility is shifted to the AEC and if primary emphasis is placed upon development of a ground test prototype propulsion system and on the flight testing of the system in an experimental aircraft, cooperation with the Defense Department should be continued. Such an approach, the committee added, should prove the feasibility of nuclear flight and would also provide the basis for a judgment by the Defense Department on firm military requirements for a nuclear-propelled aircraft.

Republican members of the committee concurred with the report's conclusion that "early nuclear flight is in the national interest," but they filed separate views regarding the report's interpretation.

"We wish to make it clear," the Republican members said, "that its recommendation to achieve it 'as early as possible' should be taken to mean getting something in the air flying on nuclear power at the earliest moment technically possible only when technical and non-technical consideration both clearly point to that interpretation."

Vanguard Units Aid New Space Projects

By Craig Lewis

Washington—Successful launch of Vanguard III marked the end of the first U. S. space science program, but elements of the much-maligned Vanguard project are continuing to make substantial contributions to the national space effort.

Vanguard III was the last in a series of 14 test and satellite launching shots under a program designed to place a scientific satellite into orbit before the end of the International Geophysical Year last December. That aim was met with Vanguard I, and National Aeronautics and Space Administration has put two more Vanguard satellites into orbit this year.

The Vanguard program was launched as the first U. S. space science program in the pre-Sputnik era when such projects received sparse support and space work generally was given minimum priority. It entered its flight test stage soon after the Sputniks triggered a scramble to organize a substantial U. S. space effort, and it bore the brunt of the nation's propaganda frustrations during that period.

In the final shot, the Martin Vanguard Satellite Launching Vehicle 7 put a satellite with a 50 lb. payload into an orbit with an apogee of 2,329 stat. mi. and a perigee of 319 stat. mi.

The satellite requires 130 min. to make a complete circuit, and its orbit is inclined 33 deg. to the equator. Velocity is 12,361 mph. at apogee; 18,567 mph. at perigee. Vanguard III (1959 Eta) is measuring the earth's magnetic field, solar X-rays and space environmental conditions. It is expected to remain in orbit for several decades.

Backup Test

SLV-7 was an unused backup test vehicle that had been converted to provide an extra satellite launch beyond the series of six SLV shots originally scheduled. It had an Alleghany Ballistic Laboratory X-248 solid propellant engine rather than the usual Grand Central X-242 third stage. The ABL engine burns 10 sec. longer than the Grand Central rocket.

Use of the more powerful ABL rocket made it possible to orbit a 50 lb. payload, a satellite more than twice as heavy as previous Vanguards. The spent rocket case is still attached to the satellite, and together they weigh about 100 lb. ABL third stage is a plastic case engine with an improved mass ratio and higher specific impulse which was developed in parallel with the simpler Grand Central rocket used in earlier Vanguards. It had flown previously as the third stage in the Thor Able vehicles.

Vanguard III is a 20 in. sphere with a 26 in. tapered tube attached. The tube is made of glass fiber-reinforced plastic, and its diameter tapers from 6 in. to 2.5 in. Section of the sphere where the tube is attached is also plastic, the rest is magnesium. Satellite structure weighs 19 lb., the battery section, containing 62 silver zinc cells expected to last 90 days, weighs 22.5 lb. Instruments and electronics weigh 8.5 lb.

The tube on the satellite has a new type of magnetometer at its tip which will measure the earth's magnetic field. It is more accurate than previous magnetometers, and, unlike the devices in Explorer VI, its signal is not dependent upon its orientation in the field. Magnetometer will be queried about 50 times daily, or twice on each pass over a tracking station. Simultaneous readings will be taken from ground-based magnetometers to provide added calibration for mapping the magnetic field and to help filter out the effect of ionospheric currents on satellite measurements.

Proton precisional magnetometer is a copper coil filled with hexane and sealed in the tip of the tube. Ground commands send 6.5 amp. of current to the coil for two seconds, and this orients the protons (hydrogen atoms) in the liquid and spins them within the coil. When current flow stops, the protons spin for 2-2.5 sec. in a wobbling orbit dictated by the earth's magnetic field. Their frequency imparts voltage to the coil, and this cyclic voltage is amplified and telemetered.

Solar X-rays are measured by two ionization chambers sensitive to radiation in the band from about one to 10 angstroms, the range area where X-rays are produced by solar flares. Memory cores will retain the maximum X-ray signal received during each orbit, with one core broadcasting the maximum signal from the preceding orbit while the other core stores data from the present orbit. A third core will transmit continuous radiation measurements.

Sun is currently in a phase of relatively high solar flare activity, and the Vanguard III instrumentation will be constantly available to record the growth and decay of solar flares as long as the satellite is within telemetry range. Some difficulty may be encountered in distinguishing between solar X-rays and similar radiation in the inner Van Allen belt, although existing data on altitude distribution of Van Allen radiation will help. X-rays detected below an altitude of 1,000 mi. will almost certainly be considered solar X-rays.

In environmental experiments, two thermisters on the inside of the satellite shell are measuring average shell temperature and orbital fluctuations. A third thermister measures internal temperature of the X-ray environmental instrument compartment.

Variety of instruments will measure bombardment of micrometeorites and other material. Erosion from very small particles is recorded with three chromium strips in which resistance changes as their surfaces erode. Larger particles, but still in the micron range, are detected by a photocell. This is a cadmium sulphide cell covered by an opaque sheet of mylar plastic and deposited aluminum. Holes gouged in the plastic cover let light into the cell, giving a measure of the size of the hole. Micrometeorite impact on the satellite shell is detected by four barium titanate microphones.

Shell Cover

About 20% of the shell is covered by two pressure zones which will measure any penetration of larger particles. These zones have partial, differential vacuums, and changes in pressure will indicate a puncture and which zone was punctured.

Engine case was left attached to the satellite to avoid any possibility of collision between the two after ejection and to avoid enhancing any tendency to precess or tumble that might be present. Scanning cycle programed for the Vanguard II cloud cover satellite was disturbed by a collision between third stage and satellite.

NASA is tracking Vanguard III with 10 Minitrack stations and by Baker-Nunn cameras at 12 stations. Satellite is broadcasting a steady signal on 108 mc. with 80 mw. power signal is modulated by X-ray and environment instrumentation when interrogated. Magnetic field data is broadcast on 108.03 mc. with an 80 mw. transmitter that operates only on ground command.

With the last shot, the Vanguard program is formally finished, but personnel, techniques and hardware developed during the program have been diffused throughout the present U. S. space program and are continuing to make substantial contributions.

Dr. John P. Hagen, NASA's assistant director of space flight development for program coordination and former Vanguard program director, points out that the Vanguard involved an entire system, including launch vehicle, tracking facilities and techniques and a scientific program.

This program has modest aims and support in terms of the present space effort, but it provided a technical and scientific base for NASA to use. Since Vanguard was an inherited program and haunted by a series of highly publicized failures, it has never stood high in the view of present space councils, but NASA is making full use of its elements.

Minitrack tracking system was developed under the program and the facilities installed formed the beginnings of U. S. tracking systems. Vanguard installations at Cape Canaveral gave the base its first satellite tracking capability. Techniques for putting a satellite in orbit were pioneered by Vanguard, and the group contributed such other approaches and techniques as using turbopump exhaust for roll control.

Parts of the launch vehicle are in use or programed for several satellite and space flight systems. Hagen terms the General Electric first-stage engine, which failed once in 12 tries, "the most successful major rocket ever built in this country." Aerojet-General second stage was the cause of a number of Vanguard failures but most of its problems now appear to be corrected. The Vanguard third stage never failed to operate.

Second stage and the ABL third stage have been used in a number of Thor Able launches and will be in the Atlas

FOUR ANTENNAE of Vanguard III satellite are extended for prelaunch tests. Notched strips on vehicle fairing break up wind currents on the launch pad and are jettisoned after launch. Saucer-shaped fixture under satellite protects it from heat and smoke.

Vanguard Launch Timetable, Results

Original Vanguard program called for production of six test vehicles (TV series), three backup test vehicles and six satellite launching vehicles (SLV series). TV-2 backup vehicle was cannibalized for parts, and the shell was given to the Smithsonian Institution as an exhibit. TV-4 backup vehicle was converted to SLV-7 and fired this month. Vehicles in the Vanguard program were fired in this order:

- TV-0, Dec. 8, 1956: Viking rocket, carrying no Vanguard components, was successfully fired in a test of range facilities, telemetering and instrumentation.
- TV-1, May 1, 1957: Viking first stage launched a Vanguard third stage in a successful test of the control system and of third stage separation, spinups, ignition and propulsion.
- TV-2, Oct. 23, 1957: Complete Vanguard configuration launched for the first time in a successful test of the first stage engine, the control system and the vehicle structure. Second and third stage were dummies.
- TV-3, Dec. 6, 1957: First test of the complete vehicle and control system failed when the first stage engine lost thrust after 2 sec. and the vehicle burned on the pad. This was the first Vanguard vehicle with orbit capability, and it carried a 3.25 lb. satellite with micrometeor impact and geodetic measurement experiments.
- TV-3 backup, Feb. 5, 1958: Repeat of the TV-3 launch attempt failed with a control malfunction after 57 sec. of flight broke the vehicle up at about 20,000 ft.
- TV-4, Mar. 17, 1958: Successful launch of Vanguard I, a 3.25 lb. satellite containing temperature and geodetic measurement experiments. This was the first flight test of the second stage.
- TV-5, April 28, 1958: Failed to put its 21.5 lb. satellite into orbit when control system relays failed and the third stage was not ignited. This first regular IGY scientific satellite had radiation and environmental measurement experiments.
- SLV-1, May 27, 1958: Failed when the second stage engine cut off improperly, and the vehicle flew in a 5,000 mi. ballistic trajectory. The 21.5 lb. satellite had solar Lyman-Alpha radiation and space environment experiments.
- SLV-2, June 26, 1958: Failed when the second stage cut off prematurely due to low chamber pressure and terminated the flight. Satellite weighed 21.5 lb. and was to have measured solar X-radiation and environmental conditions.
- SLV-3, Sept. 26, 1958: Failed when second stage didn't provide minimum thrust, and the vehicle flew back into the atmosphere. The 21.5 lb. satellite had two infrared photocells for measuring the earth's cloud cover.
- SLV-4, Feb. 17, 1959: Successful launch of Vanguard II, a 21.5 lb. satellite with infrared sensors for cloud cover measurement.
- SLV-5, April 13, 1959: Failed when the second stage didn't operate properly and the vehicle tumbled. The 23.3 lb. payload included a 13 in. ball with a magnetometer attached for mapping the earth's magnetic field and 30 in. inflatable sphere to measure atmospheric drag.
- SLV-6, June 22, 1959: Failed when a second stage malfunction allowed pressure to build up in the helium reservoir and cause a rupture about 40 sec. after ignition. The 22.5 lb. satellite was to have measured the solar-earth heating process.
- SLV-7, Sept. 18, 1959: Successful launch of Vanguard III, a 50 lb. payload which is measuring the earth's magnetic field, solar X-rays and space environmental conditions. This vehicle was the TV-4 backup vehicle with a more powerful third stage than previous Vanguards.

Able and Thor Delta. Modified Vanguard first stage will be the second stage on the Vega space vehicle. Project Scout vehicle uses the ABL third stage and another solid rocket derived from the ABL engine.

Scientifically, Vanguard I has been highly successful. It has provided geodetic information that has showed the earth is slightly pear-shaped and more precise measurements will be possible as tracking improves. This new data has important implications in theories on the internal composition of the earth and in the revision of theory on the strength of the earth's mantle.

Vanguard I is a continuing demonstration of the feasibility of its solar-powered, transistorized transmitter, since signal strength has remained constant. This indicates there has been little erosion from micrometeorites on the clear quartz plate covering the solar cells.

Orbit of the little satellite has provided data on the density of the atmosphere out to its apogee and has shown that the atmosphere is considerably more dense than extrapolations had indicated. Density varies with solar activity, so Vanguard I will have to be studied through the complete 11 year solar cycle before the picture is complete. Drag imposed by this density will dictate the life of the satellite's orbit, but it will stay up at least 200 years and may last 2,000 years.

Vanguard II was a disappointment because of the scanning trouble caused by collision with the rocket case, but it did provide readings that clearly distinguished between land, sea and clouds. NASA is now trying to untangle the unstable motions of the cloud cover satellite and integrate the readings to get a complete picture. Information is coming in from all the Vanguard III experiments, but it is still too early to determine its value.

All three of the military services conducted high altitude research programs in the decade after World War II, but they were small scale efforts and there was no integrated national program. When the International Scientific Committee was planning for the IGY, use of satellites for upper atmosphere research was discussed, and it was recommended that satellites be considered as part of the IGY effort. With this scientific interest, military interest quickened and Navy proposed Project Orbiter, an uninstrumented satellite to be launched by Redstone and Loki rockets in cooperation with the Army.

As plans and proposals began to take shape, Defense Secretary Charles Wilson took steps in March, 1955, to coordinate efforts. In April, a coordinating committee recommended three separate approaches: Project Orbiter; a Navy program using the Viking in a three-stage rocket, and an Air Force project incorporating the Atlas engine and Aerobee-Hi for a second stage.

The White House then ordered a study of IGY satellite launching prospects, and the Advisory Group on Special Capabilities was established to recommend a hardware and management approach. Over strong objections from the Army, the group recommended a program run by the Navy using a three-stage vehicle with a first stage based on the Viking and a second stage based on Aerobee-Hi. Army maintained it could put a satellite in orbit by January, 1957, and continued to press for its own satellite program until it finally received authority after Sputnik.

With the formal establishment of a U. S. space science program in September, 1955, Vanguard was to be conducted independently of military missile programs and was not to interfere with them. Specifications were vague, but the central aim was to get a satellite into orbit during the IGY. Funding was a constant problem, and a substantial amount of the $110 million eventually spent on Vanguard was diverted from unrelated sources.

Navy gave direct responsibility for the program to Naval Research Laboratory with Hagen as program chief. The Martin Co., which had been prime contractor on Viking, was chosen as Vanguard prime contractor. First schedule was set in November, 1955, but it was slipped several times as development problems occurred.

Vanguard vehicle configuration was ready to go into flight test just as the Russians orbited Sputnik in October, 1957. First full test of the vehicle failed spectacularly in December, 1957, when it burned on the pad. Although Vanguard went on to meet its objective and to add two subsequent satellite successes, it never recovered from the stigma of failure that resulted from this mishap and subsequent launch failures.

Earlier this year, the House Appropriation Committee reported in an investigation of the program that the Vanguard group did a "commendable job" within the ground rules established. The committee reported that separating the program from the missile effort was a mistake, that goals were too vague and not properly defined to the public and that complexity and cost were underestimated, leading to an overly optimistic schedule. The report also observed that the system team effort was loosely organized, possibly because the program grew out of the much smaller and less complicated Viking program. Committee observed that reliability goals were vague and the reliability effort was not a strong element in the program.

The report noted that review responsibility for Vanguard went from Assistant Secretary of Defense for Research and Development to Special Assistant for Guided Missiles in May, 1957; to Advanced Research Projects Agency a year later and to NASA in October, 1958. Committee said the last two transfers caused specific launch delays.

Defense Closes Boron Fuel Facility

Washington—Defense Department closed a newly completed $45 million boron fuel plant in Buffalo, N. Y. last week and put another at Muskogee, Okla., on standby status.

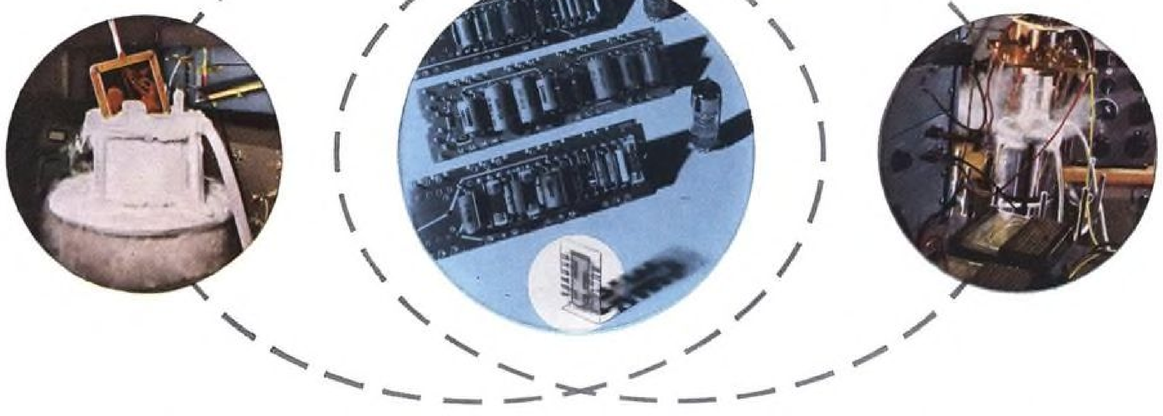
The action, expected since late August, all but scuttles the $240 million boron fuel development program except for small research and development projects directed mostly at development of a boron fuel compound for possible use in rocket fuel. Both the Air Force and Navy supported boron fuel development programs until recently when requirements for the fuel were removed by "advancing technology" and "shift in emphasis" from aircraft to missiles (AW Aug. 31, p. 30).

The Air Force dropped its requirement when it decided to switch from the General Electric J93-5 to the J93-3 engine for the North American B-70 Mach 3 bomber. The Navy's interest dropped when emphasis was shifted from high performance carrier planes to lower performance aircraft carrying high performance missiles.

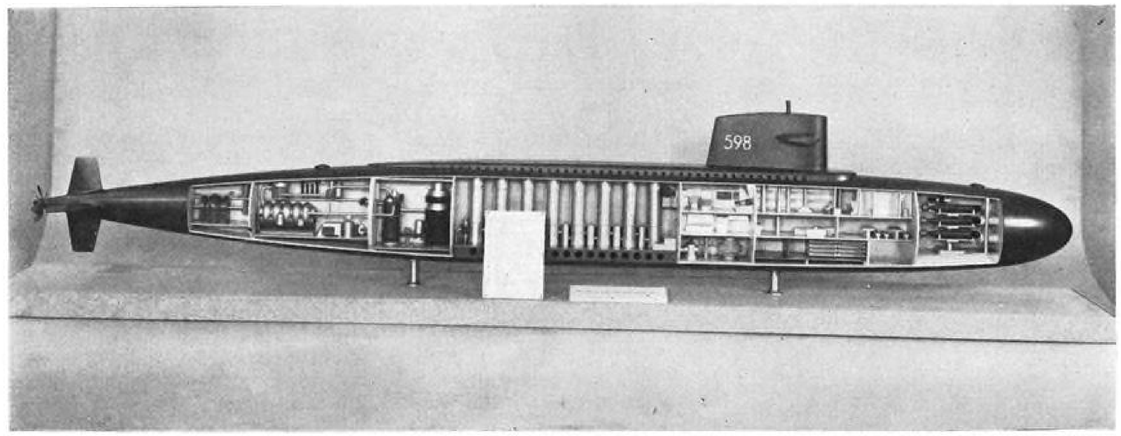
The Defense Department said the Air Force plant at Buffalo, which would have been operated by the Olin Mathieson Corp., would be closed out as surplus, except for the boron trichloride facility to feed a smaller research and development plant.

The Navy's five-ton a day plant at Muskogee, Okla., which would have been operated by the Callery Chemical Corp., will be kept on "standby" status at least until June 30, 1960, the Defense Department said. The plant, recently completed at a cost of $35 million, will not go into production but will be kept ready to start within three months in case Defense decides an increased boron research and development program is feasible.

Cancellation of the boron program prompted a congressional investigation last month by the House Science and Astronautics Committee. At that time, committee members were highly critical of the Defense Department for continuing large expenditures for construction and research after it appeared there would no longer be a requirement for the fuel (AW Sept. 7, p. 34). The committee warned the Defense Department to find a requirement in order to prevent money already invested from "going down the drain."



In center, conventional circuitry is contrasted with equivalent cryogenic device (in white circle). Left and right photos show details of specially designed apparatus used to achieve low temperatures for superconductivity.



Cutaway of Navy's first fleet ballistic missile submarine, the George Washington, shows the compartment which contains eight of its 16 Polaris launcher tubes. From tail section forward are two engine room compartments, the reactor, Polaris tubes, control centers, officers' quarters, mess room, ballast tanks and torpedo room. Model was made by U. S. Naval Exhibit Center, Washington, D. C.

Navy Starts Final Polaris Ballistic Missile Tests

U. S. Navy last week launched the first in its final series of Polaris test vehicles (right), which traveled over 900 mi. downrange from Cape Canaveral, Fla., launch site. Range will gradually be extended to a maximum of 1,200 stat. mi. as firings continue through next spring; launchings also will shift from dry pad to USS Observation Island. Steel alloy sub-scale rocket test chambers for Polaris (above) are being made by Ryan Aeronautical Co.; cylinders can withstand 35,000 psi. pressures. Ryan also will build a sub-scale titanium chamber model.

Congress Reverses Early Spending Push

By Katherine Johnsen

Washington—Loud demands from the Democratic majority in January for larger defense and civil aviation programs gradually disappeared during the first session of the 86th Congress.

By the September adjournment a few hours before the arrival of Soviet Premier Nikita Khrushchev in Washington, Congress had provided for less for defense, less for space programs, less for airports and less for civil airways than the funds requested by the Administration.

This was the record:

• **Defense Department.** The $39.2 billion approval for Fiscal 1960 was $19 million below the Administration request and $660 million below the Fiscal 1959 allocation. Congress did take the initiative in providing for acceleration of advanced missile programs—the Convair Atlas and the solid-propellant Minuteman intercontinental ballistic missile programs and Army's Nike Zeus missile defense system. On reconsideration, Defense Department endorsed the fund increases in these programs. Over Defense opposition, funds for other missiles were cut—Martin Mace tactical missile, the USAF Bomarc and the Army Nike Hercules air defense missiles.

• **National Aeronautics and Space Administration.** A fortnight before Russia's successful launching of a rocket to the moon (AW Sept. 21, p. 28), Congress sent to the White House a $500 million Fiscal 1960 budget for NASA—$30 million below the Administration's planned program.

• **Federal Aviation Agency.** Congress cut $52 million off the Administration's request for FAA's Fiscal 1960 budget. The $535 million approved was $14 million below the Fiscal 1959 allocation.

• **Airport development.** The Administration proposed a four-year $200 million extension of the authorization for federal aid for airport construction. Congress approved a $126 million two year extension.

• **Civil Aeronautics Board.** CAB's operations budget for Fiscal 1960 was reduced from the $7.5 million asked by the Administration to $6.9 million. This was still $385,000 more than the Board's funds for last year. The allocation for payments to air carriers was cut $4.7 million to $65.4 million—indicative of Congress' aim to reverse the trend toward higher subsidy costs. In Fiscal 1959, subsidy payments to airlines totaled $61.4 million.

• **Military assistance.** Funds for defense support—a lion's share scheduled for overseas missile bases—was reduced by $140 million to $695 million. This is substantially below the $750 million of Fiscal 1959.

At the start of the session, Sen. Stuart Symington (D.-Mo.), backed by Sen. Dennis Chavez (D.-N. M.), chairman of the Senate Appropriations Subcommittee on the Armed Services, denounced the Administration for failing to use $1.3 billion for defense which the previous Congress had voted over and above that requested by the Administration.

There was a flurry over a memorandum written by Budget Director Maurice H. Stans to the military chiefs of staff advising them to support the Administration's budget requests and not recommend additional funds to Congress. Rep. Daniel Flood (D.-Pa.), a member of the House Appropriations Subcommittee on the Armed Services, dramatically introduced legislation abolishing the Bureau of the Budget under the President and establishing a U. S. Budget Office under Congress. No effort was made for action on the measure.

Rep. John McCormack (D.-Mass.), House majority leader, called for higher taxes, if necessary, to finance greater defense spending within a balanced national budget.

The House Science and Astronautics Committee issued a report warning that it will take "at least five years of intensive effort" to reach an equal status with the Soviets in the space field.

Sen. Lyndon Johnson (D.-Tex.), Senate majority leader and chairman of the Senate Space Committee and the Preparedness Subcommittee, announced comprehensive hearings to determine: "Is the U. S. doing everything it reasonably can and should (1) to ensure the defense of this country and the free world against military aggression, and (2) in the exploration of outer space?" At the hearings, military officials pointed out the cuts that had been made in their recommended programs by the Administration: USAF, $2 billion; Army, $3.6 billion; Navy, $2.5 billion. NASA conceded its program was tight. The Johnson committee made no findings or recommendations after the hearings were completed.

Senate Commerce Committee, with the threat of mounting unemployment, approved a $465 million four-year airport construction program after brief hearings. Johnson promised night sessions, if necessary, to get the urgent measure passed. It was almost five months later that Congress sent a $126 million program to the White House.

At the opening of the session, the outlook for procurement legislation sponsored by Sen. Leverett Saltonstall (R.-Mass.) aimed at cutting audits, reviews and other red tape and speeding the production of advanced weapons, was favorable.

As the session advanced, concern shifted from the size of the defense program to the administrative organization for handling it as a possible area for cost-cutting through improved efficiency and away from the Saltonstall legislation, which was developed in the period immediately after the shock of Sputnik I, to closer policing of contractor costs and profits and competition in weapons system procurement.

Service chiefs, faced with a tight over-all defense budget, turned to downgrading each other's programs.

Navy called USAF's nuclear-propelled aircraft program "a poor program with little hope. . ." The hardest fought controversy was between USAF's Bomarc and Army's Nike Hercules air defense systems. Defense Secretary Neil McElroy invited Congress to cut funds and force a decision on a proper mix of the two in a "master plan." Congress did.

The plan eventually submitted reduced Fiscal 1960 Bomarc procurement by $33 million and Nike procurement by $77 million. Later, Congress cut $50 million more from Bomarc funds and $20 million more from Nike funds.

By the end of the session, there were numerous proposals pending for management reorganizations:

• **Army-USAF** merger and abolition of Advanced Research Projects Agency was proposed by the House Government Military Operations Subcommittee headed by Rep. Chet Holifield (D.-Calif.) after extensive hearings on missile management. The subcommittee insisted that Space Technology Laboratories, technical manager of USAF ballistic missile programs, be converted to nonprofit status (AW Sept. 14, p. 19).

• **Senate Space Subcommittee** headed by Sen. Symington urged the appointment of a permanent executive secretary for the Space Council, clarification of the space roles of the three services and closer liaison between military and civilian programs.

• **Sen. Clair Engle** (D.-Calif.) recommended complete reorganization of the defense structure according to functional roles—retaliatory striking force, limited war force, continental defense and a logistics command—instead of by services. Sen. John Sherman Cooper (R.-Ky.) advocated one procurement director for the entire defense establishment.

General Accounting Office reports showing over $50 million in "intentional" over-pricing by Air Force and Navy aviation contractors were largely responsible for spurring congressional pressure for tightening procurement practices and policies:

• **Renegotiation law** was extended virtually as it had been in the past. Before release of the first of the GAO reports—showing $30 million in over-pricing by USAF contractors—the House had eased the law to provide for more favorable profit treatment on incentive type contracts and to provide for contractor appeals, by a wide voting margin.

• **House Armed Services Committee** held hearings to obtain Air Force assurances that it already had obtained $17 million in reductions on over-priced contracts, was taking steps to obtain further reductions and was adding over 200 auditors to police contracts.

• **House Armed Services** Investigating Subcommittee headed by Rep. Edward Hebert (D.-La.) launched an investigation into the employment of retired military officials by defense industries and charges of "munitions lobby" influence in military procurement programs. The probe was designed to stave off demands for immediate passage of drastic legislation which would have banned contracts to any firm which hired a high-ranking officer within five years after retirement. Such a measure was tentatively passed and later defeated only on assurances of an investigation.

Two projects which received lengthy congressional consideration were:

• **Aircraft Nuclear Propulsion.** Insistance of the Joint Congressional Atomic Energy Committee on an Air Force "fly early" program appeared in midsession to have achieved the endorsement of the Administration. However, following the death of Donald Quarles, Deputy Secretary of Defense, a re-appraisal of the project under the direction of Dr. Herbert York, Defense Department director of research and engineering, led to a decision to shift emphasis to materials research rather than early flight.

• **Military Air Transport Service.** Congress expressed its displeasure at both MATS—for invading the commercial airline domain—and at Air Transport Assn. for its opposition to MATS. Under congressional pressure, MATS revised its Fiscal 1960 program for procurement of commercial airline services from $54 million in January to $71 million. Congress earmarked $85 million in the Defense budget for commercial service. A House-Senate appropriations committee report declared MATS is essential and must be modernized and called civil aviation "a giant grown fat by government subsidies and high rate charges."

USAF Replies to East Coast Criticism

New York—Geographical location, despite some implications to the contrary (AW July 20, p. 28), is not a factor in qualifying companies for Air Force contracts, Maj. Gen. Ben. I. Funk, head of the Air Materiel Command's Ballistic Missile Center, told the New York City Rotary Club last week.

The U. S., Gen. Funk said, is spending close to $2 billion a year on its ballistic missile program alone. America's first solid-propellant intercontinental ballistic missile, the Minuteman, which will be considerably less expensive than its two liquid propellant predecessors, the Atlas and Titan, is expected to cost $1 million "in the hole," according to Gen. Funk. This, he referred to as a "cut rate price" as far as ballistic missiles go.

In the area covered by the New York Air Procurement District, 352 companies hold 1,584 Air Force contracts with a total value of more than $1.75 billion, he pointed out. Major ballistic missile work in this area breaks down approximately as follows:

• American Bosch Arma Corp.—$203 million (including $53 million in new contracts) for production of all-inertial guidance system for the Atlas.

• Bell Telephone Laboratories—$115 million for development and production of radio command guidance systems for the Titan.

• American Machine & Foundry Co.—$85 million (including $42 million in new contracts) for building, installing and testing underground launching systems for the Titan.

• Missile and Space Vehicle Department of General Electric—$150 million for development and production of Thor and Atlas re-entry vehicles.

• Defense Systems Department of General Electric—$250 million for production of radio-command guidance systems for the Atlas.

• Lycoming Division of Avco Corp.—$100 million for development and production of Titan and Minuteman re-entry vehicles.

In addition to these major prime contracts, Gen. Funk said, first tier subcontracts have been awarded to approximately 100 companies in the New York area, representing almost 25% of all major subcontractors in the entire ballistic missile program.

News Digest

Hiller Aircraft Corp. and Twin Coach Corp. directors are discussing merger. William H. Coleman, president of Twin Coach, which manufactures aircraft and missile components, would become chairman of the board of the merged company, and Hiller President Stanley Hiller, Jr., would become its president.

Army support of its flying jeep program has all but evaporated. Funding has been suspended on the Chrysler and Aerophysics Development Corp. projects. Of the three winners in the flying jeep competition held on paper about a year ago, only Piasecki Aircraft is still receiving Army money. Piasecki will deliver two of the vehicles to the Army. One is powered by two gas turbines. The other has one gas turbine engine and is considered marginal. Chrysler's flying jeep crashed during the late spring and an investigation of the program resulted in its termination. Aerophysics' jeep flew for the first time early this month, but the project is now financed completely by the company. A public demonstration of the vehicle is planned early next month.

"Spread-the-work" schedule providing temporary alternate week layoffs affecting some 250 employes over an anticipated seven weeks period has been agreed upon by officials of Chance Vought Aircraft, Inc., and Local 893, United Auto Workers union because of "changes in a military and research and development program." The nature of the program would not be identified by the company. Schedule, which went into effect last week, is an effort to prevent permanent layoffs of approximately 125 skilled workers.

Air Force has canceled its contract with Aerojet-General for a backup first stage engine for the solid-propellant Minuteman intercontinental ballistic missile. Notice of termination was sent to Aerojet earlier this month by Air Materiel Command's Ballistic Missile Center. In explaining the cancellation, an Air Force spokesman said work by Thiokol on its first-stage engine for the Minuteman has progressed to the point where the requirement for a backup powerplant is no longer needed.

Westinghouse Electric Corp. has developed an Atlas missile erector control system which the company says makes it possible to store the weapon horizontally and erect it to firing position in two minutes at push of a single button. System will be built under contract to Goodyear Aircraft Corp., builder of the erector.

Resignations May Spur CAB Policy Shifts

Departure of four members could leave the Board without a majority of veterans for the first time.

By L. L. Doty

Washington—Civil Aeronautics Board, shaken by the recent resignation of Louis J. Hector (AW Sept. 21, p. 36), now faces more sweeping changes that could leave its five-man membership with but one experienced member.

For the first time in its 21-year history, the CAB will be without at least a majority composed of veteran members if plans of three of the four remaining members materialize. Only Vice Chairman Chan Gurney plans to retain his seat and finish his second six year term which began last year. Gurney is now the obvious choice to be named to the chairmanship after James Durfee, the present chairman, resigns.

Louis Hector was scheduled to be replaced immediately. Leading candidate late last week was Thomas Davis, formerly of the Virginia Port Authority and once an Assistant Secretary of Commerce. Because of his Board experience, Franklin Stone, CAB general counsel, is now a leading candidate for a Board seat but he probably will be forced to settle for an unfinished term rather than a full term.

Here is how the future composition of the Board looks to observers here:

• **James Durfee** will accept a recess appointment to the Federal Court of Claims and will resign from the Board in sufficient time to take over the judgeship when the court convenes Oct. 5. Gurney will be named chairman. The resultant vacancy probably will be filled by Stone.

• **Harmar Denny** has privately expressed his desire to leave the Board in October. In any event, Denny's term expires Dec. 31, and he probably cannot be persuaded to take a second term.

• **G. Joseph Minetti** reportedly will resign within the next year to accept another position in New York. Minetti and Hector are the two Democratic members of the Board.

• **Hector's resignation** was effective immediately upon its acceptance by President Eisenhower on Sept. 16, and he is no longer participating in Board cases. His replacement will finish Hector's term which has another three and one-half years to run.

Each of the four members is leaving for a different reason. Hector is the only one to resign because of dissatisfaction with the Board's structure and its performance. And, beyond Davis and Stone, the White House has not yet settled on any of the six or seven candidates in the running for the two Board positions that are expected to become vacant before the end of the year.

Major influence in the final choice of members will be carried by Federal Aviation Agency Administrator Elwood R. Quesada, who, by his past record, has shown a tendency to steer away from political considerations in his selection of personnel.

Professor Favored

Quesada also is believed to favor a college professor type for at least one of the openings on the Board. This has given rise to speculations that Paul Cherington of the Harvard Business School, Stanley Brewer of the University of Washington and Gayton Germaine of Stanford University are now under consideration for one or more of the posts.

The Hector resignation is not viewed as one of the reasons behind the changes in the five-man Board membership. Hector resigned with the knowledge that Durfee was scheduled for the Federal Claims Court vacancy and that Denny was eager to retire. He probably also knew of Minetti's plans. In view of this awareness of the prospects of an early revamping of the Board's membership, Hector's resignation has drawn some criticism from industry and government circles.

One airline official recalled that Hector had answered strongly in the affirmative to a question during the Senate hearings on his nomination asking if he planned to serve out his full term.

During his tenure, Hector had grown increasingly popular with top airline officials as a member who acted with intellectual honesty backed by a widening understanding of basic airline problems. His resignation, however, is being viewed by many within the industry as a miscalculated move.

Several airline spokesmen feel that his proposal for reshaping the CAB as outlined in his memorandum to President Eisenhower (AW Sept. 21, p. 36) is valueless without Hector on the scene to promote it and back it against the resistance it will inevitably meet. In addition, a number of industry officials, as well as Board staff members, are expressing serious concern that major cases pending before the Board may be unnecessarily delayed, if not actually jeopardized, by the resignation.

Tiedin with these major cases are certain established Board policies that could feasibly be scuttled by a change in the character of the Board.

An example is the Board's adopted policy on local-service operations, including the "use-it-or-lose-it" policy, skip-stops to lengthen stage hauls and the transfer of some routes from trunklines to local-service carriers. The policy is experimental at best, and its benefits can be determined only after it has been in practice for a number of years. A new Board could justifiably introduce a revised policy, creating a serious loss of time in the development of local-service operations.

A policy now being formulated with respect to subsidy standards also could be dropped by a new Board, even though a considerable amount of time and expense already has been devoted to the project.

A third policy that could be threatened by a new Board—and several carriers would like to see it threatened—has to do with the strengthening of smaller trunklines by increasing competition on major routes. Outcome of the Southern Transcontinental Service Case now in its early stages of proceeding could definitely be affected, not only by a change in policy but, probably, by a change in Board members.

Hector, in his memorandum, accused the Board and independent commissions of making policy with "appalling inefficiency" and urged that policy-making functions be transferred to an executive agency in much the way air safety policy and planning was transferred to the Federal Aviation Agency. He said:

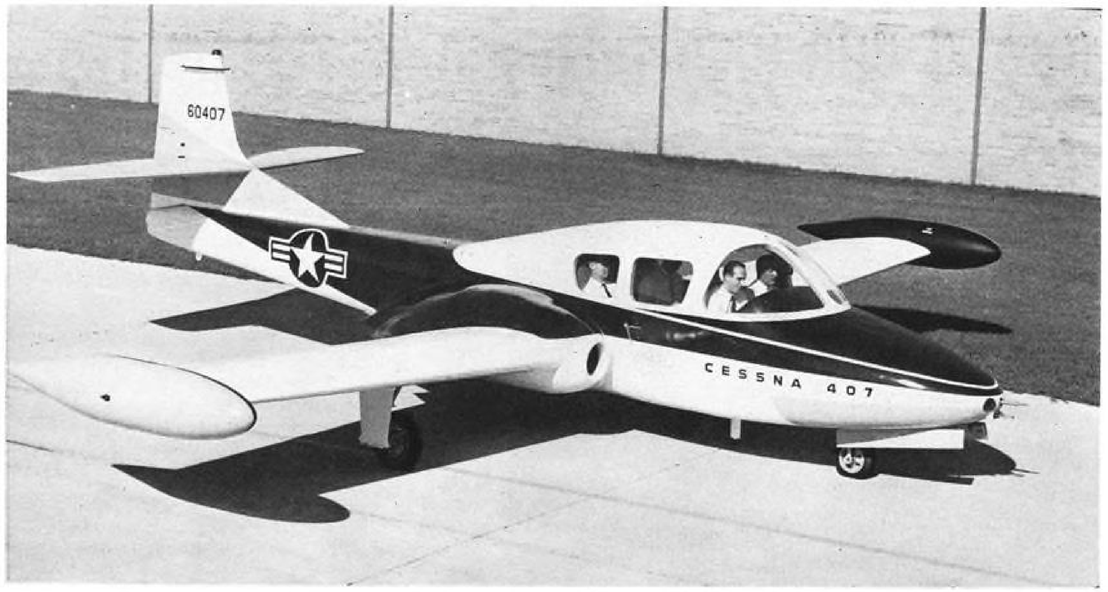
". . . in some economic matters, such as the encouragement of air cargo, where the Board has achieved nothing in a decade, the FAA has already proved the value of an executive agency by evolving in a few months an imaginative and far-reaching program."

Of all the major cases pending before the Board, the General Passenger Fare Investigation, which is now being voted upon by the four remaining members of the Board, is the leading issue in current airline activities. A tie vote on one or more of the three phases of the case is possible as the result of Hector's resignation.

In such an event, Hector's replace-

First Air France Boeing 707 Intercontinental Flies

First Air France Boeing 707-328 Intercontinental jet transport, powered by four Pratt & Whitney JT4A-3 turbojet engines, makes its initial flight at Boeing Field, Seattle, Wash. Air France has ordered 17 Intercontinentals, will begin Paris-New York jet service this winter. First of the planes will be delivered in October and will be flown from Seattle to Paris. Crew training now is under way.



Cessna Designs Four-Place Utility Jet

Detailed full-scale mockup of Cessna Aircraft Co.'s new four-place twin-jet utility airplane is being displayed at Arlington, Va., this week to Department of Defense civilian and military officials, opening the company's drive to sell this privately financed project to Air Force, Army, and Navy. Although bearing some resemblance to Cessna's T-37A twin-jet trainer, now in service in large quantities, the 407 is a completely new design featuring a fully enclosed cabin with entrance door on right side (just in front of jet engine intake), more powerful Continental J69-T-29 turbines delivering 1,400 lb. thrust each and wingtip fuel tanks to extend range. Model 407 has a design maximum level cruise speed of 404 kt. at 45,000 ft., maximum speed of 423 kt., range of approximately 1,380 naut. mi. and gross weight of 9,300 lb. Cabin is designed for 7.5 pressure ratio. Designed as an economical high-speed light transport, crew refresher training and missile site liaison vehicle, the Model 407 probably would cost about $200,000 and, because it uses T-37A components, could be placed in production rapidly after receipt of contracts. Cessna probably would await receipt of contract or indication of firm interest before building an actual flying prototype. Airplane also could be developed for the business flying market if sufficient military production developed.

ment is virtually under a direct obligation, according to a legal memo that has been circulated through the Board, to study the case's history and cast a vote to break the tie. The replacement has no such obligation in petitions for reconsideration but can act according to his own discretion.

Thus, Hector left the CAB with the General Passenger Fare Investigation well beyond the point of no return. Yet he has this charge to make in his memorandum:

"In the twenty years since its creation, the CAB has still not finished the formulation of a policy on the general level of passenger fares."

Another interesting aspect of the Hector resignation concerns the New York-San Francisco Nonstop Service Case. The vote was three-two in favor of authorizing American Airlines to operate the nonstop service with Hector voting with the majority.

Since the resignation, Northwest, TWA and United have filed petitions for reconsideration. If each of the four remaining members holds to his original vote, the petitions will die with a tie vote unless Hector's successor chooses to cast his vote.

Hector was particularly critical of the Board's failure to take affirmative action in reappraising the position of U. S. carriers in the international field. He charged:

"We are still proceeding on the basis of a set of principles deriving generally from an agreement made with the British at Bermuda in 1946, which have become confused and unrealistic in recent years." Hector has been the mainstay in dealings with Mexico on bilateral problems and is well acquainted with the issues involved. Had he remained on the Board, he would have been the Board's representative in renegotiating the Mexican air transport bilateral agreements when they are reopened next year.

Other major cases that are pending and which will be decided upon without Hector are the Rate of Return Local Service Carriers Case now awaiting briefs with oral arguments scheduled for October, foreign aspects of the Large Irregular Air Carrier Investigation and the Pan American-National agreement calling for the leasing of jet aircraft and the exchange of common stock between the two companies.

The investigation of the Air Transport Assn.—officially called "inspection and review"—is still in progress and the removal of Hector from the picture may have a strong effect on how the results of the investigation are used. Hector admits in his memorandum that there was a bitter conflict among members as to whether the investigation should have been launched.

Hector makes this statement on the ATA investigation which would suggest that his resignation may bring about a different approach toward the matter:

"At each step of the investigation, the battle between those who strongly support it and those who are lukewarm is fought out all over again. The members are not to be criticized for this. They have strong convictions on the matter, and they continue to hope that they can persuade their fellow members. There is no top executive who can bring discussion to a close, announce a policy and then carry it out."

Hector's Proposals

In his memorandum, Hector strikes out at no particular individual but attributes Board inefficiency to a basic weak structure. His proposals for a remodeling of the Board first reported by AVIATION WEEK (Sept. 21, p. 38) are:

- **Basic policies and economic** regulatory policy should be formulated "on a unified and rational basis by the executive branch of the government under the direction of the President."
- **Routine administration** of economic regulation would be handled by a delegation within the executive branch "in the same way that countless other administrative tasks are performed."
- **"Adjudication of major** litigated cases and appeals from administrative action should be performed by an administrative court, free from policy-making or administrative detail. The members of such courts should be appointed for a fixed term, and they should be as genuinely independent as judges of other statutory courts such as the Court of Claims and the Tax Court."

Since the memorandum had not been widely circulated by late last week, industry reaction to the Hector report was sparse and non-committal. How far his detailed 72-page report will go toward bringing about reforms in the CAB is still a matter of conjecture but Board staff members are convinced that it will attract much congressional attention next year and that Board members can expect to spend long hours on Capitol Hill answering questions of congressional investigators probing CAB activities.

Such congressional action may or may not result in a study similar to the Curtiss Report that culminated in the formation of the Federal Aviation Agency.

That the memorandum will stir some action, however, is best indicated by the reaction of Rep. Samuel N. Friedel (D.-Md.) to the speech made last August by Hector and one which forms the basis of the material contained in the memorandum. Friedel said in part:

"Mr. Hector should be commended for his interest in reform and improvement, but he should focus on the immediate possibilities for reform such as a wiser expenditure of appropriated money."

Curved Nacelles Proposed for SC.5 Britannic

Curved nacelles in artist's conception of Short Brothers & Harland SC.5 Britannic turboprop freighter are the only external change from the Mk.3 Britannic (AW Mar. 2, p. 37). Gross weight of the SC.5 is proposed to be 218,000 lb. compared with 195,000 lb. for the Mk.3. The newest version's powerplants will be four Rolls-Royce Tyne R.Ty. 12 turboprops rated at 5,730 eshp. each. The SC.5, scheduled to fly in early 1962, is being developed for the Royal Air Force. Britannic design uses the same wing, tailplane, undercarriage, flight deck and systems as the Bristol Britannia. Overseas sales will be handled by Bristol Aircraft, Ltd.

Hertz Air Rental Plan Attacked in Complaint

Washington—Rental of private aircraft by Hertz Rent-A-Plane System, Inc. hit a legal snag when Civil Aeronautics Board attorneys charged the company with excessive control of its air taxi operator members and failure to comply with CAB regulations.

Answering complaints filed last December by the National Air Taxi Conference, Inc. that Rent-A-Plane is operating in violation of CAB regulations, Board Examiner Walter W. Bryan said the plane rental company, a wholly-owned subsidiary of the Hertz System, Inc. auto rental agency, is an indirect air carrier which has failed to obtain either authority to conduct operations or an exemption, thereby violating provisions of the Federal Aviation Act.

Bryan also found that terms of agreements between Hertz Rent-A-Plane and its licensed members allowed the corporation to dominate the operations of its members in further violation of other sections of the act. He asked the CAB to issue a cease and desist order that would direct the Hertz subsidiary to file its licensing agreements with the Board in terms that will identify the individual air taxi operators.

Bryan said that, although Hertz Rent-A-Plane does not actually own or operate any aircraft for hire, the terms of its licensing agreements permit it to dominate the business practices of Rent-A-Plane members, without any legal responsibility for the passengers carried. On the other hand, Bryan said that the firm's advertising campaigns create the impression that Hertz conducts, and is responsible, for the entire operation. Rent-A-Plane, Bryan said, is primarily an administrative organization, which licenses air taxi operators to operate under the Hertz name.

The examiner said the average passenger is unaware of any party to the aircraft rental other than Hertz until he reads the "smaller" print on the reverse side of the agreement, which contains a clause exempting the corporation from any legal responsibility.

"Certainly," he added, "an operation, such as advertised by Hertz, cannot escape regulation by merely inserting an exculpation clause in small type on the reverse side of a contract for hire."

License agreements between Hertz and air taxi members "severely" restrict the freedom of the individual operator, according to Bryan, who said the corporation is in a position to control operator members by issuing procedures, methods, rules, policies and regulations.

Terms for licensing include stipulations that members must feature the Hertz emblem on all aircraft, stationery and contract forms, permit Hertz representatives access to operator's books, charge time and mileage rates determined by Hertz, provide insurance coverage in amounts set by the corporation and install private-line telephones in the Hertz name.

In turn, Bryan said, members of Hertz Rent-A-Plane benefit from national advertising, merchandising, promotion and public relations programs conducted by Hertz. Original contract terms between Hertz and air taxi operators called for an annual fee to Hertz of $200 for each aircraft rented under the firm's name plus 10% of the operator's gross rental and charter receipts.

National Air Taxi Conference also complained that Hertz later changed these contract terms to set the percentage due Hertz according to the size of the city from which the member operates, with extra fees due if business volumes exceeded a prescribed level.

As further evidence that Hertz Rent-A-Plane System, Inc.'s national advertising tends to leave the impression that the corporation conducts and is fully responsible for the aircraft rental service, Bryan said, all of 1,500 auto rental offices of Hertz System, Inc., a subsidiary of Hertz Corp., were advised to handle Rent-A-Plane reservations.

Chicago Helicopter Buys Sixth S-58

Chicago, Ill.—Sixth Sikorsky S-58 has been added to the fleet of Chicago Helicopter Airways with the purchase of a reconditioned helicopter from Sikorsky. The manufacturer recently bought from Vertol three S-58s and five S-55s, the former fleet of New York Airways, which had been turned into Vertol Aircraft Co., as part of the New York airline's purchase of Vertol 44-Bs.

John S. Gleason, Jr., president of Chicago Helicopter Airways, said the additional S-58 was required to handle increasing passenger loads, which were up 71% for the first eight months of 1959 and totaled 21,114 passengers in August. Jet airliner traffic into O'Hare International Airport has had a strong impact on the helicopter traffic, according to Gleason. Passengers connecting with jets accounted for 40% of the total August traffic of CHA.

The carrier expects to handle more than 170,000 passengers during 1959. August load factor was 51.7%.

Sikorsky has reconditioned and sold two of the S-55s acquired from Vertol. One went to Aero Service Corp. and one to World Wide Helicopters.

Polish and Rumanian Il-14M Transports

Russian built Il-14M transports operating under the colors of LOT, (above), the Polish national airline, and TAROM, the Rumanian national airline, (below), are shown in Kastrup Airport, Copenhagen. The Il-14M is an improved version of the original Il-14, once in widespread service with Aeroflot, the Soviet airline. The Il-14M is powered by two 1,850 hp. radial engines and carries a payload of 24 passengers plus about 4,000 lb. of cargo. Cruise speed is about 200 mph.

Unions Planning Mutual Aid Pact To Counter Airline Aid Agreement

Washington—Threat of intensified airline labor disputes and possibility of industry-wide bargaining mounted last week as six air transport unions planned a mutual aid pact as a counter to the mutual aid pact signed last year by six major airlines.

Airline pact was signed last year by Capital Airlines, Eastern Air Lines, American Airlines, Pan American World Airways, Trans World Airlines and United Air Lines at a time when Capital had been struck by the International Assn. of Machinists and other carriers were threatened with strikes (AW Nov. 10, p. 40). Civil Aeronautics Board subsequently approved the pact.

Although union attorneys had indicated such action might result from CAB approval of the airline pact, announcement of the labor union agreement at the American Federation of Labor-Congress of Industrial Organizations convention in San Francisco came as a surprise to most of the airline industry.

Members of the proposed "coordinating committee for unions in the air transport industry" are the International Association of Machinists, Air Line Pilots Assn., Flight Engineers International Assn., Air Line Dispatchers Assn., Transport Workers Union and the Brotherhood of Railway Clerks.

As outlined by IAM President A. J. Hayes, main concern of the union committee would center on the following five point program:

- **Problem of working hours** and conditions brought about by jet aircraft.
- **Expansion of the air freight** industry.
- **Effect on labor** of the airline mutual aid pact.
- **Solution of air safety** problems.
- **Effect of the new labor** reform law placing greater restrictions on union activity.

Actual working details of the proposed committee will not be determined until after a November meeting of the members in Washington.

While neither the AFL-CIO nor any of its coordinating committee members would officially comment beyond their brief statement, other labor spokesmen did not hesitate to point out that the primary purpose of the committee is to combat the airline mutual aid pact and fight the inroads of the Teamsters Union in the growing field of air freight. Earlier this year, Teamster President James R. Hoffa directed union officials in 22 major cities to survey airports for workers that might be persuaded to join Teamsters.

Reasoning behind the Hoffa recruiting drive, a committee spokesman said, is that the steady growth of air freight may soon account for a major portion of long haul freight transport, and if the air freight industry is not unionized, Teamster bargaining powers in the trucking industry might be weakened.

Union committee plans to fight the airline mutual aid pact, under which four of six carriers collected benefits while struck last year and call for a change of contract dates by the six unions involved so that contract renewals fall on a common date. All carriers refusing to grant the unions' collective bargaining demands could thus be forced into a strike simultaneously, according to union spokesmen.

Clear indications that the unions plan such a course were evident last year when representatives of the engineers, mechanics and pilots' unions fought the airline mutual aid pact before the CAB. At that time, FEIA warned the Board that approval of the management agreement could lead to the "prospect of a unified labor front in the airline industry for the purpose of breaking the combine," while ALPA stated that approval might lead to an industry-wide strike by its members.

However, airlines feel that unions might think twice before carrying out their across-the-board strikes, since any large scale crippling of the airline industry could be termed a national emergency, permitting the government to assume control of the carriers until labor disputes were settled.

The labor committee also hopes to settle the current cockpit jurisdiction dispute between the engineers and pilots. An ALPA petition (AW Sept. 21, p. 47) asking the National Mediation Board for a class and craft determination of flight deck crew members with United Air Lines drew a stern rebuff from AFL President George Meany, who last week informed the pilots' union that their action is considered "union raiding" in violation of AFL-CIO constitutional principles.

Cancellation Costs

Washington—Cutting its order of Douglas DC-8 turbojet transports from 20 to 16 cost Eastern Air Lines a total of $352,000, according to Thomas F. Armstrong, Eastern executive vice president.

Testifying at hearings in the Civil Aeronautics Board Southern Transcontinental Service Case, Armstrong said the loss represents the amount of interest it would normally earn on the funds it had on deposit with Douglas for the four aircraft. Armstrong told the Board that during early cancellation negotiations, Douglas had originally asked Eastern to pay the manufacturer $2.3 million, or $575,000 for each of the four aircraft involved in the order cancellation.

Flying Tiger Accused Of Illegal Lease Plan

Washington—Charges that the Flying Tiger Line arranged the establishment of a Part 45 air carrier in order to share in its profits as a small business operator handling Military Air Transport Service contracts were filed last week with the Civil Aeronautics Board.

Attorneys filing for California Hawaiian Airlines contended that Flying Tiger Line helped establish Pacific International Airways for use as a "stooge to bid on MATS contracts" for small business firms and leased one of its aircraft to Pacific International for a one-day period to help the smaller carrier meet Federal Aviation Agency requirements for an operating certificate as a Part 45 operator.

In addition, they claimed that Pacific International has no pilots or operating personnel and has failed to make any revenue flights since its establishment.

Asking the Board for a cease and desist order against Flying Tiger, the complaining carriers said the large cargo airline is engaging in unfair business practices and controls the operation of Pacific International through illegal lease and the use of Flying Tiger personnel.

Rumanian Carrier Predicts Traffic Boost

Budapest—TAROM, Rumania's state-owned airline, aided by sharply-increased inter-satellite nation tourist travel, is anticipating a 23% gain in passenger business this year.

TAROM reports that it carried over 10,000 vacationers to the Black Sea coast and the Danube delta from East Germany alone during the past season. Deputy Director C. Nenoiu, predicts that acquisition of Russian four-turboprop Il-18 transports, together with the inauguration of new routes and the start of night-time operations, will boost traffic substantially in the early 1960s.

At present, TAROM uses Soviet-built Il-14s for international flights to Moscow, Sofia, Budapest, Prague, Berlin, Warsaw, Belgrade, Vienna, Athens, Brussels, Copenhagen and Stockholm.

Russian Li-2s (DC-3s) provide scheduled service on 11 domestic routes stemming from Bucharest.

Delta DC-8 Takeoff at Idlewild

Sharp climb angle after takeoff is demonstrated by this Delta Air Lines Douglas DC-8, shown leaving Idlewild International Airport for Atlanta, Ga.; smoke is from water injection. Delta started New York-Atlanta service Sept. 18 with DC-8 in 119-passenger configuration. United Air Lines began DC-8 service the same day.

United Asks Rehearing in Case

Washington—United Air Lines asked for a complete rehearing of the New York-San Francisco Nonstop Service Case last week on grounds that parties in the case attempted to bring pressure to bear on Civil Aeronautics Board members.

In a sharply-worded petition, United charged that American Airlines, the City and County of San Francisco and the Port of New York Authority attempted to influence the Board and its staff in the case. The Board's decision gave American Airlines nonstop operating rights between New York and San Francisco.

The petition charged that the three parties in the case "had acted in gross violation of the Board's principles of practice and of fundamental principles of procedural due process."

The airline said that known communications addressed to the Board and other efforts to influence Board members or the CAB staff fall into these five categories:

• **Communications addressed** directly to the Board from the mayor of San Francisco or other representatives of the City and of the Port of New York Authority.

• **Similar communications** written by non-parties—but inspired by parties to the proceeding—including the governor and lieutenant governor of California, senators from California, New York and New Jersey and a number of congressmen.

• **Communications sent to members** of Congress suggesting that they exert influence on the Board and its staff.

• **Public statements made** by the interested parties suggesting that pressure be brought to bear on the Board.

• **Direct communications** with members of the Board and its staff in a meeting "ostensibly designed to do no more than discuss 'general aviation problems in the City of San Francisco.'"

United also questioned the "fairness" of the Board's action during the oral argument in which members of Congress favorable to American Airlines argued for over two hours in addition to American's allotted time of 40 min., while United's entire presentation was limited to 30 min. Prior to his resignation, CAB Member Louis Hector raised this issue in a dissent charging that this disproportionate representation was "an unfair mode of procedure" (AW Sept. 21, p. 36).

United also said that traffic figures presented to the Board were forecasts, rather than the actual facts now readily available.

The airline said in the petition that in July last year, there was a daily average of 127 to 328 empty seats between New York and San Francisco and maintained that "there is no evidence that a single San Francisco-New York passenger was deprived of air transportation between those cities" due to inadequacy of service.

PanAm Reorganizes Top Management

New York—In a reshuffle of Pan American World Airways top management, Roger Lewis has been named executive vice president-administration. Lewis' former position was executive vice-president-development and defense projects.

John C. Leslie, former vice president-administration, becomes a vice president and assistant to President Juan T. Trippe under the reorganization. Leslie will handle special assignments from Trippe and will continue to represent the company in International Air Transport Assn.

He will continue to coordinate the activities of Pan American concerning international air agreements and will continue to represent the company on the board of the Air Transport Association.

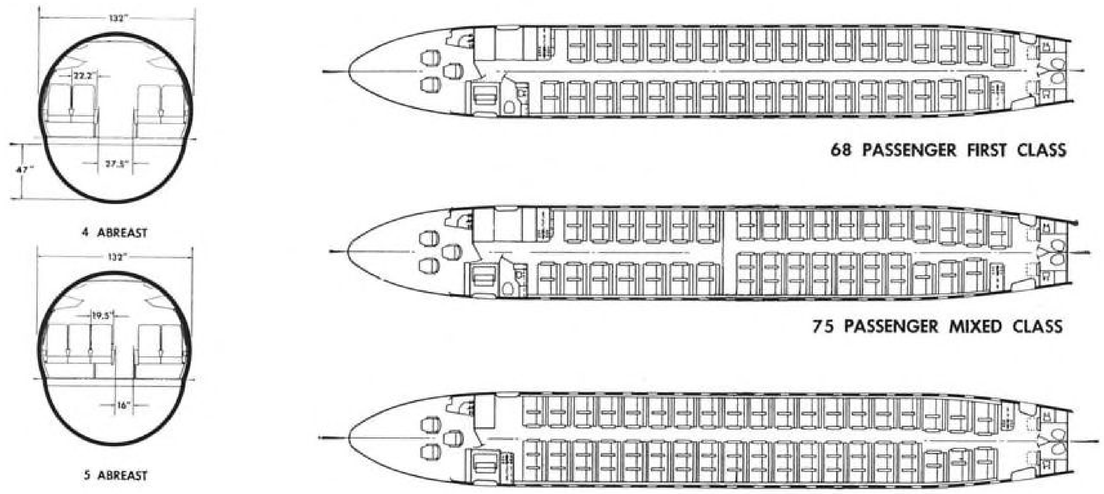
Lewis will coordinate activities of the Atlantic, Latin American and Pacific-Alaska divisions of the airline, as well as traffic and sales activities, technical assistance programs, company mobilization and the Civil Air Reserve Fleet program, and the Pan American investment in Panagra.

Samuel F. Pryor, former vice president and assistant to the president, will remain a vice president and will continue to coordinate system public relations and polar route application activities.

John B. Gates, as vice president-development, will supervise the development of overseas travel and tourist facilities and will coordinate the executive department activities in respect to Intercontinental Hotel Corp., a wholly owned subsidiary.

Vice Presidents Franklin Gledhill and Russell Adams will now report to Lewis.

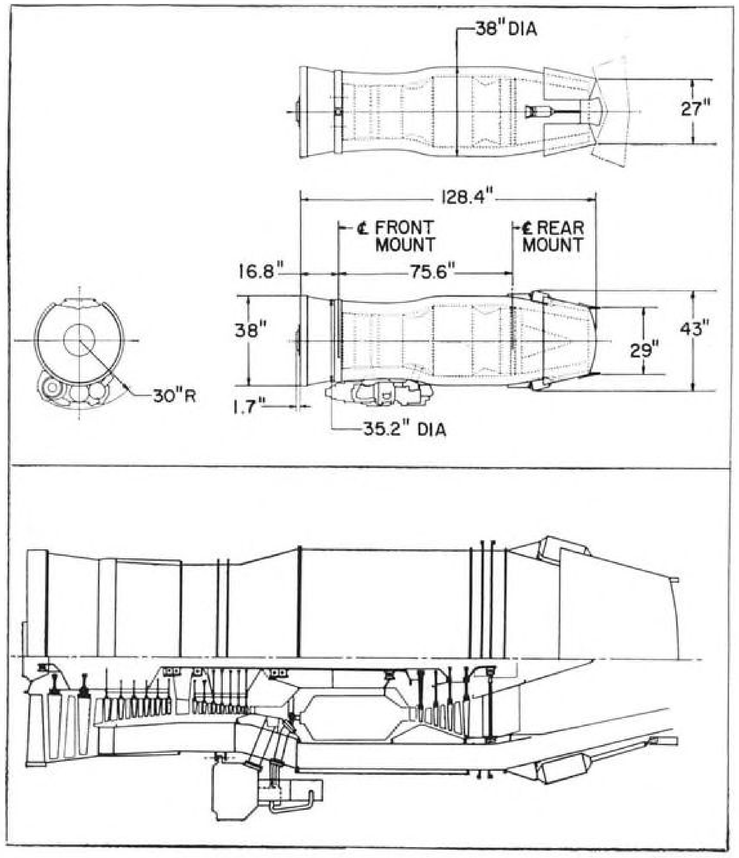
The reorganization of executive responsibilities was occasioned, according to the airline, by "the expanding scope of Pan American's interests."



Douglas DC-9 four turbofan transport will be available in three passenger configurations; fuselage cross sections are at left. Douglas Aircraft also is studying a twin-engine version (AW Sept. 7, p. 40).

Design Details of Turbofan for Douglas DC-9

First experimental prototype of Pratt & Whitney's JTF10A-1 turbofan engine, four of which will power the proposed Douglas DC-9 jet transport, is scheduled for initial running before the end of the year. New turbofan is designed for use in transports in the 90,000-130,000 lb. gross weight class (see drawings at right). Top drawing is engine outline in top and side views; bottom view shows engine in longitudinal configuration. First experimental run is scheduled for December and first flight is planned for December, 1960. Pratt & Whitney expects to deliver prototype engines by April, 1961, and production engine deliveries are scheduled for July, 1962. The JTF10A-1 is a smaller member of the J57 turbojet family, which includes the JT3D turbofan (AW July 27, p. 43). Pratt & Whitney is applying certain refinements that were developed since the JT3C and JT3D were designed, but using the basic JT3D configuration offers a considerable saving in time and design effort, officials pointed out. Company rates the engine at 8,250 lb. thrust and says it has a good growth potential. JTF10A-1 weighs 2,110 lb. with the fan exhaust duct, and it has a bypass ratio of 1.5. The JTF-10A-1 which will be used on the DC-9 transport has an annular bypass sleeve that carries the bypass air the length of the engine case, but Pratt & Whitney also is prepared to build the engine with a bifurcated duct that will exhaust the bypass air just aft of the fan in the front section of the engine. Thrust reversers can be provided with each version. A major advantage of the JTF10A-1 is a specific fuel consumption that is about 10% lower than that of conventional jet engines.



HOT GAS SYSTEM COMPONENTS NOW AVAILABLE FROM CHANDLER EVANS

CECO SYSTEMS CONTROLS

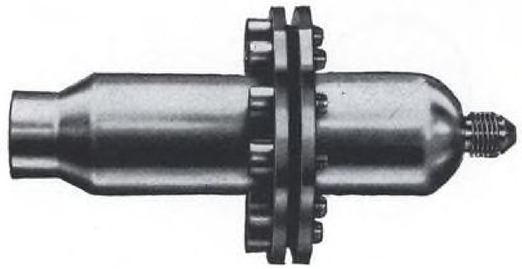
As by-products of extensive development work in the field of high-pressure pneumatics, Chandler Evans has—over the past several years—designed, developed, tested and produced a number of hot gas servo system components, some of which are presented here.

The products shown and described were developed for use with high-pressure hot gas generated from liquid or solid propellants, and are suitable to such applications as auxiliary and control power systems for guided missiles and space vehicles.

All the components shown are developed items, ready for use. However, because they have been fabricated to meet the requirements of particular applications, the specifications presented should be considered only representative. Design modifications can readily be made to adapt these devices to *your* requirements.

If you, too, are engaged in hot gas systems work and want to save considerable time and money in development, by using proven components not heretofore available, CECO will be happy to afford you its traditional cooperation.

For detailed information on these and other components, or for data on CECO's hot gas servo *systems*, contact any of the Field Engineering Offices listed at the right.

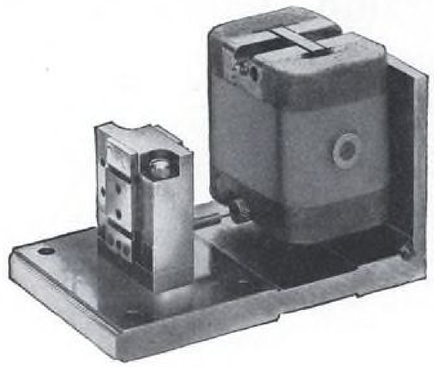


LIGHTWEIGHT HYDRAZINE REACTION CHAMBER

This reaction chamber, containing a suitable catalyst bed and injection nozzle, is used to generate hot gas. When hydrazine from a pressurized source is introduced, the catalyst immediately initiates a chemical reaction which continues until the fuel supply is exhausted.

Representative specification:

Operating temperature	to 1800°F.
Operating pressure	to 2000 psi
Flow capacity	.10 lb./sec.
Operating time	in excess of 5 hrs.
Weight (including catalyst)	1.27 lbs.
Size	1.50″ O.D. x 5.00″



REED-SUSPENDED, CLOSED CENTER SERVO VALVE

Developed for use with hot gas produced by decomposition of liquid propellants, the servo valve shown here is currently available in a variety of sizes to accommodate the requirements of individual applications.

Representative specification:

Inlet gas supply pressure	to 2000 psi
Inlet gas supply temperature	to 1500°F.
Operating temperature (ambient)	to 350°F.*
Valve stroke	±.004″
Flow capacity (total gas flow)	.01 lb./sec. air @ 1500°F., 2000 psi
Overboard leakage (valve at null position)	10% of total flow
Power input (maximum)	2 watts
Natural frequency	430 cps
Weight	1.00 lb.
Size	1.75″ x 2.75″ x 1.75″

** With additional torque-motor cooling, ambients to 1200°F. can be tolerated.*

PROPELLANT FLOW MODULATING AND PRESSURE REGULATING VALVE

The problem of operating hot gas generators at a specified constant pressure level led to the design, test and development of the liquid fuel regulating valve pictured here.

This valve may be described as a spring-loaded, spool-type throttling valve. Full open when the pressure at its outlet port (gas generator pressure) is low, it progressively closes off as the outlet pressure increases.

With minimum leakage an important objective, the valve shown meets the following specification:

Flow (hydrazine)	.002 to .02 lb./sec.
Upstream pressure	500 to 3000 psi
Regulated pressure	500 to 2000 psi
Temperature	0° to 200°F.
Weight	.38 lb.
Size	1.75″ O.D. x 3.00″

Limited changes in regulated pressure can readily be accomplished by means of a simple adjustment screw. Broader changes in regulated pressure or in flow capacity can be accomplished through slight re-design of the spool or spring elements.

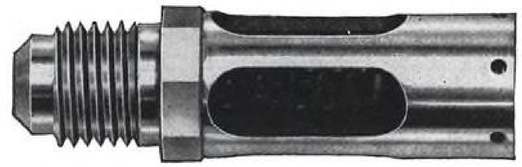
SOLID PROPELLANT HOT GAS FILTER

Since small-orifice areas of servo valves cannot tolerate contaminants produced by combustion of solid propellants, CECO found it necessary to develop the special hot gas filter shown here. Unlike those heretofore available, this filter can easily be cleaned for re-use and has amply demonstrated its ability to withstand the temperatures and pressures encountered in hot gas systems.

It operates as follows: hot gas flows into an annulus between the filter element and housing, then diffuses through to the outer surface of the element, depositing solid particles as it goes. With gas flow at .015 lb./sec., this filter operates for several minutes, with average contamination, filtering out particles as fine as 10 microns.

Representative specification:

Operating temperature	to 1800°F.
Operating pressure	to 2000 psi
Initial pressure drop at .015 lb./sec.	2 psi @ 1000 psi
Filter housing size	1.38 O.D.″ x 5.00″
Weight	.88 lb.

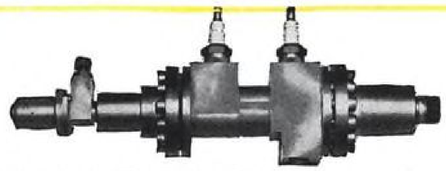


HOT GAS PRESSURE RELIEF VALVE

Typical of component hardware developed by CECO in its work with hot gas servo actuation and reaction systems is the valve pictured here. While it can easily be modified to satisfy other requirements, specification for the valve shown is as follows:

Relief pressure	1000 psi*
Reseat pressure	950 psi
Flow	.02 lb./sec. @ 1000 psi
Temperature	1800°F.
Weight	.032 lb.

** Adjustable from 800 to 1200 psi.*



HOT GAS REACTION CHAMBER FOR LABORATORY USE

This unit is used as a "workhorse" hydrazine reaction chamber to provide clean, hot, high-pressure gas for test purposes.

Ideal for laboratory use, its flow rates range between .001 and .1 lb. sec., and may be extended in either direction by changing nozzle and load orifice sizes. Operating temperatures are between 1200°F. and 1800°F. with pressures to 2000 psi.

The chamber is preheated by an electrical coil, a feature which facilitates repetitive starting without need for disassembly between test runs to renew the catalyst.

The above picture shows CECO's generator with the pressure regulating and flow modulating valve in position. For those who require a complete, "packaged" system for providing a continuous supply of hot gas, Chandler Evans can supply a complete laboratory model hot gas generator system including the fuel storage, pressurizing, purging and pressure regulating elements in addition to the gas generator reaction chamber described above.

CECO SYSTEMS CONTROLS

CECO FIELD ENGINEERING OFFICES:

WEST COAST
WILLIAM B. GURNEY
7046 Hollywood Boulevard
Hollywood 28, California

MID-WEST
KENNETH L. MOAN
Room 305, Spitzer Building
Toledo 4, Ohio

EAST COAST
ROBERT M. CAMPBELL
Chandler Evans Corporation
Charter Oak Boulevard
West Hartford 1, Connecticut

CHANDLER EVANS CORPORATION

Literature, including a reprint of this ad, available by request to Department 69.

AIRLINE OBSERVER

► Vickers-Armstrongs is canvassing Commonwealth operators with a VC.11 family of short-medium range turbojets based on the VC.10 (AW Sept. 21, p. 38). The project will include the rear-mounted four-engine configuration of the VC.10, but using a smaller bypass engine than the Rolls-Royce Conway. None of the various designs in the VC.11 group show much exterior difference, but each will be optimized for a particular combination of range, payload, speed and weight. Vickers told Aviation Week its objective is to produce a basic structure more flexible than the DH-121, so that with its variants, the VC.11 series could replace most of the Viscount series of aircraft. Vickers maintains it could get the aircraft into service within four years of receiving the first order and is prepared to go ahead with the project without a British airline order.

► Northwest Airlines will win operating rights between Hong Kong and Tokyo. Civil Aeronautics Board last week voted 4-0 to request the State Department to notify the British government that Northwest is now authorized to serve the route. Northwest previously had been prohibited from serving Hong Kong because the carrier's terminal points–Seattle and Portland–were not listed as traffic points in the Bermuda Agreement. Northwest, however, later discovered that the two cities had since been quietly added to the agreement, giving the carrier the right to implement its certificate which extends its Pacific route from Tokyo to Hong Kong.

► Air India International is looking at Lockheed Electras and Boeing 720 turbojets for its medium-range route. British Overseas Airways, meanwhile, is attempting to persuade Air India to buy the de Havilland Comet 4 for its shorter routes and, as an additional inducement, de Havilland has offered to accept the carrier's Lockheed Constellations as trade-ins on the Comets. Also, a factor in favor of the Comet is "dollars would not be required to buy them."

► Japan Air Lines officials will fly to Washington next month to draw on the $17 million credit negotiated with the Export-Import Bank in December, 1956, to finance four Douglas DC-8 turbojet transports scheduled for delivery in May. Export-Import Bank thus far has approved loans for the purchase of 27 U.S. turbine aircraft by foreign flag carriers.

► Watch for Pan American World Airways to apply for an Export-Import Bank loan to cover costs of hotel equipment, such as air conditioning units and kitchen facilities, for the carrier's chain of overseas hotels.

► Pan American World Airways and Trans World Airlines will press hard for lower fares at the International Air Transport Assn. traffic conference which opens this week in Honolulu. Pan American wants to extend economy class fares which are now effective only on North Atlantic routes to include transpacific and round-the-world routes. TWA will seek a lower fare that is promotional in nature to level off seasonal traffic variations.

► Allegheny Airlines has extended the lease on its Canadair 540 turboprop transport for another three months. Original three-month lease started July 1. Napier Engines, Inc. reports that 338 regular flights were scheduled by Allegheny with the single aircraft from July 31 through Sept. 15, with an engine availability of 99.41%.

► French government has sided with the privately-owned Union Aeromaritime de Transport in the carrier's battle over operating rights in French African territories. Under the ruling, UAT is the only French carrier with the right to work with the new French African republics in developing local air transport systems–a right Air France previously claimed. However, the government reaffirmed that Air France is the essential and permanent instrument of French air transport policy.

► Russian 85-seat four-turboprop An-10, which went into regular passenger service in July, has been assigned to two more Ukranian routes: Moscow-Kharkov and Moscow-Stalino. Aeroflot also reports that by mid-winter, cargo An-10s, capable of carrying 10-12 metric ton loads, will begin supplying Soviet scientific stations on drifting ice packs near the North Pole.

SHORTLINES

► **Flying Tiger Line** reports August air freight revenues at $1,283,348, an 11.5% gain over the same month of 1958. The air freight carrier's eight-month traffic revenues stand at $9,824,-125 for a gain of 34.6% over the same period of last year.

► **Frontier Airlines** flew 32,900 passengers a total of 8,396,000 passenger miles during August, a 60% gain over the total for August, 1958. During the third quarter period ending Aug. 30, Frontier carried over 89,000 passengers and logged 22,855,000 passenger miles.

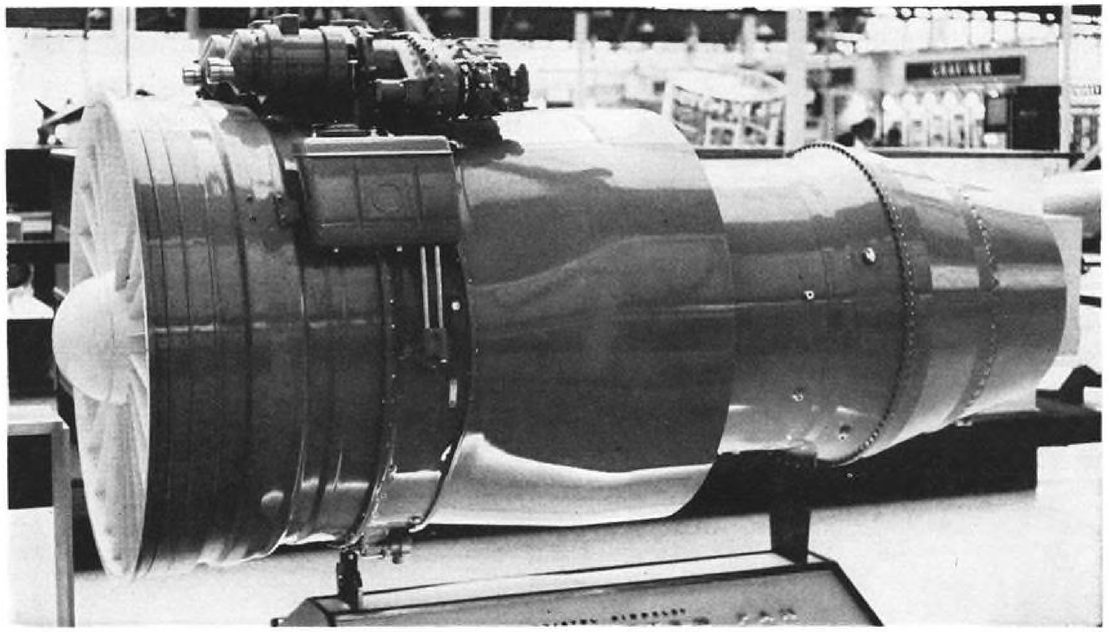
► **Irish Air Lines** flew 110,500 European and transatlantic passengers in August as compared with 95,160 persons during August, 1958. Transatlantic passengers totaled 4,000, and the carrier's Dublin-London route accounted for 35,000 passengers. Dublin Airport reports that it handled 118,160 passengers during August as compared with 107,500 handled during the same month of last year.

► **Lufthansa German Airlines** will add Karachi, Calcutta and Bangkok to its route system on Nov. 1 and, at the same time, drop Paris, Shannon and Manchester. The German carrier says service to the three European cities is being discontinued to better utilize present equipment and to prepare for nonstop transatlantic Boeing 707-430 turbojet service expected to be inaugurated early in 1960.

► **Northwest Airlines** was scheduled to begin service to Atlanta yesterday on its Chicago-Florida route on a daily basis of three northbound and three southbound flights.

► **Ozark Air Lines** reports that it carried 50,278 passengers during August, a 33% increase over the same month of last year. During the first eight months of 1959, Ozark carried 357,679 passengers to maintain a 51.90% load factor for a 29% increase in passengers flown over the same period of last year.

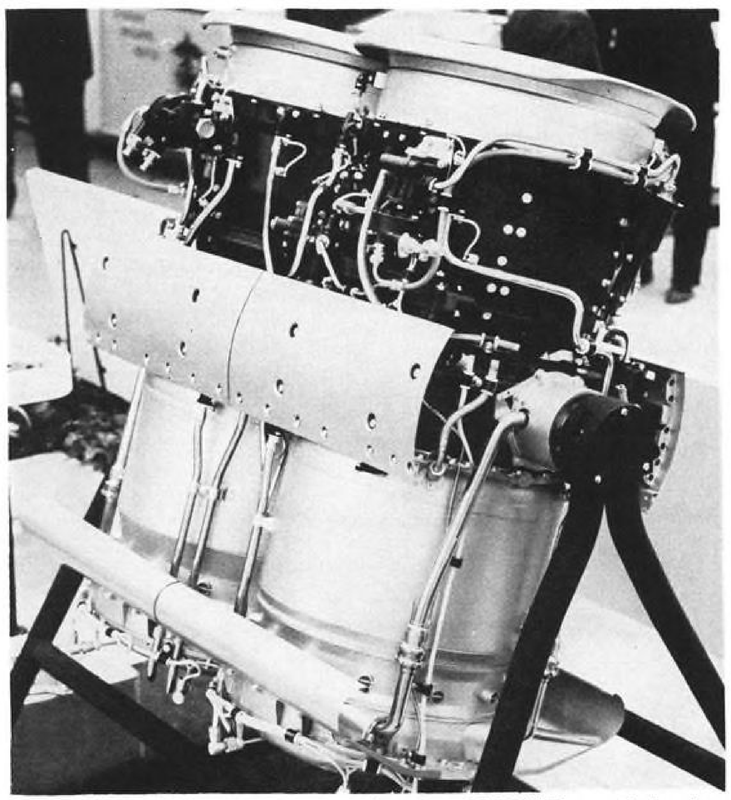
► **Trans World Airlines** flew 615 million revenue passenger miles on its domestic and international routes during August, a 22% gain over the same month of last year. Domestic revenue passenger miles were up 21% from August last year at 481,417,000. During the first eight months of 1959, TWA flew a total of 3,814,000,000 revenue passenger miles.



BRISTOL SIDDELEY BE.58, shown in mockup form, has an inlet diameter of about 4 ft.; thrust rating is 14,500 lb.

British Unveil Three Turbine Powerplants

By David A. Anderton



PAIRED Rolls-Royce RB.108 engines power Short Bros. SC-1 VTOL research aircraft.

Farnborough—Three gas turbine powerplants were shown for the first time at the 20th Society of British Aircraft Constructors Flying Display and Exhibition here but only one was new.

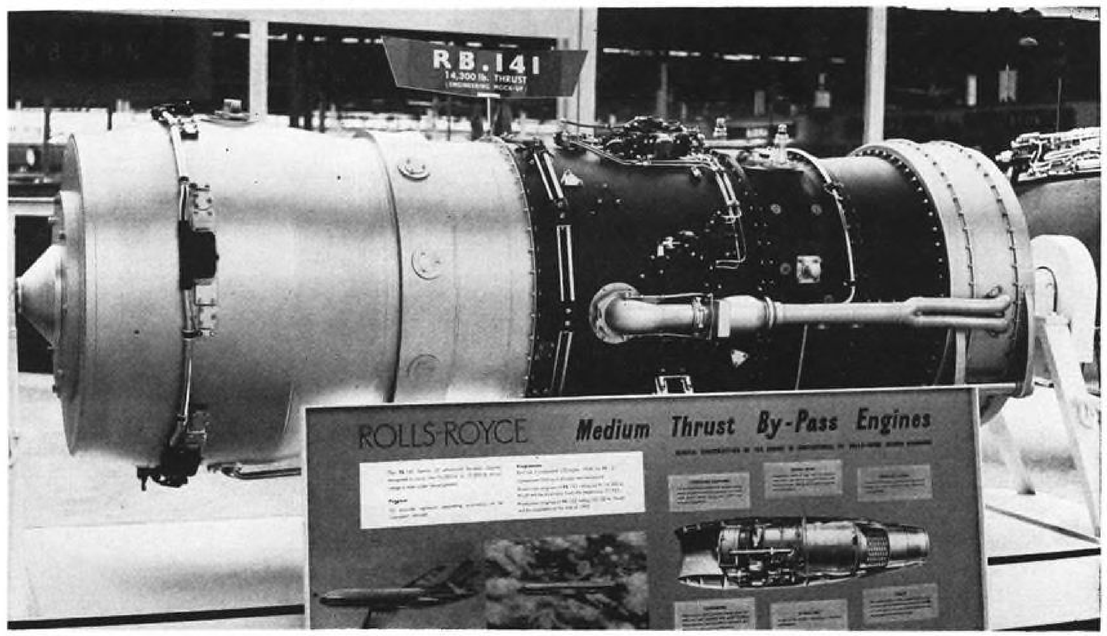
The three: Bristol Siddeley's BE.58 ducted fan unit and Rolls-Royce's RB.-141 bypass engine and the RB.146 Avon (AW Sept. 14, p. 29). The new engine was the BE.58, one of a family that Bristol Siddeley is developing.

New details were available on some of the engines shown, but it was indicative of Britain's export drive that most of the information on new engines, generally reserved for public presentation during the Farnborough fanfare, had already been issued three months ago at the Paris air show.

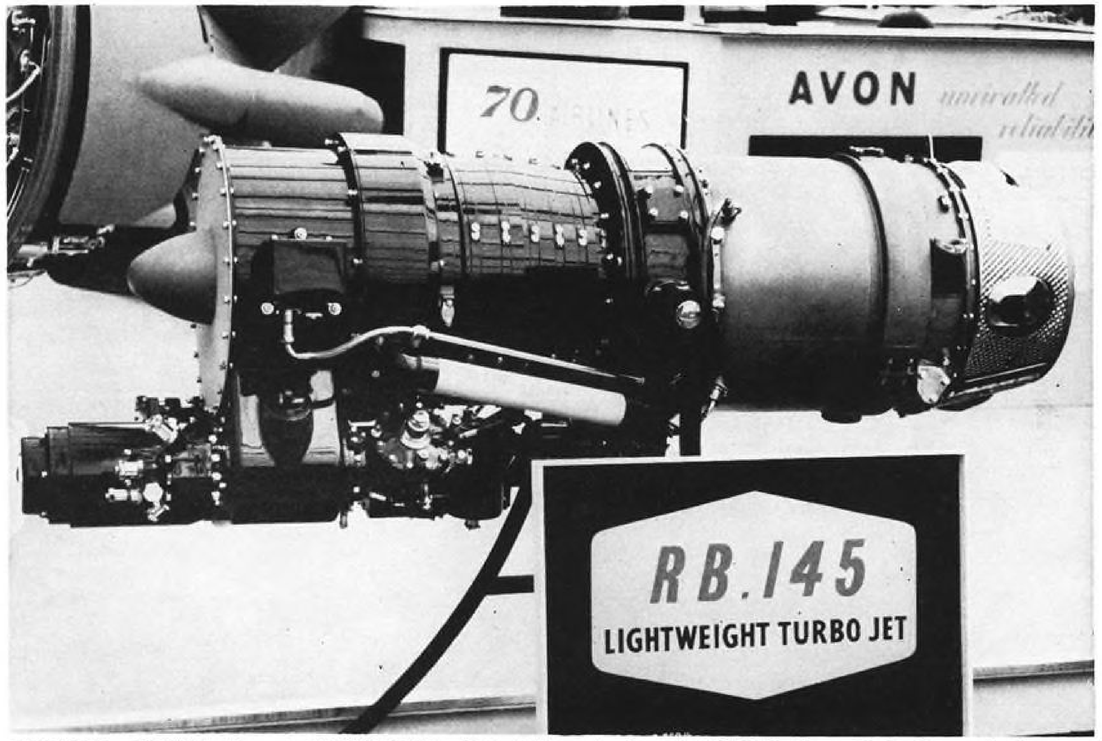
"We're waking up," said one British technician. "Our main market isn't on this island any more."

Design Plan

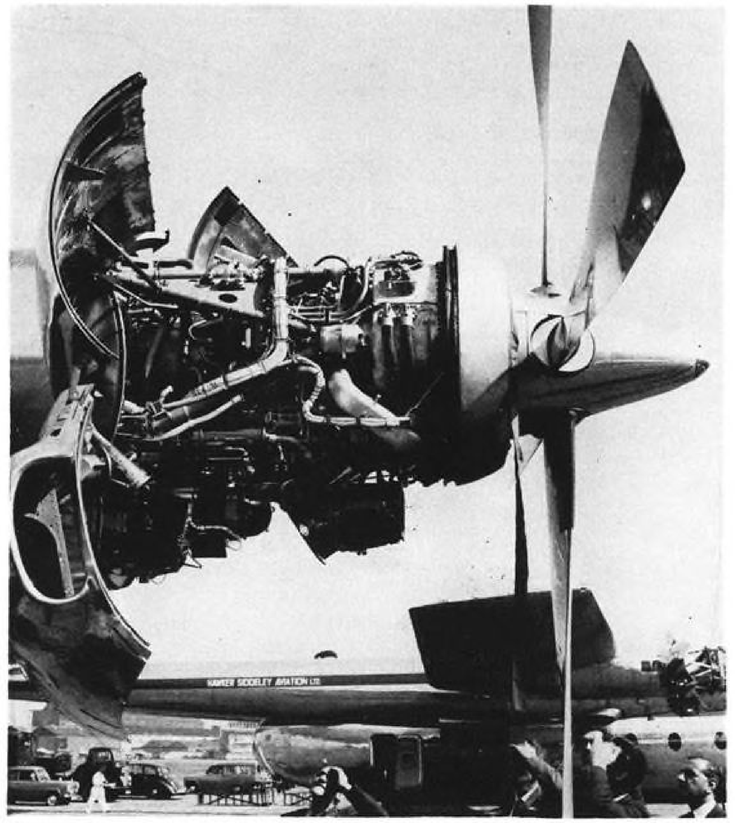
Bristol Siddeley's biggest claim is that their family of ducted-fan engines has been designed from the start as that class of engine, and is not merely an adaptation of an existing design. This is a dig at both General Electric, with its aft-fan CJ-805, and Pratt & Whitney with its forward-fan JT3D. Rolls-Royce developed the Conway as a bypass engine right from the start, but whether or not it is also a ducted



MOCKUP shows general outline of the Rolls-Royce RB.141 bypass engine. Sud Aviation has specified this engine at its design rating of 14,300 lb. for an advanced Caravelle jet transport. Engine originally was intended for first design of the Airco DH.121 airliner but changes require the Rolls-Royce RB.163, in the same family of bypass power plants but with a thrust rating of 10,000 lb.



BASICALLY an RB.108 development, this RB.145 lightweight turbojet engine is rated at 2,750 lb. thrust. Engine has an afterburner and anti-icing equipment. The company is pushing the powerplant for executive aircraft applications.



PETAL cowlings on Rolls-Royce Tyne turboprop engine installation on the Vickers Vanguard transport open wide for engine inspection and maintenance.

fan is simply an argument couched in semantic, not technical, terms.

Both types of engines swallow some air and blow some more air around the outside. The Bristol Siddeley ducted fan engines operate with a ratio of cold air flow to the swallowed, heated air, of between 1.5 to 2.0. Rolls-Royce believes in a lower ratio than that.

Bristol also claims a reduction in noise level of about 10 db. compared with the best jet engine, and 15 db. below the average engine. Because decibel units are related to the logarithm of the actual noise intensity, a 10 db. reduction means the noise is halved.

The BE.53 is a related engine in the same family, being used as the powerplant of the Hawker-Siddeley P.1127 VTOL strike fighter. Reports here are that the engine is being supported by Mutual Weapons Development Program funds.

Only BE.58 performance figures have been revealed: thrust of the engine is 14,500 lb., weight is 2,600 lb. Cruise specific fuel consumption is 0.8 lb./lb./hr. at 36,000 ft., and at sea level static, the fuel consumption is 0.572 lb./lb./hr.

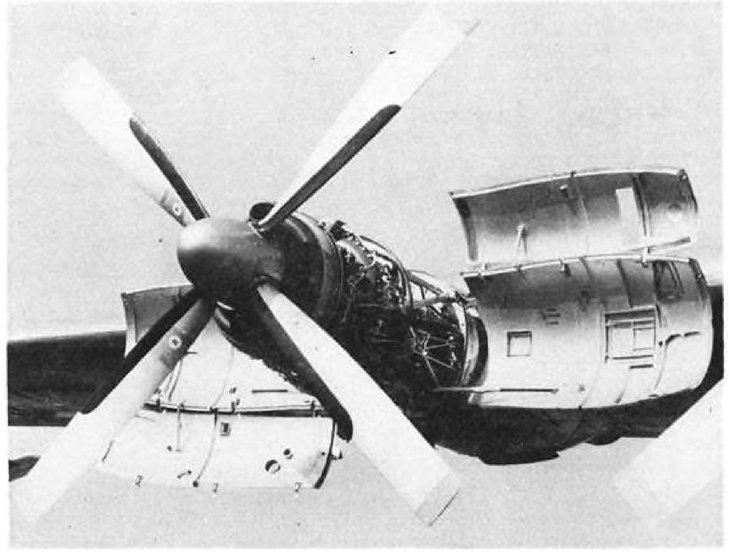
Thrust-weight ratio of the BE.58 is 5.6 to one. Inlet diameter is about four feet.

Bristol showed its Orpheus BOr.12-to the British for the first time. The engine was developed as a second-generation strike fighter powerplant under MWDP sponsorship. Design thrust is 6,810 lb., increasing to 8,170 lb. with simplified afterburning. The engine weighs 1,110 lb., bare and dry, and has a thrust-weight ratio of 6.15 to one.

Olympus 201

Giant on the Bristol Siddeley stand was the Olympus 201, now rated at 17,000 lb. dry thrust. One development of this engine, using a Bristol Siddeley Solar fully variable afterburner, has been run at 33,000 lb. thrust. The Olympus 200 series powers the Avro Vulcan B.2 bomber, and a developed Olympus has been chosen as the powerplant for the TSR-2 strike aircraft under joint contract to English Electric and Vickers.

De Havilland's Gyron Jr. DGJ.10 (AW Sept. 14, p. 68), used as the engine for the Bristol T.188 all-steel supersonic research aircraft, was shown with an experimental afterburner. Both



ONE of four Rolls-Royce Dart turboprop installations on the Armstrong Whitworth AW 650 Argosy transport shows the cowling arrangement, designed for accessibility.

the engine and the afterburner now are being installed at the National Gas Turbine Establishment for simulated high supersonic flight tests. Engine rating is 10,000 lb. dry thrust and with the afterburner operating at 2,000K, the static thrust increase is approximately 40%.

Over-all length of the Gyron Jr. in this version is 92 in., width is 32.3 in. and height is 39.3 in.

Rolls-Royce's newest entry in the field is an engineering mockup of the RB.141, one of a group of bypass engines being developed to cover the thrust range from 10,000 lb. up to the 17,500 lb. lower edge of the Conway brackets. First RB.141 is scheduled to run sometime in October this year. Production engines will be available in 1962 at a thrust rating of 14,300 lb.

Also in the family is the RB.163, now the announced engine for the Airco DH-121 medium-range airliner for BEA. Rated at 10,000 lb. thrust, the RB.163 is expected to be available at the end of 1962 for the DH-121.

Newest engine in the Avon line is the RB.146, powerplant for the English Electric P.1B, rated at 13,220 lb. thrust without afterburner. The paired installation of these engines in the P.1B features fully variable afterburners. Limiting thrust is determined by fuselage size, because there is not enough room in the rear end of the P.1B to take two afterburners for 2,000K operation.

Probable thrust increment is on the order of 25 to 30%, giving a maximum installed thrust of about 34,000 lb.

Viscount 810 Checks Vanguard Tail

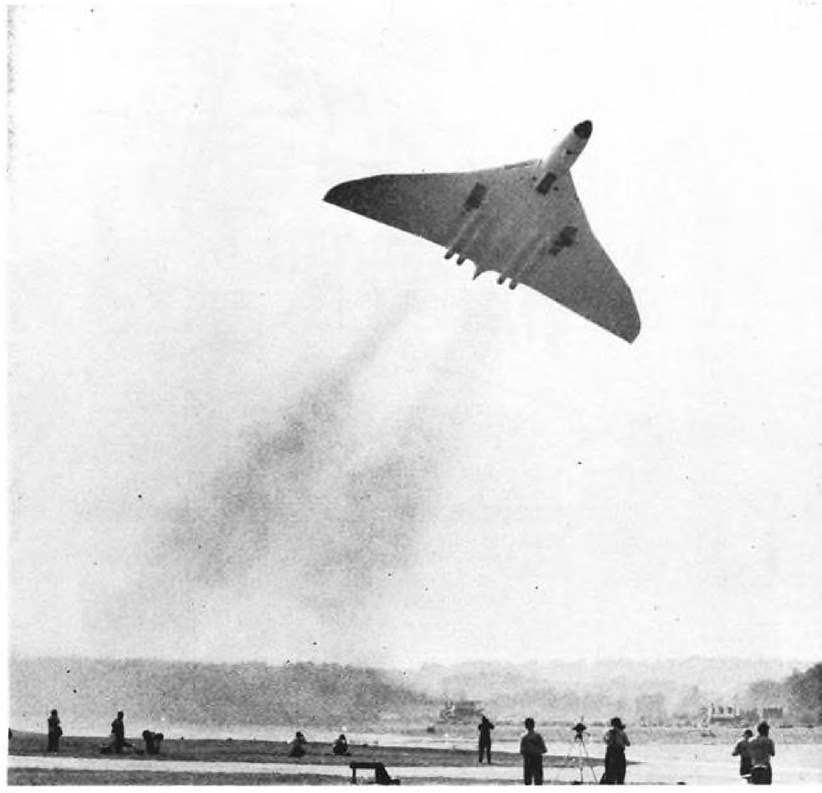
Vickers Vanguard transport tailplane equipped with Napier Spraymat deicer is carried by this Viscount 810 (in Continental Air Lines markings) in place of the regular fin as part of Vanguard certification trials. Closed circuit TV monitors effect of water sprayer ahead of tail.

Vickers Supermarine Scimitar, with markings of Royal Navy's 807 Squadron, folds its wings after landing. Naval flight display featured toss-bombing demonstration with mock tactical atomic weapon, formation aerobatics, high speed runs and unique landing.

Blasting across the field like a fighting bull across the ring, the English Electric Lightning T.4 supersonic trainer shows the bulged form of area-ruling near the cockpit. The aircraft is basically a two-seat Lightning. The trainer is carrying two de Havilland Firestreak infrared homing missiles. The ventral tank carries extra fuel. The aircraft can also mount a Napier Scorpion rocket for boosting performance at altitude. Powerplants are twin Rolls-Royce Avons with afterburners.

British Display Varied Aircraft At Farnborough

Flight demonstrations were the principal attraction at the 20th Society of British Aircraft Constructors Flying Display and Exhibition. The Vickers Supermarine Scimitar (top left) participated in a landing maneuver in which it and another Scimitar landed downwind, each hugging the shoulder of the runway. During their landing roll they folded their wings so a third Scimitar could land upwind between them (AW Sept. 21, p. 32). Ranald Porteous, an aerial acrobat well known to Farnborough spectators, brought the Auster Aiglet down in an abrupt approach, making steep slips right and left on to the runway and then skating as shown at right, below. The English Electric T.4 trainer (below, left) was flown by R. P. Beamont, who made a series of low-level high-g turns. During the landing roll at the conclusion of his performance the drag chute blew out and Beamont was forced to swerve off the runway to avoid hitting vehicles parked at its end. He came to a stop without damaging the aircraft. Three of the Royal Air Force's Bomber Command Avro Vulcans participated in the flying display. The Avro Vulcan B.2 bomber (top right) is powered by the Bristol Siddeley Olympus 200 series turbojet. One version of this engine, equipped with a Bristol Siddeley Solar afterburner, has been static-tested at 33,000 lb. thrust.



Four Bristol Siddeley Olympus engines shove the Avro Vulcan B.2 off the ground in a roaring climb after a takeoff run on the order of 2,000 ft. Engines are putting out an estimated 25,000 lb. thrust each with afterburning. Airplane is a prototype B.2; production planes have a rear fuselage bulge, probably for rearward-looking radar.

Ranald Porteous lands the Auster Aiglet out of an impossible approach after the only classical acrobatic routine at the Farnborough display. Porteous flight demonstration of the Aiglet was done in a minimum cube of sky, featured competition acrobatics and a final landing that had the Auster skating down the runway alternately on left and right wheels.

New Alloys Shown At Farnborough

Farnborough—New alloys and fabrication techniques of interest to the aircraft industry provided some of the highlights of the annual exhibition organized here by the Society of British Aircraft Constructors.

Of special significance were indications that the British steel industry, despite former reticence, now is taking steps to produce high strength steels with reduced sulfur and phosphorus content.

Research by rocket engineers at Bristol Aerojets, Ltd. has pointed to these two elements as the cause of hot cracking in welded steels.

Magnesium Elektron, Ltd. introduced two new, high-temperature magnesium alloys. One, a casting alloy called MSR, is currently being used in certain British missiles.

Its proof stress, which is markedly higher than that of existing magnesium alloys in the 0-250C range, is comparable to that of high strength, heat-treated aluminum alloys while its density is ¼ less. In addition to magnesium, the alloy contains 2% rare earth metals, 2.5% silver and 0.6% zirconium.

The other Magnesium Elektron product is a new wrought alloy named ZTY which is said to be hot formable, fully weldable and easily machined. It retains an almost constant proof stress to 190C and a virtually constant Youngs modulus up to 300C. Ultimate tensile strength falls off from 34,000 psi. to 24,000 psi. at 190C. Alloying constituents are 0.75% thorium, 0.5% zinc and 0.6% zirconium.

Imperial Chemical Industries displayed a new titanium alloy that is now being used in compressor disks and blading of major British jet turbines. Alloy has an ultimate strength of 104,000 psi. at 500C. In addition to tin and zirconium, which are the principal alloying ingredients, material contains small amounts of aluminum, molybdenum and silicon.

Firth Vickers announced the development of new, inexpensive, low nickel, austenitic stainless steels which are reportedly easy to weld and suitable for subzero tempering. The new steels contain molybdenum and copper additives.

Mond Nickel Co., Ltd., also claimed improved weldability for two new nimonic sheet alloys; one, an 80/20 nickel-chrome alloy; the other, a 37/18 nickel-chrome alloy with an iron base. Both alloys are stiffened with molybdenum.

Promised soon is nimonic 105 sheet material with reasonable welding properties at 1,050C.

Henry Wiggin and Co., Ltd., showed a new family of nimocast nickel-chrome casting alloys with 12-in. diameter billets suitable for turbine disks weighing up to 1,500 lb.

Also shown here were new trends in metal fabrication. Among the more outstanding are the switch to vacuum-melted, high-temperature, high-strength, master stock alloys; more centri-spinning and precision casting of highly alloyed metals; and wider use of draftless pressings and multi-segmented dies to replace castings, particularly in light alloys.

Use of draftless pressings and segmented dies, according to the manufacturers, results in better metal utilization with over-all thickness tolerances better than 0.02 in. reducing to 0.003 in. at bores. Moreover, metallurgical characteristics are improved. On a typical pressing made in a segmented die, a 16 bladed centrifugal impeller 6 in. in diameter, tolerances over the 0.03-in. thick blades were kept to 0.003 in.

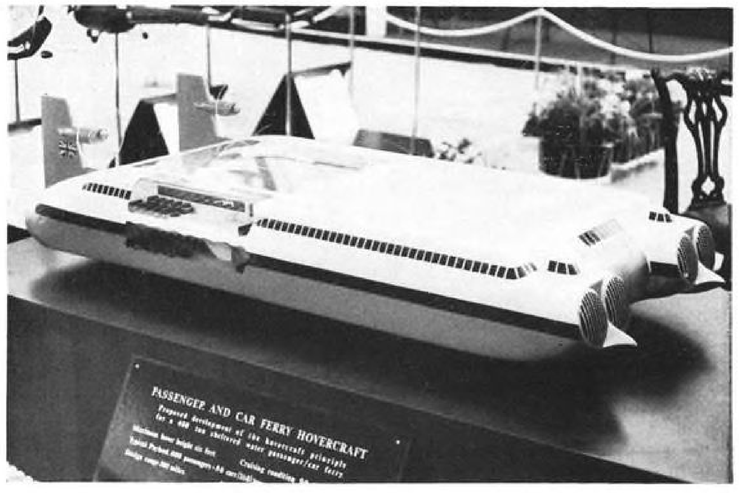
The largest example of a vacuum-melted, high-temperature, master steel stock was a 3-ton ingot in a high cobalt alloy.

One of the major reasons for the growing use of vacuum melting is to prevent the oxidation of the titanium and aluminum used in these alloys to improve hardening properties.

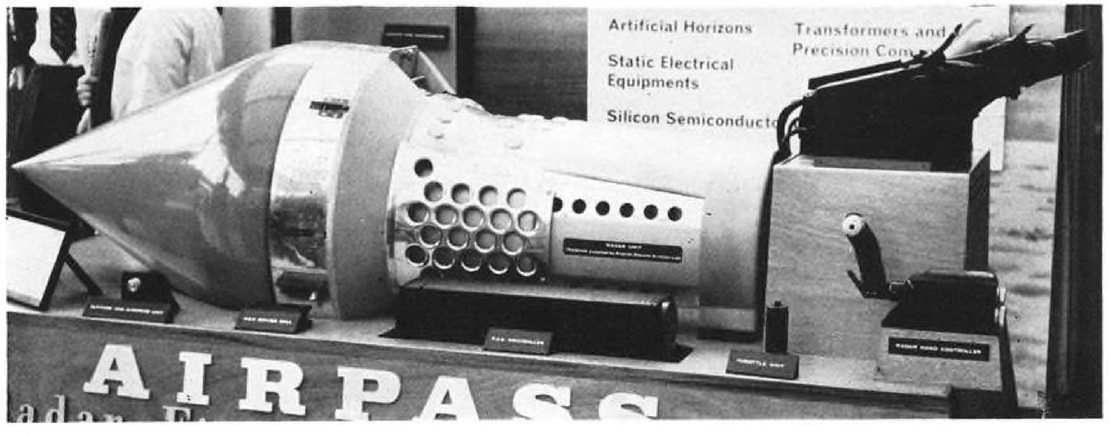
Westland Westminster in its final form as a crane-transporter will look like this model exhibited at Farnborough air show.

Advanced Westminster Model Shown at Farnborough

Displays at the 20th Society of British Aircraft Constructors Flying Display and Exhibition included a model of the Westland Westminster crane (above), with a basic load capability of six tons. Utility pod would be 35 ft. long, 10 ft. wide and 8 ft. high. Helicopter would straddle and lift any load within its capacity and with a width up to 15 ft. and height up to 10 ft. Hovercraft (right) is planned around a payload of 800 passengers and 80 cars, and is estimated to cruise at 90 kt. with a six-foot hover height. Design range is 300 mi. Airpass fire control system (below) is shown in package form as installed in the English Electric P.1B. Large unit at upper right is pilot's sight, combining radar display and optical aiming system as alternates. Basic scheme is that radar scans during search phase, presents target information to pilot. He locks radar beam on target for automatic tracking, computer produces approach data.



Model of Saunders-Roe's proposed 400-ton Hovercraft is above; Ferranti, Ltd., fire control system for English Electric P.1B is below.



Stepping stones to space . . .

In the history of the conquest of space, these vehicles will be counted among the true pioneers; they are the first American vehicles to orbit the earth.

Like the small satellites, which are test vehicles for large spacecraft, Westinghouse test equipment precedes and insures the flights of the future. Westinghouse is *the* single-source supplier of research and test equipment for the aero space industry.

Over half the wind tunnel horsepower in the U.S. was provided by Westinghouse. Today, radiant and rf heating, plasma jet, blowdown and shock tunnel facilities all over the country depend on Westinghouse power supplies and control systems. Westinghouse inductance coils helped achieve 32,400 mph in Hotshot II tests.

Test stands for evaluation of any type of rotating equipment are other well-known products from the world of Westinghouse; a-c and d-c motor powered test stands for rotor blades, constant speed drives, generators, fuel pumps, and many other aircraft, missiles, and spacecraft components. For faster, more accurate research and production testing of these components, Westinghouse has designed a 400-cycle power generator and distribution system around the only 400-cycle high-frequency bus duct in existence. In yet another area, Westinghouse created the world's largest amplifier to vibration-test Polaris components.

Trade on this unmatched capability in standard or custom-designed test equipment . . . and minimize the problem of selecting and relating equipment from multiple sources.

YOU CAN BE SURE . . . IF IT'S

Westinghouse

Illustrated, the original American satellite, Explorer I, as it heads into its orbit. Vanguard I, the second successful satellite of the U.S., shows off its solar batteries which feed 'eternal' power to its electronic payload. Also shown: the full scale Vanguard satellite and the solid-fueled Scout satellite launcher due to fly soon. Scout will be the first economical vehicle to orbit a 150-lb. payload. Lastly, two inflated foil satellites: the globe is the forerunner of tomorrow's communications satellite, the other shape is a 'corner reflector' for radar tracking.

Clockwise: Vanguard I, (7 o'clock) ● Scout, (9 o'clock) ● Vanguard 22-lb. satellite, (12 o'clock) ● corner reflector, (1 o'clock) ● small-scale communications satellite, (3 o'clock) ● Explorer I and Jupiter C Booster, (5 and 6 o'clock).

Automatons in orbit . . .

Here are the first payloads-in-orbit big enough to shape our earth-bound lives. Communications, weather, reconnaissance and astronomy satellites, each one paves the way for the time when human teams will supplement the robots now circling the earth.

Westinghouse, too, is helping to bring about the era of big spacecraft. Metals and materials shaped to space age needs are a major Westinghouse capability. The world of Westinghouse has already brought historic contributions to American metals technology: in steam turbine metallurgy, magnetic metal alloys, high temperature alloys.

Beyond basic research, Westinghouse materials engineering teams bridge the gap between ideas and applications — develop, evaluate and apply new metals and processes. Now, the new Metals Plant at Blairsville, Pennsylvania, calls on advanced facilities to create space age products through modern metallurgy.

Here, new materials and processes are developed, and the problems pertaining to their fabrication in quantity are solved in the pilot plant facilities. Equipment includes vacuum- and atmosphere-induction furnaces, vacuum-arc melting furnaces, bell-type furnaces and special quenching facilities. Other metalworking facilities include heavy equipment for metal conditioning, forging, pressing and rolling. For precision parts or intricate shapes, facilities for skull-melting, investment casting and sintered metal processes are used.

Here again, Westinghouse offers a one-stop source for you — from design conception, materials engineering, pilot runs to finished part. Here is your guarantee that the finished product will be right at every step. Explore the Westinghouse world of new metals for your requirements for space age alloys.

YOU CAN BE SURE . . . IF IT'S

Westinghouse

Illustrated, an inflated foil satellite, for global communications and TV broadcasting; an artist's impression of an observation satellite 'looking' at the world below; a larger radar corner reflector; a Discoverer package containing a recoverable capsule and a Centaur flanked by the payload of a sister ship, moving fast on its fuel of liquid hydrogen. Closer to the earth is Score, the 'talking' Atlas-in-orbit which carried the President's message to the world.

(Bottom, left:) observation satellite and communications satellite; ● (bottom, right:) Score ● (center:) Discoverer second stage ● (center right:) corner reflector ● (top:) Centaur, and Centaur second stage.

SPACECRAFT U. S. A.

Look for these spacecraft in the banner headlines of tomorrow . . . look for them in the history books of the future. All these fantastic craft will affect the shape of things to come in the dawning space era.

And Westinghouse will be a part of every flight. With a universe of research, development, and production facilities, Westinghouse contributes to every space mission. Sixty-one major manufacturing plants, 112,000 employees with 10,904 graduate engineers and scientists among them — this is the reality of Westinghouse today.

From the Westinghouse Advanced Systems Planning group to the Astronautics Institute and the materials development facilities, from missiles or spacecraft handling and checkout equipment to space guidance systems, here is *complete capability*.

Here are unique qualifications to take on and complete any space age project — from study and research, planning, materials planning and development right through to pilot manufacturing and mass production. And any phase of this total, system-coordinated capability can work for you.

Write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

YOU CAN BE SURE...IF IT'S Westinghouse

1. two-man deep space ship **2.** Thor-Hustler booster vehicle **3.** radar reflector satellite **4.** The X-15 — first piloted space-airplane **5.** Scout satellite launcher **6.** Vega satellite- and spaceprobe launcher **7.** Dyna-Soar glide bomber **8.** Pioneer I moon probe **9.** reconnaissance satellite **10.** Nova space ship booster **11.** Pioneer IV moon probe **12.** Discoverer second stage **13.** Centaur second and third stage **14.** Saturn booster configuration with Titan second stage **15.** Venus probe with solar batteries mounted on paddles **16.** 100-foot foil satellite for global communications **17.** Mercury capsule for manned satellite.

Free full-color reprint of this spacecraft panorama will be sent to you upon request. Oversized (30" x 20") full color reprints without advertising copy available for $1.00 each. These quality reproductions are printed on heavy stock, are suitable for framing. *Send all requests for reprints to:*

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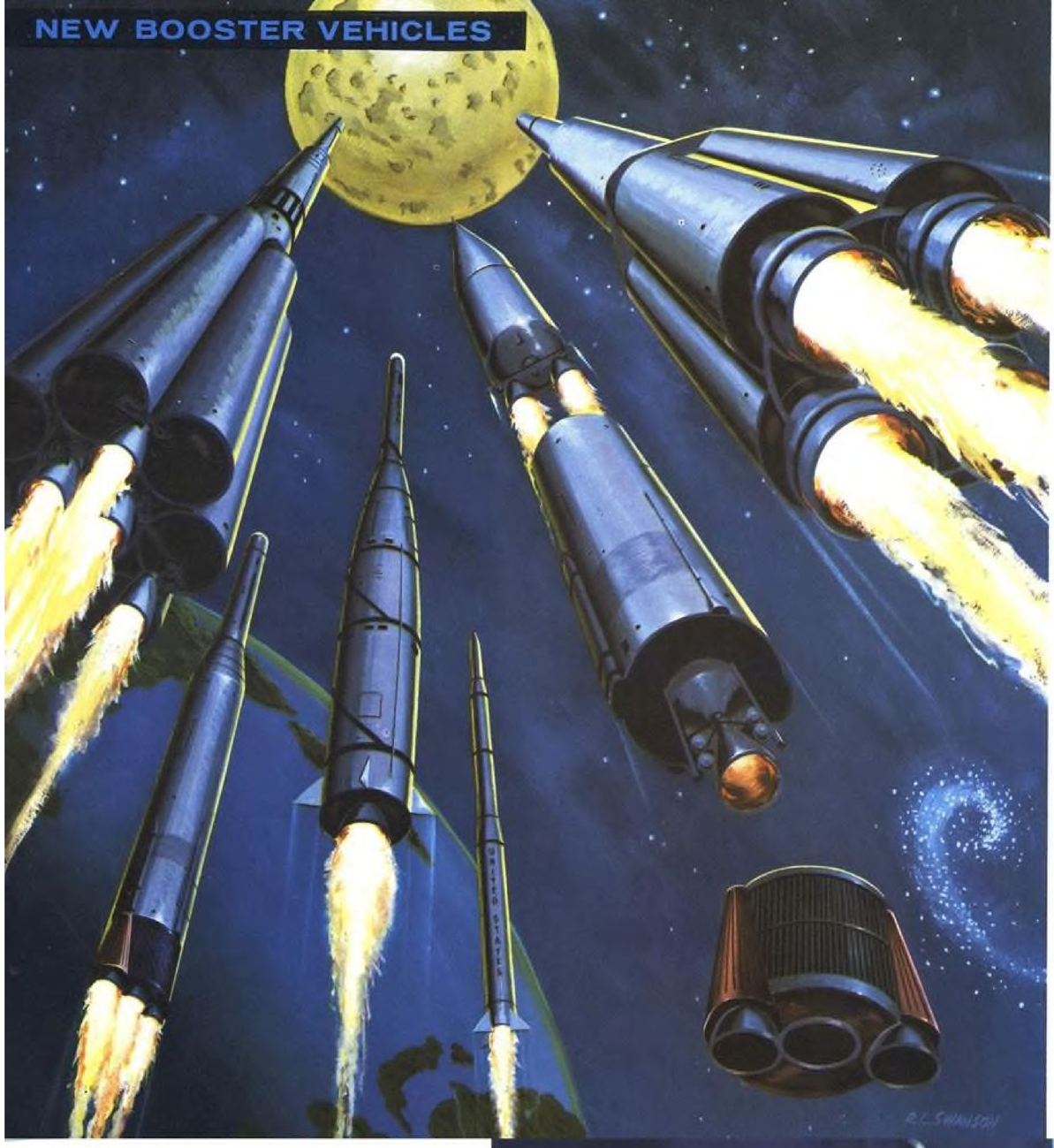

Power is the key . . .

Right now, humanity knows how to fly to the moon, to the planets. Nothing new has to be invented: it's only a matter of developing the right hardware. Development of large rocket engines now becomes the real measure of space capability. Power is the key to the secrets of the solar system — and these booster vehicles are the embodiment of propulsive power.

And power for the space age is yet another area of Westinghouse pioneering. Westinghouse leads the world in atomic power, which requires no oxygen, is equally at home below the surface of the sea, in the void of space, or on the surface of the moon. The new Westinghouse *astronuclear laboratory* will work exclusively on such nuclear energy applications for outer space projects.

Here are some nuclear power milestones already marked by Westinghouse products: the first atomic powerplant to produce useable power in quantity; the Nautilus, the world's first nuclear-driven submarine; the Skipjack, the world's fastest submarine; the George Washington, first Polaris-firing submarine; the Long Beach and the Enterprise, respectively the first nuclear powered cruiser and aircraft carrier. The Shippingport reactor for electricity is another showpiece of space age power from Westinghouse.

Other space era power sources will also come from Westinghouse. Look to Westinghouse for progress in thermoelectricity, propulsion concepts and systems. From the teamed efforts of the Westinghouse Atomic Power Organization, the Research Laboratories, the Aviation Gas Turbine Division, the Aircraft Equipment Department, the Astronautics Institute, the materials development facilities, and other creative Westinghouse groups will come new sources of power for craft and stations in space.

YOU CAN BE SURE...IF IT'S

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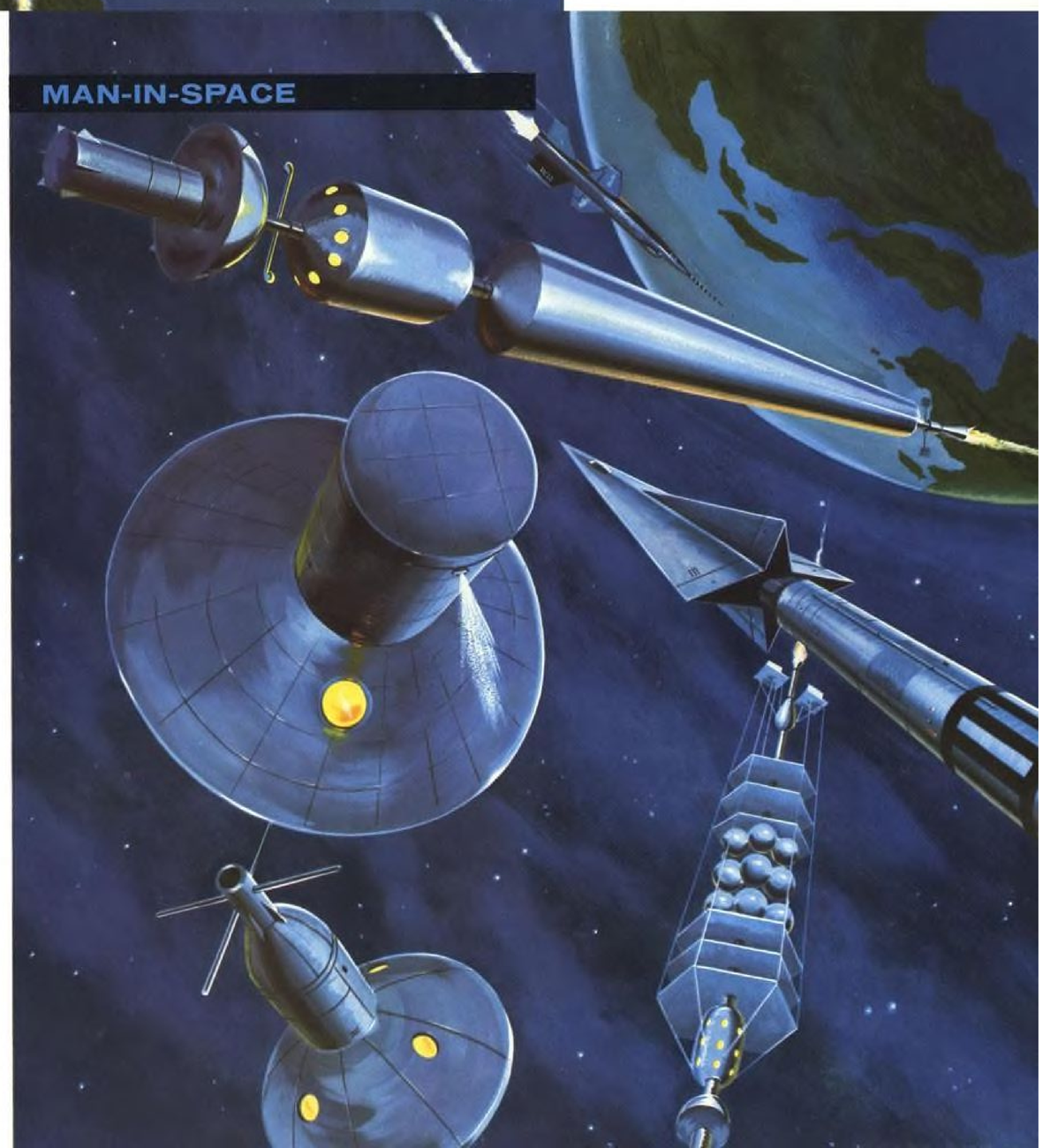
Shown: Atlas-Able and Thor Able — the slingshots which hurl small probes into deep space; and Scout, the prime mover of small satellites. Centaur, depicted separating its first and second stage, features a stage propelled by two rockets burning liquid hydrogen. Saturn is a tremendous eight-engine vehicle which develops a total of 1,300,000 lbs. of thrust in its first stage. Finally, there is Nova, the long-range hope of our space program. This monstrous rocket, more than four times as powerful as Saturn, may be able to return a 25,000 lb. payload from a Mars orbit.

Left to right: Saturn • Atlas-Able • Thor Able • Scout • Centaur • Nova



The supreme adventure . . .

Now Man has dared to reach out into space and see for himself. Now his world has grown to include the whole solar system. This is the supreme adventure.

This is also the supreme test of the electronic components that help put him in space, and help bring him back again. Reliability, compactness, light weight become all-important. Reliability and creative design — these are the two hallmarks of missile, aircraft and spacecraft equipment created in the world of Westinghouse. Look to Westinghouse as *the* source for consistent reliability and best design for all these: amplifiers, electronic and magnetic capacitors, circuit breakers, coils, contactors, cores, electronic tubes, gyrospin motors, instruments, inverters, lamps, magnets, meters, motors, rectifiers, relays, semiconductors, switches, toroids and transformers.

The systems made up from these and other components are designed to capitalize on special qualities designed into each unit.

In addition, Westinghouse research work in the areas of high temperature electrical insulation, low-noise solid state microwave amplification, infrared, nuclear and high vacuum research has far-reaching applications in such system areas as propulsion systems, reconnaissance systems, space guidance and control systems. Of particular significance to the designers of sub-miniaturized electronic systems is a recent Westinghouse breakthrough in the method of semiconductor crystal "growth". This new development in molecular electronics may lead to the creation of outer-space equipment one thousand times smaller and lighter than anything now in existence.

YOU CAN BE SURE...IF IT'S

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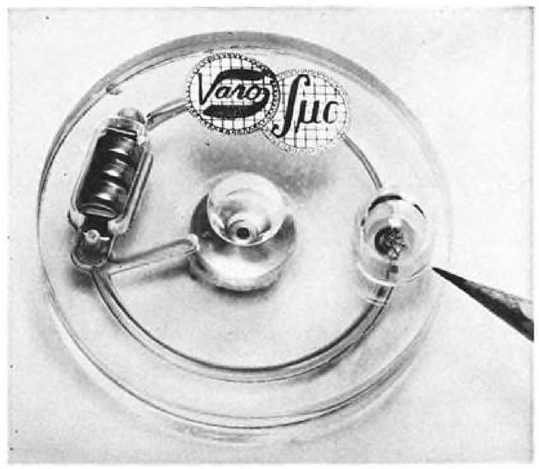
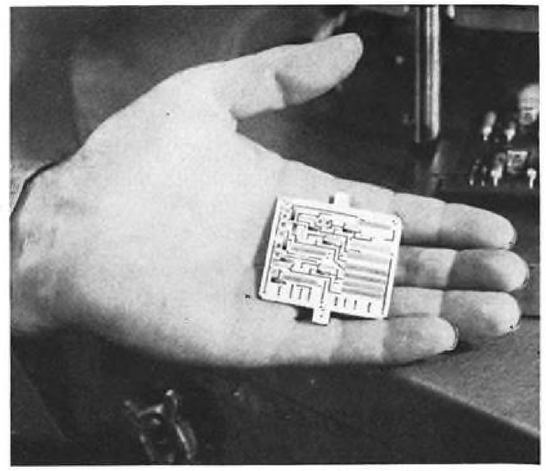
Shown: The X-15, our first piloted space-airplane and the Dyna-Soar glide bomber, quickly darting out into the void before plunging back into the atmosphere; the Mercury capsule contains the first human-in-orbit. The Vega two-man capsule is seen as an artist's impression. The two-man spaceship with the long hull is headed for Mars or Venus — the other ship illustrated will be assembled while in orbit. The two-man re-entry capsules near the crew compartment are the launches of the space age, returning the travelers from the unknown seas to the familiar shores of earth.

Clockwise: Vega capsule, (7 o'clock) • Mercury capsule, (9 o'clock) • Venus or Mars ship, (12 o'clock) • X-15, (1 o'clock) • Dyna-Soar, (3 o'clock) • deep-space ship, (5 o'clock)

AVIONICS





PEA-SIZED FM transmitter (near pencil point), made by Varo Manufacturing Co., using vacuum deposition techniques, utilizes a tiny hearing aid microphone (center) and battery (left). At right, three-stage experimental flip-flop circuit, made by Bell Telephone Laboratories, uses sputtering technique to deposit thin tantalum films to make resistors, capacitors and interconnections.

Space Needs Spur Molectronics Activity

By Philip J. Klass

Washington—Interest and activity in molectronics (molecular electronics) and micro-circuitry is spreading through the avionics industry, sparked by the needs of space and missile technology and by a recent major program launched by Air Force at Westinghouse Electric Corp. (AW April 27, p. 54).

At least 20 companies, ranging in size from the giants to the smallest, from semiconductor and component makers to equipment manufacturers, are actively engaged in molectronic research and in related micro-circuitry development.

The advanced research laboratory of any of these avionic companies, with its vacuum deposition chambers, electron miscroscopes and semiconductor crystal-growing furnaces, looks more like a chemistry or physics laboratory than an electronics facility.

A representative list of companies known to be active in the field includes: Airborne Instruments Laboratory, Bell Telephone Laboratories, Burroughs Corp., Electro-Optical Systems, Inc., General Electric, Giannini Controls Corp., Halex, Inc., Hughes Aircraft, International Resistance Corp., Lear, Litton Industries, Lockheed Aircraft, Motorola Radio Corp. of America, Servomechanisms, Shockley Laboratories, Stanford Research Institute, Sylvania, Texas Instruments, Varo Manufacturing and Westinghouse Electric.

The field is so new and relatively unexplored that most companies are tight-lipped about their efforts and accomplishments. During the recent Western Electronic Convention (Wescon), however, Bell Telephone Laboratories and Lockheed Aircraft made the first public disclosure of some of their activities in this field.

'Stepping Transistor'

Bell Telephone Laboratories scientists described a new "stepping transistor," a solid-state device that operates as a multi-stage flip-flop circuit. Other BTL scientists described the use of passive circuits, consisting of resistors, capacitors and interconnections, fabricated with "sputtered" tantalum films.

Lockheed disclosed that it is working with vacuum deposition technique for integrated circuit fabrication, using a process similar to that pioneered by Servomechanisms and by Varo Manufacuring (AW Sept. 30, 1957, p. 70; June 2, 1958, p. 64).

Earlier this year, Texas Instruments disclosed its progress in fabricating a complete flip-flop circuit from a single semiconductor crystal measuring only $\frac{1}{4}$ x $\frac{1}{8}$ x $\frac{1}{32}$ in. (AW Mar. 30, p. 33). Electro-Optical Systems has developed a semiconductor radiation tracking transducer, with no moving parts, first disclosed by Aviation Week (Sept. 21, p. 79). In addition to the foregoing, here is a brief summary of molectronic and micro-circuitry programs known to Aviation Week to be under way at this time.

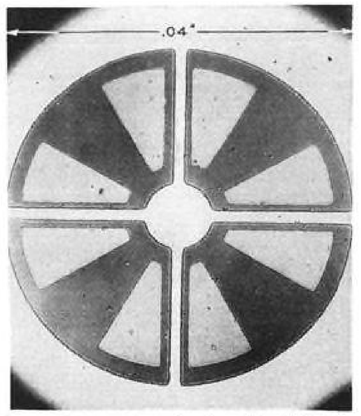
• **Airborne Instruments Laboratory** is developing a molectronic radio frequency amplifier for use as a low-noise front-end for an existing telemetry system operating in the 2,200 mc. band. Design objective calls for minimum gain of 20 db., minimum bandwidth of 4 mc., noise figure of less than 0.5 db. and rapid tunability over the band. Program is sponsored by Wright Air Development Center.

• **Electro-Optical Systems Inc.,** Pasadena, Calif., is investigating semiconductor delay lines and semiconductor transducers that employ the piezo-electric effect. The company has approximately 30 persons, including 15 professional en-

Developments Urged

Air Force soon will start urging avionics manufacturers to apply new molectronic developments in their proposals, as part of more conventional circuitry, and not to wait until a complete equipment can be constructed using the new technique, according to Col. C. H. Lewis. Lewis is head of the Electronics Directorate at Air Research and Development Command Headquarters and one of the major proponents of the USAF molectronics program.

Col. Lewis also is urging scientists to concentrate on the development of a molectronic equivalent of a tuned circuit for radio-radar system use. A tunable tuned circuit would be ideal, but a fixed-tuned molectronic circuit would also be valuable because a number of such elements could be used with semiconductor switching to provide equivalent of a tunable circuit, Lewis says.



STEPPING transistor, developed by Bell Laboratories, is four-stage ring counter fabricated on a single piece of silicon measuring only 0.04 in. in diameter.

gineers and scientists, working in its Solid State Division on molectronic projects.

• **Giannini Controls Corp.,** Pasadena, is investigating semiconductor transducers, including such devices as potentiometers, function generators and analog multipliers.

• **Halex, Inc.,** El Segundo, Calif., is a newly formed company that specializes in vacuum deposition of thin films of conductive, semiconductive and resistive materials to form integrated circuits.

• **Hughes Aircraft Co.** recently decided to launch a company-wide molectronics program to integrate efforts of its several laboratories and its Semiconductor Division.

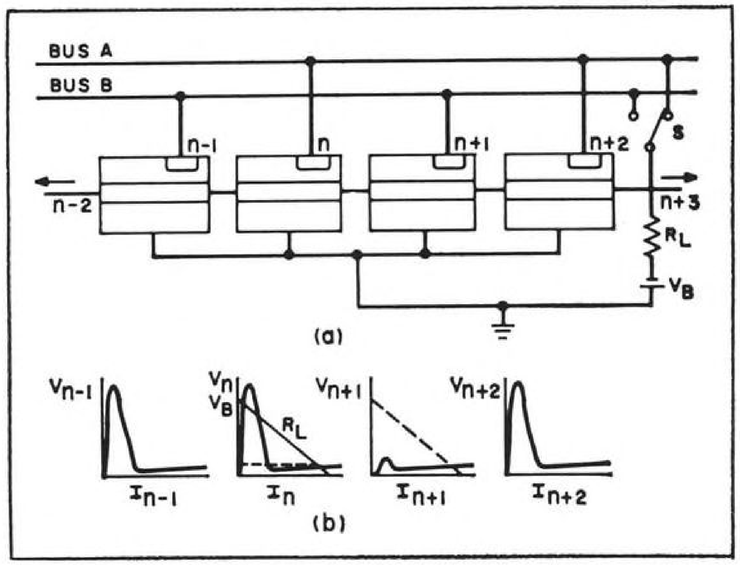
• **International Resistance Corp.** is working with vacuum deposition techniques to fabricate integrated resistive-capacitive circuits into which active elements (transistors, diodes) can be inserted.

• **Lear has set up** a solid-state physics laboratory in Santa Monica, Calif., to work in the area of photoconductivity, electroluminescence, storage devices and solid-state circuitry. A new $400,000 laboratory facility now employs about 10 professional scientists, a figure expected to double by the end of the year.

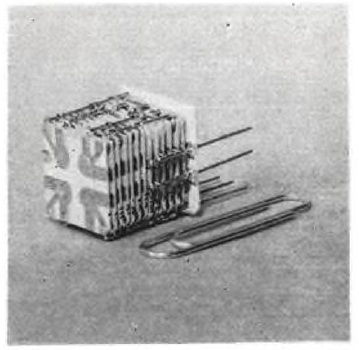
• **Litton Industries** has a molectronics research facility operating within its Computer Systems Laboratory to investigate vacuum-deposited thin magnetic films for use as computer logic and storage elements. The facility also is experimenting with diffusion doping of barium titanate to produce diodes. Litton has fabricated a semiconductor device which performs like a bi-metallic strip to provide overload protection.

• **Servomechanisms, Inc.,** at its Santa Barbara, Calif., research facility also is working with thin magnetic films, produced by vacuum deposition, for use as high density computer storage elements. The nickel-iron alloy, about 2,000 angstroms thick, has a flip-time of a fraction of a milli-microsecond. Company research laboratory also is actively investigating new types of ternary compound materials for use in thermoelectric power generation.

• **Motorola is investigating** both etching and film deposition techniques for fabricating integrated molectronic circuitry, including active and passive cir-



PRINCIPLE of operation of stepping transistor is shown in a three-stage counter in which the lower impedance state moves one stage to the right each time switch (S) is closed. V-I characteristics at bottom show stage "n" in low impedance state.



COMPLETE digital computer adder (top), with a component density of 300,000 per square foot, is constructed by Arma using 0.5 x 0.5 x 0.03 in. ceramic wafers upon which resistors, capacitors and semiconductors have been deposited (below). Construction resembles RCA Micro-Module.

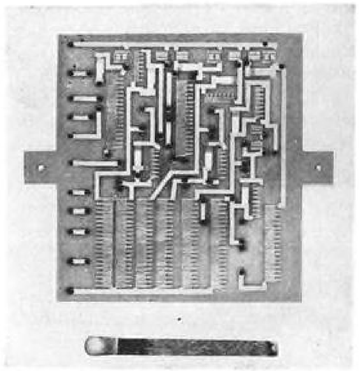
cuit elements. The company predicts its work will soon make possible component densities of "tens of millions" per cubic foot.

In addition to the foregoing, there is the RCA-Army Micro-Module program (AW April 13, p. 75) and the Army Diamond Ordnance Fuze Laboratory micro-circuitry program (AW June 16, 1958, p. 243).

Stepping Transistor

Unique functional equivalent of a series of flip-flop circuits in the form of a four-stage ring counter, fabricated on a single silicon crystal measuring only 0.040 in. in diameter, was reported by L. A. D'Asaro of Bell Telephone Laboratories, Murray Hill, N. J. during Wescon.

Each stage in the ring counter consists of a P-N-P-N transistor which operates as a bi-stable element without any external resistors or capacitors. The device can operate at frequencies as high as 1 mc., and even higher operating rates may be possible with future developments, D'Asaro indicated. The device can be designed to operate wit.



SPUTTERED circuit, which uses tantalum films for resistors, capacitors and conductors, shows precision with which circuit elements can be fabricated using copper masking. Lines 0.02 in. wide, with 0.02 in. separation were achieved by Bell Laboratories.

supply voltage of 10 to 100 v. Current gain per stage is greater than unity and can run as high as five, he reported.

D'Asaro pointed out that the new stepping transistor resembles the gas discharge stepping tube in its operation, with one important difference. Whereas the transfer of a pulse from one electrode to another in the gas tube requires physical proximity between the electrodes, each stage of a stepping transistor can be packaged separately, if desired, with only an electrical connection between stages. If several stages are fabricated on a single crystal, the transfer from one stage to the next is accomplished by emission of minority carriers from the P-N junction which is common to all stages. Non-symmetrical geometry in transistor configuration is used to establish the desired direction of transfer.

Tantalum Circuitry

Bell Telephone Laboratories has fabricated complete passive circuits, including resistors, capacitors and interconnections from a single metal—tantalum—using a variation of the vacuum deposition process which is known as "sputtering."

One three-stage flip-flop fabricated by this process contained 24 resistors with resistances up to 121,000 ohms, nine capacitors with values of 0.01 mfd., and plug-in holes for six transistors and nine diodes on a ceramic board measuring only 2 x 2 x 0.05 in., to give a passive component density of 275,000 per cubic foot, according to D. A. McLean of Bell Telephone Laboratories.

McLean told Wescon that considerably higher packaging densities appear possible. For example, by using both sides of the ceramic sub-strate, component density could be nearly doubled. If multiple layer films were employed,

still higher densities could be achieved.

The novelty of the Bell Telephone Laboratories approach is in the use of tantalum to fabricate all passive elements of the circuit. The capacitor elements are fabricated by depositing a thin tantalum film, anodizing it, then depositing a counter-electrode of gold or aluminum. Using this process, BTL has fabricated capacitors with a capacitance of about 0.1 mfd. per square centimeter for operation at 50 volts. These have an insulation resistance of about 3,000 to 5,000 ohm-farads at 75 volts, with dissipation factors of 1% or less, McLean reported. Temperature coefficient is about 250 ppm. per degree centigrade. Dielectric constant of the anodic tantalum oxide is approximately 25.

Tantalum's specific resistance is approximately 15 times higher in thin films than it is in bulk, McLean pointed out.

Its temperature coefficient of resistivity is only 100 ppm. per degree Centigrade in thin films compared with 3,000 ppm. for the bulk tantalum. This makes thin films of tantalum attractive for fabrication of resistors.

Tantalum Films

Tantalum films react with oxygen to form a thin surface layer of oxide, causing resistance to change. For this reason, it is necessary to stabilize tantalum film resistors with a heat treatment in air, McLean said. Once this has been done, the resistors prove quite stable, he reported. Tests on BTL laboratory samples indicate an average change of resistance of only about 0.2% after 800 hr. of operation at 100C. Resistances of up to 500 ohms per square have been obtained with tantalum films, McLean reported.

The sputtering technique for thin film desposition is used instead of the conventional evaporative deposition process because tantalum does not vaporize at the low temperature of other metals. In the sputtering process, the vacuum chamber is filled with some argon gas. A high voltage is then applied between the tantalum cathode and a base electrode to which is attached the substrate upon which the film is to be deposited.

Positive argon ions are attracted to the tantalum cathode by the high potential. As these positive ions strike the cathode, they knock off tantalum ions which are attracted to the substrate and deposited there.

In order to deposit the required pattern of tantalum for the desired circuit configuration, the ceramic substrate is first covered with a thin layer of copper by evaporation or sputtering which is then removed in the desired pattern using conventional photo-etch techniques.

Tantalum then is sputtered over the whole surface and it is again immersed

in an etchant. The copper and overlaying tantalum are now etched away leaving tantalum only where the substrate had been bared by the previous photo-etch process. If additional tantalum must be applied to capacitor areas, this can be done by using masks, after which these areas are isolated with wax or electroplater's tape and anodized, McLean said.

Through the use of the expendable copper masking technique, it is possible to get extremely fine detail. Resistive and conducting lines which measure only 0.002 in. wide, with 0.002 in. spacing between lines has been achieved. With additional development these figures may be further reduced, McLean indicated.

McLean said that Bell Telephone Laboratories is now working on "compatible active elements" (transistors, diodes), but he declined to elaborate.

Dynamic testing of the switching characteristics of a flip-flop circuit while it is being fabricated by vacuum deposition process was described by W. D. Fuller of Lockheed's Missile and Space Division. (Fuller formerly was employed by Varo Manufacturing Co.) Fuller told Wescon that Lockheed observes the wave shape of the circuit during the process of depositing resistive material to determine when the process should be terminated.

Fuller described several deposited flip-flop circuit configurations with extremely high packaging densities. One achieved density of six million passive components per cubic foot, Fuller said.

Arma Program

Edward Keonjian of American Bosch Arma Corp. told Wescon about his company's micro-miniaturization program which calls for the construction of a space vehicle guidance computer by 1961-62 which will be only 1/10th as large and heavy as present designs using conventional construction techniques.

Arma has selected an adder circuit from its Atlas inertial guidance computer as a test unit to see how much its size and weight can be squeezed down. The adder consists of eight "And" circuits, seven amplifiers and one flip-flop.

Working with half a dozen component manufacturers, Arma has constructed an adder consisting of a stack of ceramic wafers measuring 0.5 x 0.5 x 0.03 in. upon which are printed resistors, miniature capacitors and unencapsulated silicon transistors and diodes. The stack of wafers is interconnected by means of external bus bars, giving it a marked resemblance to the Micro-Module being developed by RCA for the Army, except that the latter employs smaller wafers.

The Arma adder occupies a volume of about 0.5 cu. in. and achieves a

component density of about 300,000 per cubic foot, Keonjian said. To protect the semiconductor devices, the entire module would be sealed in an airtight container.

Next phase of the Arma program is to redesign its computer logic for optimum micro-miniaturization, with the objective of minimizing the number of different circuits required.

With further effort, Keonjian believes the Arma module approach can yield component densities of around 600,000 per cubic foot. He concedes that solid-state circuitry probably is the more promising approach for the more distant future, not only because of smaller size and weight, but because of its potentially greater reliability due to the fewer number of separate components and soldered interconnections.

During the recent Army-Navy Instrumentation Program (ANIP) symposium in Dalas, Tex., (AW Sept. 14, p. 85) Varo Manufacturing displayed some of its latest micro-circuitry devices, with component densities ranging from 1.3 to 10 million per cubic foot. One such device was a tiny FM radio transmitter, powered by micro-miniature batteries and using a hearing aid as a microphone.

The bulk of the effort in micro-circuitry is being expended by equipment manufacturers rather than by component manufacturers. Notable exceptions are Texas Instruments (which is both an equipment and component producer) and International Resistance Corp. It is true that a number of component makers are cooperating in the RCA/Army Micro-Module program, but only to the extent of making their regular components in a size and format suitable for the Micro-Module.

The state of the art in molectronics appears to be at about the same point as the transistor was 10 years ago, about a year after it had been invented by Bell Telephone Laboratories. The next several years will see the development of a number of useful molectronic devices, which can be used with more conventional circuits or with micro-circuitry in avionic equipment.

It probably will be 1962 before a subsystem of modest complexity, such as a digital computer constructed entirely with molectronic circuitry, will be in operation, and this will be an experimental model.

By 1965 observers expect that digital computers constructed by molectronic techniques will begin to come into service. Digital computers probably will be the first complex equipment to use molectronics throughout because of the major size, weight and power reduction and because such computers are built up from a very few types of basic circuits.

By 1970, observers believe that

avionic system designers will have a wide range of circuit functions which can be performed by molectronic devices.

The situation will be comparable to the state of the transistor art today. Currently there are a sufficient number of different types of transistors on the market to enable the designer to fully transistorize his equipment in nearly all, but not every, application.

One major hurdle to widespread use of molectronics sometimes is overlooked as its proponents glowingly describe its potential for improving reliability by slashing the number of components and soldered connections required.

Manufacturing Problems

Here is the way an official of a major semiconductor manufacturer expresses it: "Anyone who knows the difficult problems of producing in quantity an extremely reliable diode or transistor, and obtaining an economical yield, shudders as the problems involved in manufacturing in quantity a complex circuit which in effect contains dozens or hundreds of semiconductor junctions—and obtaining an economical yield."

Yet the demand for semiconductor devices has forced manufacturers to mechanize increasingly the fabrication of the devices and this has forced them to dig more deeply into the basic causes of low yield. This is removing much of the "black magic" that has long surrounded the fabrication of semiconductor devices.

It therefore appears likely that when the research scientists have developed the new functional molectronic devices, the state of the manufacturing art will have developed sufficiently to meet the challenge of producing them.

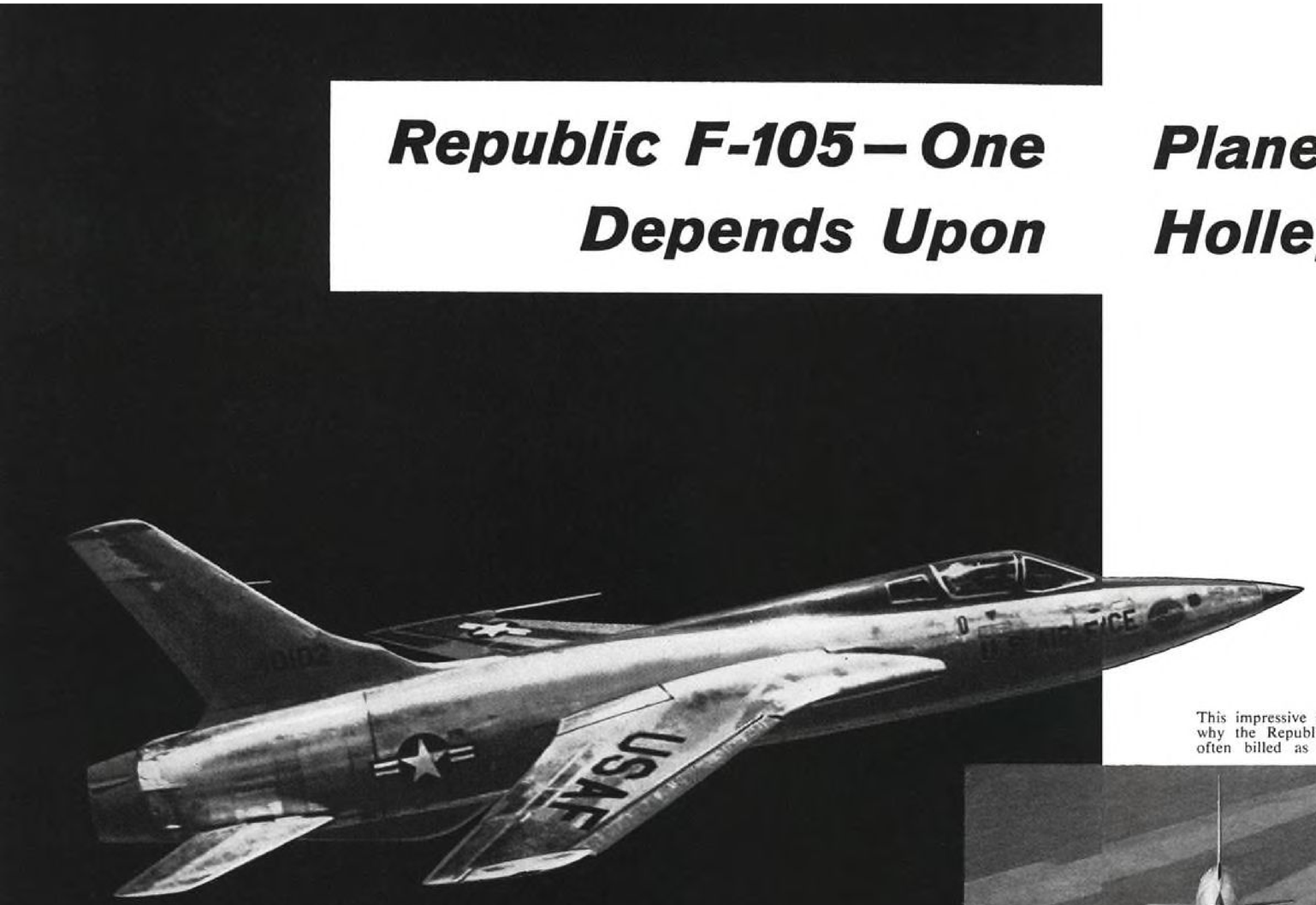
Litton Industries Opens Electronics Facility

Litton Industries has formally opened a new plant housing its Electronic Equipments Division in the San Fernando Valley area of Greater Los Angeles. Located in Canoga Park, the facility is under the direction of Dr. Norman Enenstein.

Litton officials announced that work on several contracts is being conducted by the Electronic Equipments Division, including inertial navigation, man-machine relationships, space environment research, data processing for tactical systems, digital and analog computer systems.

Division has five departments: Advanced Systems Engineering Department, Guidance Systems Laboratory, Computer and Controls Laboratory, Tactical Systems Laboratory and Space Research Laboratory.

Republic F-105—One Plane "Bomber Formation" Depends Upon Holley for Fuel Control



New Wings for the Eagle!

World War II's famed Eagle Squadron, now the 335th Squadron of TAC's Fourth Fighter Wing will soon be flying the F-105 fighter-bomber.

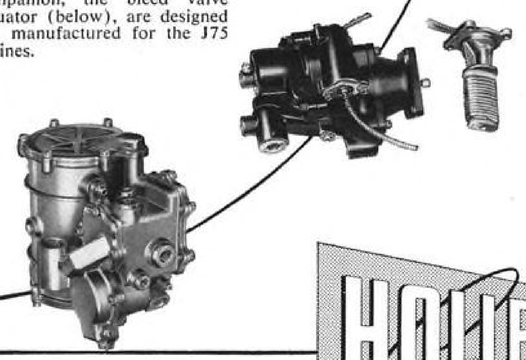
This impressive array of fire power shows why the Republic F-105 supersonic jet is often billed as the "one man airforce."

World's most powerful one man airplane, is reported to carry "as much destructive power as an entire big bomber formation of World War II." Capable of carrying an atomic bomb, the exciting Republic "Thunderchief" gets more than 25,000 pounds of thrust from its Pratt & Whitney Aircraft J75 jet engine with afterburner.

Holley designed, engineered and manufactures the main fuel control, bleed governor and actuator for the J75 engine which has both military and commercial applications. The Holley R-95 control combines "small package" design with light weight and exceptional performance reliability. It's another important reason why more and more engine and air frame manufacturers are turning to Holley for engine components.

The R-95 is the military version of Holley designed and engineered fuel controls made for the J75 jet engine.

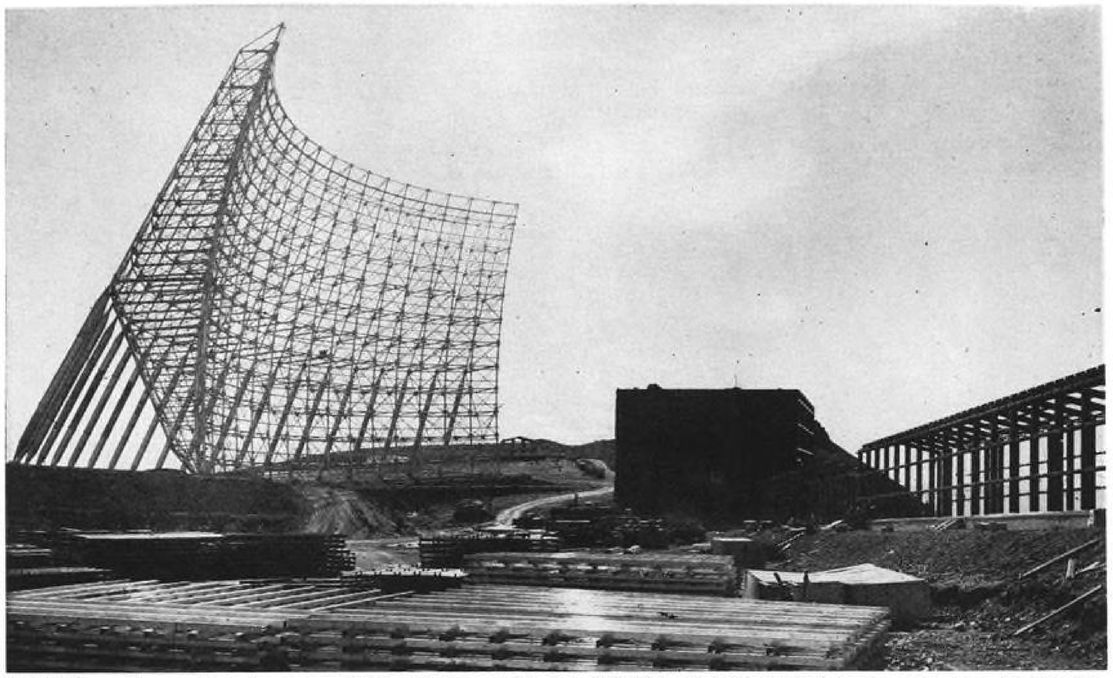
Both the Holley R-98 compressor bleed governor and its companion, the bleed valve actuator (below), are designed and manufactured for the J75 engines.



HOLLEY Carburetor Co.

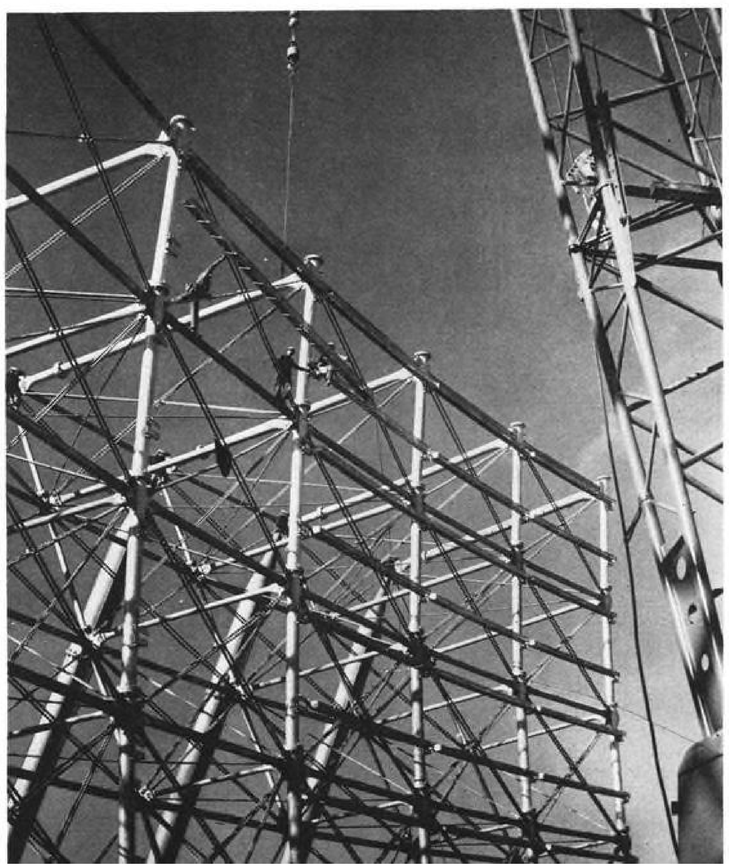
A-29 11955 E. NINE MILE ROAD
WARREN, MICHIGAN

Leader in the Design, Development and Manufacture of Aviation Fuel Metering Devices

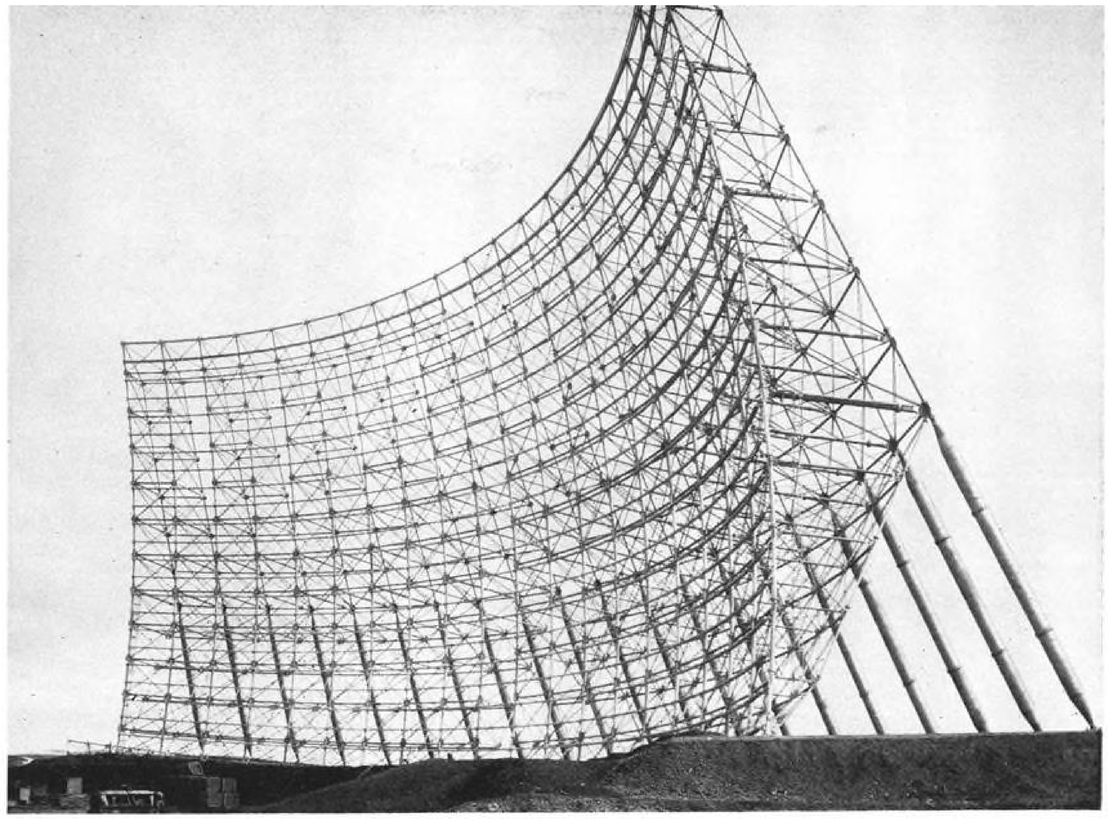


BMEWS surveillance radar antenna, one of four recently completed in Greenland. Building (center) houses radar transmitter/receiver.

ICBM Detection Antennas Completed at Thule



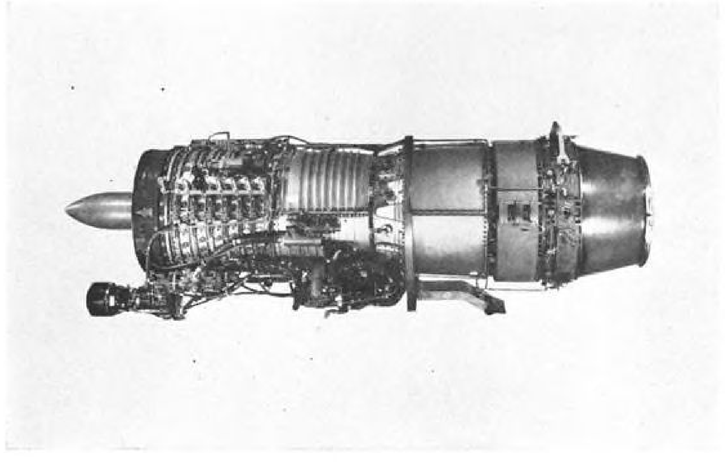
Construction of four surveillance radar antennas for Air Force's Ballistic Missile Early Warning System (BMEWS) near Thule, Greenland, has been completed several months ahead of schedule and installation of radar transmitter-receiver equipment now is under way. The four surveillance antennas, each measuring approximately 400 ft. wide and 165 ft. high, are the largest ever constructed by the United States, possibly the largest in the world. Antennas were designed and built by D. S. Kennedy & Co., under subcontract to General Electric which is developing and manufacturing the surveillance radars. Radio Corporation of America is prime contractor on BMEWS. Each of the four antennas will cover a 30-deg. wide azimuth sector, providing a total of 120 deg. azimuth coverage. Radars, with speak powers of approximately 10 mw., are expected to have a range of 2,500 to 3,000 mi. against enemy ballistic missiles. A "pipe organ" feed array installed in two-story building in front of each antenna (which also houses radar transmitter-receiver) will produce a split (dual) vertical beam which will scan rapidly in azimuth. Dual vertical beams will make it possible to establish missile's approximate altitude and speed, for use in aiming tracking radars. Antennas will provide a radar beam that is approximately one degree in width (AW July 28, 1958, p. 19). Each of the antennas weigh approximately 1,500 tons.



Each torus-shaped surveillance antenna, designed and built by D. S. Kennedy & Co., weighs nearly 1,500 tons. Construction was completed in two months, several months ahead of schedule. Antenna structure will be covered with a mesh screen to reflect radar signals. Surveillance radars are expected to have detection range of 2,500 to 3,000 mi. against enemy ballistic missiles. Radio Corporation of America is prime contractor on BMEWS, and General Electric is building the surveillance radar transmitters and receivers.

Convair 880 exceeds performance specs

General Electric's CJ-805 jetliner engine shares in an outstanding aviation achievement: in flight tests the CJ-805 powered Convair 880 has not only bettered all performance guarantees, it has met or bettered even drawing board estimates for speed, range and short distances required for take-off and landing. For airlines and their passengers, these flight test results demonstrate how the 880 will go more places and provide the world's fastest, most versatile air transportation. Powered by dependable General Electric CJ-805 turbojets, the Convair 880 will be years ahead for years to come.



TAKE-OFF
less than 5,450 ft.

Flight tests have proved that the 880 can lift off before reaching the 5,450-foot mark* originally estimated. Flight experience indicates that actual runway length needed for take-off may prove to be as much as 5% less. CJ-805 performance has been outstanding throughout Convair's continuing test program. Supporting this record was thorough G-E flight and ground testing which provided information for engine improvements prior to 880 testing. Extensive flight and ground testing continue. **(sea level standard conditions—typical 1,000-mile trip.)*

Outstanding CJ-805-3 performance has helped the Convair 880 exceed performance guarantees for speed, range and short distances required for take-off and landing.

SPEED
615 mph

Four CJ-805 turbojets have provided power for Convair 880 cruise at true air speeds of 615 mph—above guarantee and faster than any other commercial passenger plane in the world. Six months of intensive flight testing have proved speed. 615 mph flights have been powered routinely by CJ-805 engines equipped with reversers and suppressors, demonstrating minimum thrust losses. Engine, thrust reverser and sound suppressor have been produced and tested together by G.E., so their performance is especially well matched.

RANGE
3,450 miles

Engineering estimates of the 880's range and fuel economies have been confirmed by data accumulated during 250 hours aloft on 130 flights. Flown for best economy, the 880 will range 3,450 miles. Excellent CJ-805 SFC's make an especially important contribution. The 880 was designed and built to operate from most present-day airports. Proved range makes the 880 even more versatile by permitting non-stop jet 880 service between metropolitan centers as well as on shorter routes. The 880 can go more places.

LANDING
less than 5,350 ft.

880 landing tests show that the estimated 5,350-foot landing distance may be considerably shortened. In tests, only aircraft brakes were used. Thrust reversers, which provide reverse thrust equal to 48% of forward thrust, can reduce landing distance even further. Short take-off and landing is another reason the 880 can go more places. The CJ-805, which helps make 880 performance outstanding, is the result of knowledge and experience gained in more than 23 million G-E jet flight hours. *General Electric Company, Cincinnati 15, Ohio.* 237-33

Progress Is Our Most Important Product

GENERAL ELECTRIC

U.S. Traffic Control To Cost $1 Billion

New York—Federal Aviation Agency funding for air traffic control facilities for the next several years will average between $150 and $200 million, bringing the total U. S. investment in air traffic control and navigation to about $1 billion by 1962, according to Joseph H. Tippets, FAA's acting director of facilities, speaking at FAA's commissioning of the air traffic control radar beacon system in the New York area.

Tippets said that the immediate goal of FAA is to bring air traffic control facilities to the point where on a nationwide basis, all traffic above 15,000 ft. will be under radar and beacon surveillance or control, plus additional radar and beacon coverage of usable instrument altitudes on all major approaches and through the cooperative integration of civil and military terminals, radar beacon systems.

The radar beacon system placed in operation at the New York Air Route Traffic Control Center (AW May 4, p. 126) includes installation of beacon interrogations and receivers, with defruiting equipment to reject spurious replies, at these New York facilities:

- **Idlewild tower** air route surveillance radar.
- **New York air route** traffic control center terminal area radar.
- **La Guardia tower airport** surveillance radar.
- **Newark tower airport** surveillance radar.

The FAA plans that eventually all airport surveillance radars, terminal area radars, and en route radars will be equipped with radar beacon systems. Scheduled to be placed in operation this year are systems at Air Route Traffic Control Centers in Washington, Norfolk, Pittsburgh, Boston, Indianapolis, Miami, Atlanta, Memphis, St. Louis, Los Angeles, Seattle, Salt Lake City, and Denver.

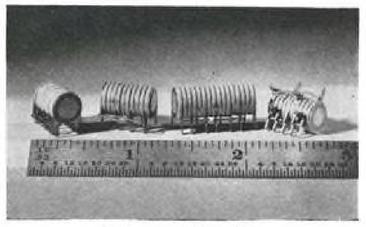
FILTER CENTER

► **Transistorized Weapons**—Transistor sales for the first seven months of this year are approximately double those for the same period of 1958, both in units and dollars, according to figures compiled by the Electronic Industries Assn. One reason for mushrooming sales is found in figures on the number of transistors used in major missiles, aircraft and support systems compiled by Defense Departments Electronics Production Resources Agency. Examples:

- **Atlas:** 5,393 transistors plus 61,443 for guidance control and launch equipment.
- **Bomarc:** 1,414 transistors, plus 27,440 for guidance control and launch equipment.
- **Polaris:** 1,420 transistors, plus 20,991 for guidance control and launch.
- **B-52:** 19,961 transistors.
- **F-105D/E:** 1,299 transistors.
- **Navy Tactical Data System:** 30,764 transistors.

► **What's in a Name?**—Insiders report that Lockheed Aircraft is particularly grateful that AVIATION WEEK coined the word "avionics" more than a decade ago. Company, whose slogan is "Look to Lockheed for Leadership," carefully named its new operation Lockheed Electronics & Avionics Division, whose initials spell LEAD. Without the word avionics it would have spelled: LED.

► **USAF Fishes for New Warning Technique**—In search for new detection techniques, Air Force is sponsoring a study of the ability of the tropical knife fish and electric eel to detect the presence of other fish and discriminate between friend and foe by distortions produced in the electric field set up by the knife fish and eel, according to Dr. Harvey E. Snavely, chief biologist for Air Force Office of Scientific Research. At recent symposium on Comparative



Thermionic MicroModules

Tiny TIMMS (thermionic integrated Micro-Modules), miniature ceramic vacuum tubes with built-in circuit elements, have been constructed by General Electric in four different types. From left to right, a double cathode follower containing two triodes, four resistors and two capacitors; a cascade amplifier containing two triodes, four resistors and one capacitor; a multiple-element logic module with eight diodes and three resistors; and a multivibrator containing two triodes, two capacitors and six resistors. Multivibrator has a component density of 250,000 per cubic foot. Device has been operated at temperatures as high as 580C, and requires no internal heaters.

Bio-Electrogenesis in Rio de Janeiro, Dr. H. W. Lissmann of Cambridge University said that fish and eels recognize the nature of other objects by their varying electrical conductivity. Dr. Lissmann believes the changes in electric field are detected by pores in the skin of the fish or eel that lead through canals filled with a jelly-like substance to glandular sense organs, called "mormyromasts," which in turn connect to the brain.

► **Missile Detection Radars**—Both Hughes Aircraft and Bendix Radio are investigating new rapid-scan radar techniques for detection and tracking of ballistic missiles.

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

• **Collins Radio** reports orders for $1 million from Lockheed for communication and navigation equipment to be used on Lockheed JetStar business-jet aircraft. First 25 aircraft will use Collins equipment throughout, including integrated flight system, four 51X-2 VHF receivers, two 17L-7 VHF transmitters, two DF-202 automatic direction finders, two 51-V glide slope receivers, a 51Z-2 marker beacon receiver, two associated instrumentation units, an ATC transponder and antennas for all equipments. Deliveries will begin in October.

• **International Rectifier Corp.**, El Segundo, Calif., $500,000 in contracts from Lockheed Missiles and Space Division for silicon solar cells and panels.

FINANCIAL

Insurance Funds Go To General Dynamics

New York—General Dynamics Corp. carried out a major long-term financing program with the sale of $60 million of 20-year promissory notes to the Prudential Insurance Co. of America in the face of a tightening money market.

A similar loan involving $75 million completed a year ago provides the corporation with $135 million in long-term money. Combined with its short-term bank credit available of $150 million, the funds will meet General Dynamics capital needs for the foreseeable future, Board Chairman Frank Pace said.

The financing adds another notch in a gradually growing total of aviation industry companies which have successfully obtained funds from the relatively small amount of insurance company capital channeled to industrial sources (AW May 25, p. 23).

Interest rate on the new funds is 5¼%. It was set at 5.2% in the first borrowing. With prime bank short-term interest rates now at 5% (AW Sept. 14, p. 37), the long-term rates are considered very favorable by the company. No common stock dilution is involved as in the case of many recent public bond offerings by aviation companies and no underwriting expense was necessary.

The funds are needed for such development projects as the Convair 880 and 600 jet transports, the Canadair CL-44 turboprop transport and the attendant costs involved in such situations as the trade-in of American Airlines' DC-7 piston-engine aircraft on its order for Convair 600s.

New acquisitions which require straight cash outlays also will draw on the financing as will opportunities for new business gained in scientific research and development carried on by the company.

New Offerings

Radiant Lamp & Electronics Corp., Kearney, N. J., a newly organized company. Offering is $250,000 of 6% 10-year convertible debentures and 120,000 shares of Class A common stock at $5 per share; it is to be made by Amos Treat & Co., Inc., underwriting group, for the purpose of acquiring the business and certain of the assets of Radiant Lamp Corp., Newark, N. J., manufacturers of special purpose electric lamps. Purchase price is $1,000,000, with $600,000 payable in cash at the closing, and $400,000 payable at

the closing by delivery of $400,000 of 5% debentures to be issued by the new company. As part of the agreement, the new company will be permitted to occupy the premises now owned and occupied by the seller, pursuant to a 10-year lease at a rental of $20,000 per year, plus certain expenses.

Chance Vought Aircraft, Inc., Dallas, Tex., 57,354 shares of common stock, for issuance upon the exercise of options granted or to be granted under the company's Employe Stock Option Plan.

Radiation Dynamics, Inc., Westbury, N. Y., engaged in the development, production, manufacture and sale or rental of Dynamitron, a high energy accelerator. Offering is 25,000 shares of common stock. Subject to subscription of all the shares being offered to stockholders, Hayden, Stone & Co. has agreed to purchase 2,500 shares for its own account and to place 11,175 shares with selected investors at $10 per share, with warrants to purchase an equal number of shares at $12.50.

Hickok Electrical Instrument Co., Cleveland, Ohio, manufacturer of electrical indicating meters, electronic laboratory and service testing instruments, and other electronic equipment. Offering is $500,000 of convertible debentures and 100,000 shares of Class A common capital stock—90,000 shares to be offered to the public and 10,000 shares to employes. Proceeds will be used to retire bank loans; to construct and equip research and development laboratories, for additional equipment for a subsidiary, for leasehold improvements, etc., with the balance to be added to working capital.

Financial Briefs

• **Hycon Mfg. Co.** earned $305,195 and reported sales of $3,211,143 in the six months ended July 31. Of this net, $200,000 was from sale of 4,500 shares of Hermes Electronics Co. preferred stock owned by Hycon, the rest from sales. Last year for the same period, the profit was $46,000 on sales of $4,085,000. Hycon has progressed from a net operating loss of $505,000 in Fiscal 1958 and a net working capital deficit of $483,000 to the profit side of the picture and total working capital of $1,052,000 as of July 31.

• **Marquardt Corp.** sales will reach $70 million in 1959 and its earnings $1.8 million, the company president, Roy E. Marquardt, forecasts. Marquardt is working on high-energy fuels, a program which will continue despite cancellation of military boron programs,

Symbols painted on Radioplane XQ-4 drone show five recoveries from firing missions.

Radioplane Drone Recovered After Direct Hit

Radar-guided Radioplane XQ-4 drone was recovered successfully (below) after a direct hit by a Sidewinder air-to-air missile after the drone was air-launched by a Boeing B-50 bomber. XQ-4 is powered by a Westinghouse XJ-81-WE-3 turbojet engine, producing 1,740 lb. thrust; production Q4-B drone will be powered by a General Electric J85-5 turbojet which develops 3,850 lb. thrust with afterburner. Ringsail recovery parachute is located in the tail cone; vertical stabilizer separates during recovery.

and on a rocket-ramjet combination engine (AW Aug. 10, p. 30).

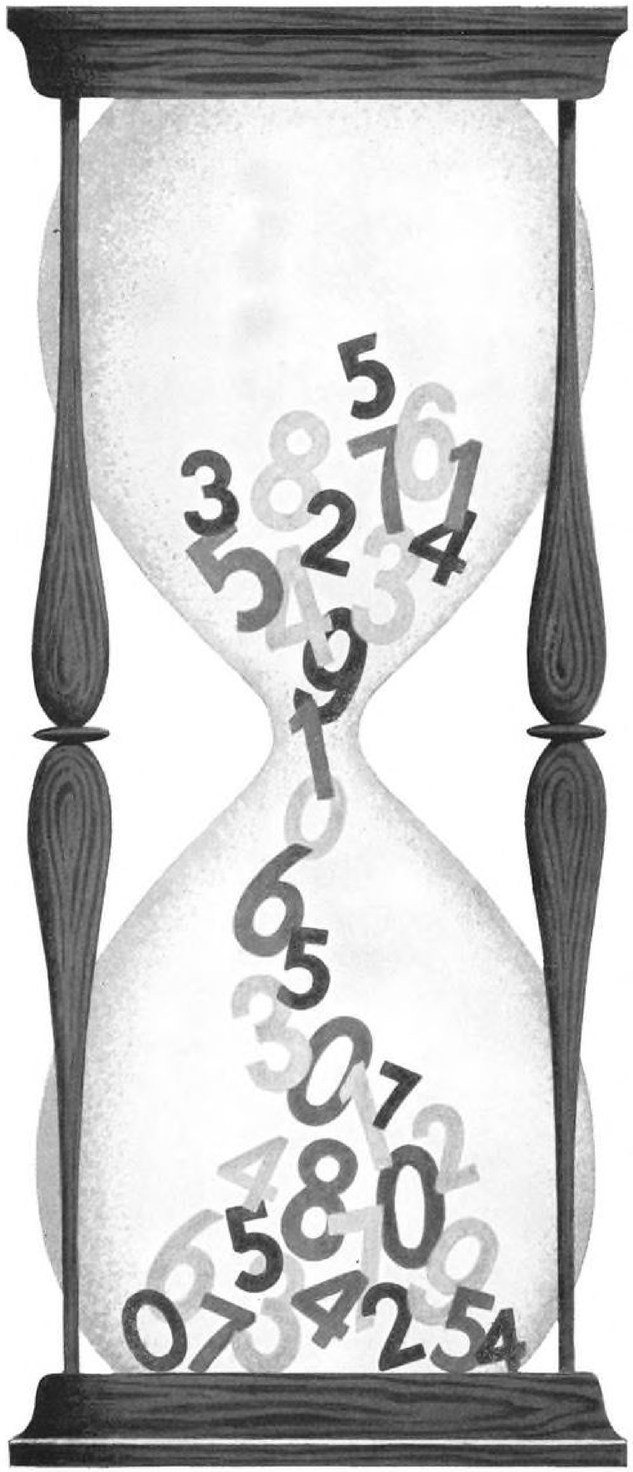
• **Doman Helicopters, Inc.** agreed to a consent injunction in connection with Securities and Exchange Commission complaint on the issuance of common stock of the company, largely to employes in payment for services, without registration under terms of the Securities Act of 1933. The SEC said 350,000 shares had been issued since Jan. 1 to 125 persons. Issuance itself would have required registration, the SEC said, but the situation was further complicated by the resale of the stock, quoted in the National Daily Quotation Sheets at prices from ⅞ to 1¼.

• **Kaman Aircraft Corp.** reported first half sales increased from $9,416,473 to $14,196,398 and earnings from $207,147 to $324,859. Deliveries of the USAF rescue helicopter, the H-43B Huskie, will accelerate in the next six months.

• **Raytheon Co.** sales in 1959 will approach half a billion dollars, $100 million more than 1958, Raytheon President Charles F. Adams reported. Backlog amounts to about $400 million.

• **Garrett Corp.** improved its working capital position in the fiscal year ended June 30, which also included increases in sales and earnings. Sales were $193,641,345, compared with $170,409,368. Earnings of $4,767,796, which compared with $4,118,707 a year earlier, represented a 2.46% profit margin on sales and a 13% margin on net worth. Current backlog of $114 million, compared with $120 million a year ago, is 74% military. The working capital increase, from $25,052,277 to $35,314,683, was obtained through sale of $10 million in convertible debentures last year, $9 million of which was used to reduce the company's V-Loan borrowings. Problems in debt management appearing increasingly in the industry are illustrated by the Garrett borrowings. After the debentures were used to reduce the V-Loans to $17 million in September, 1958, the company was required to increase borrowings against this line of credit to $30 million by April to carry larger receivable balances. By June, these loans had again been reduced to $25 million with a credit commitment of $35 million available. But Garrett's receivable account rose from $18,046,488 to $28,536,652.

• **Atlantic Research Corp.** has purchased Jansky & Bailey, Inc., 30-year-old communications research firm currently grossing $1.5 million annually, and has acquired a 16% stock interest in General Communications Co. in the transaction.



Three generations of ARMA computers:
THE PRESENT GENERATION

6,000
continuous hours of higher mathematics . . . without an error

The thinking apparatus of the guidance system of the **ATLAS ICBM**—ARMA's airborne digital computer—has now completed 6,000 hours of continuous laboratory operation without one catastrophic or transient error.

Fully transistorized, with no moving parts, this remarkable ARMA computer can be relied upon for dependable performance when the **ATLAS** becomes the nation's major deterrent weapon.

Two further generations of ARMA computers will be applicable to even more sophisticated uses. ARMA's advancement of the state of the art has made possible computers—soon forthcoming—that will surpass the present computer's reliability at a small fraction of its weight.

ARMA research and development has made the digital computer truly airborne. ARMA, Garden City, N. Y., a division of American Bosch Arma Corporation . . . the future is our business.

7264

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NEW AVIATION PRODUCTS

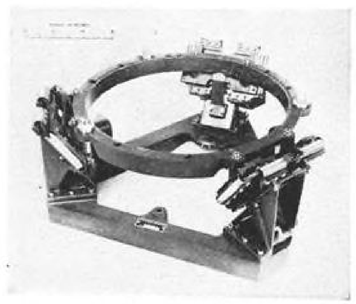
Titanium Bands Prevent Crack Propagation on DC-8

Titanium alloy (Ti-6A1-4V) bands are riveted at 18 in. intervals about the forward fuselage of the Douglas DC-8 to prevent crack propagation. The aircraft uses about 1,000 lb. of titanium chiefly in the "rip stopper" bands and on the engine pod access panels. Unalloyed titanium (Ti-75A) is used for the access panels which can withstand 2,000F temperatures for short periods.

Vibration Isolator

Suspension system for vibration isolation for gyros and other navigation equipment provides freedom for omni-directional rectilinear motion, but maintains high-stiffness constraint against rotation.

The mount assembly utilizes metal C-shaped springs to maintain the desired stiffness characteristics. System damping is provided by elastically supported unit dampers. Two configurations of the mount are in production and are incorporated in an aircraft navigation and bombing system. One mount has an angular returnability of 30 sec. of arc.



Allied Research Associates, Inc., 43 Leon St., Boston 15, Mass.

Portable Hoist

Hoist, capable of being operated electrically or manually, weighs 47 lb. and has a lifting capacity of 6,000 lb. The unit is applicable for portable ground handling or airborne use, according to the designers.

Hoist's anti-fouling mechanism, consisting of a spring shroud device covering the drum, prevents cable fouling and backlash. Power for the hoist is provided by a 3 phase, 400 cps., reversible a.c. motor enclosed within the cable drum. A modified version is supplied with a 24 v.d.c. or 60 cps. a.c. motor if desired. Planetary gearing is irreversible, eliminating the danger of

the load being involuntarily released when operated manually.

AirResearch Manufacturing Division, 9851 Sepulveda Blvd., Los Angeles, Calif.

Hydraulic Filter

Resin-impregnated cellulose elements are used to filter the Skydrol 500 hydraulic fluid on the Boeing 707 jet transport. Elements, used in both low and high pressure hydraulic circuits, are rated at 10 microns.

Micropleat filter element weighs 12 oz., total weight of the filter is less than 6.5 lb. The pressure drop through the filter is 10 psi. at a rated flow of 40 gpm.

Bendix Filter Division, 434 W. 12 Mile Rd., Madison Heights, Mich.

Non-Magnetic Space Battery

Silver-zinc battery powers two transmitters, a receiver, a magnetometer and other equipment in the Vanguard III earth satellite.

The HR 05 Silvercel battery, weighing 0.8 oz., delivers 15 amp. at peak pulse discharge. Expected life of the battery is approximately 90 days.

Yardney Electric Corp., 40-50 Leonard St., New York, N. Y.

WHAT'S NEW

Publications Received:

The Big X—by Hank Searls. Harper & Brothers, 49 E. 33rd Street, New York 16, N. Y. $3.50; 241 pp. Novel about the professional and personal life of a test pilot.

Target for Tomorrow—by Dr. I. M. Levitt. Fleet Publishing Corp., 70 E. 45 Street, New York 17, N. Y. $4.95; 319 pp. A book on space travel based on scientific fact. Analysis is made on the use of satellites, space stations, space suits, etc.

Prices of Used Commercial Aircraft 1959-1965—The Transportation Center, Northwestern University, Evanston, Illinois. $10.00; 111 pp. A research report of a one-year study of the prices of used commercial aircraft which will be displaced as the airlines of the world make the transition to turbine-powered fleets.

Basics of Missile Guidance and Space Techniques—Marvin Hobbs. John F. Rider Publisher, Inc., 116 W. 14th Street, New York 11, N. Y. Through the use of pictures the author tries to make the most complex subjects understandable. Vol. 1 covers the principles of control and guidance; Vol. 2 the satellite theory and practice, telemetering and space exploration by optics and electronics. Total of 304 pp. at $3.90 ea. paperbound, and $9.00 for the two in single cloth binding.

Squadron Histories—RFC, RNAS & RAF 1912-1959—Peter Lewis. Putnam & Company, Ltd., 42 Great Russell St., London, WC1. 30s (4.20); 208 pp. Details of operational squadrons and details of its movements, aircraft types and strengths, most memorable achievements and outstanding pilots. A complete and accurate chart of the RAF fighter squadron markings in color is also included.

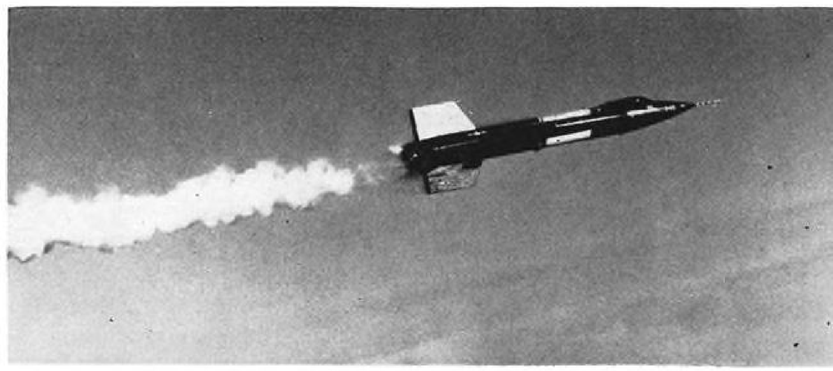
Sounding Rockets—Homer E. Newell, Jr. McGraw-Hill Book Co., Inc., 330 W. 42 Street, New York 36, N. Y. $12.50; 334 pp. Book on rocket theory, high altitude research results, individual rocket detail and launching procedures. The principal upper-air sounding rockets of the U. S., England, France and Japan are covered.

Illustrated Guide to U. S. Missiles & Rockets—Stanley Ulanoff. Doubleday & Co., Inc., 575 Madison Avenue, New York 22, N. Y. $3.95; 128 pp. Descriptions of more than 65 types of U. S. missiles and rockets.

First two chambers fire as X-15 drops away from Boeing B-52 mother ship 38,000 ft. over Edwards AFB at 255-kt. IAS. White area at top and bottom of the mid-fuselage is frost from liquid oxygen.

X-15 Exceeds Expectations on First Rocket Flight

Dual Reaction Motors XLR-11 rocket engines produced 10-15% greater acceleration than anticipated on the first powered flight of the North American X-15 (AW Sept. 21, p. 35), pushing the aircraft beyond the planned Mach 2 speed and 50,000-ft. altitude limits. At right, X-15 begins climb with all eight thrust chambers firing. Below, after burnout, the aircraft approaches Rogers Dry Lake for landing with vapor from venting hydrogen peroxide trailing behind. Bottom half of vertical stabilizer was parachute-recovered after jettison on final approach at about 1,500 ft. Aircraft, carrying full fuel load and weighing about 33,000 lb., flew under power for about 3.5 min.



Plastics Gain in Solid Rocket Uses

By Michael Yaffee

Atlantic City, N. J.—Developments in plastics technology promise improved performance in solid propellant rockets and significant weight reduction in airborne components of both aircraft and missiles.

At the 136th national meeting of the American Chemical Society here, chemists and engineers described their efforts in developing plastic rocket nozzles, plastic heat insulators for rocket motors, new polyurethane solid fuels, and lighter embedding systems for airborne electronic equipment.

F. T. Parr of Westinghouse told how the use of small, hollow, phenolic spheres reduces the weight of a typical embedded electronic circuit by 27%. Use of polyurethane foam, he said, will cut the original weight by 51%. But polyurethane's low thermal conductivity has restricted its use, so far, to embedding transistorized circuits where very little heat is generated. For circuits containing tubes and resistors, heat sinks would have to be designed into the package to take care of the heat these components generate.

Manufacturers of airborne electronic equipment have long been using plastic envelopes to protect their products against vibration, thermal shock, humidity, fungus and salt spray. The most popular formulation has been an epoxy resin with a silica filler to improve the resin's electrical and physical characteristics. The large amount of silica filler used, however, made the embedded circuitry rather heavy for airborne applications. When various kinds of small hollow spheres appeared on the market, the avionic manufacturers were quick to investigate them as possible substitutes for the silica.

Originally developed to cut evaporation losses on oil storage tanks, these spheres or microballoons had the lowest bulk density of any material available at the time. Westinghouse investigated four different kinds of microballoons, decided that the phenolic spheres were best on a weight basis. Thermal conductivity of the epoxy resin-phenolic microballoon filler embedding system was poorer than that of the epoxy-silica combination but not prohibitively so. Moreover, this particular combination showed the lowest stress index and least tendency for the filler to float of all the low density filler materials evaluated.

Phenolic plastics also showed up very well in Aerojet-General's investigations of materials for light weight, uncooled, solid propellant rocket nozzles. These tests, which are still going on, indicate, according to Aerojet's George Epstein and Harry King, that glass fiber-reinforced phenolic resins can be successfully used in nozzles if the designer takes into consideration dimensional changes due to ablation.

To test promising materials under realistic conditions, Aerojet researchers developed the SPAR (Structural Plastics Ablative Rocket) rocket motor which operates on gaseous hydrogen and gaseous oxygen and is designed for firing at controlled stagnation temperatures from 2,000 to 6,000F. Small test nozzles are fit directly into the aft end of the motor.

Resins Used

Aerojet used commercially available resins for the nozzles. Principal plastics used were heat-resistant phenolic, phenolic-silicone and amine-cured epoxy resins reinforced with chopped Refrasil fabric (a fiber produced by H. I. Thompson Fiber Glass Co. which contains 96-99% SiO_2) and a melamine-glass fabric laminate. As part of the over-all program, Aerojet also evaluated different reinforcements, fillers and protective coatings. Some important results of these tests, as noted by Epstein and King, are as follows:

- **Heat resistant phenolic** and phenolic-silicone resins are essentially equivalent in performance and both are substantially superior to the melamine and epoxy resins tested.
- **Refrasil,** which retained a comparatively high amount of carbonaceous or charred material, proved to be the best reinforcing agent, with Fiberglas, "E" glass, glass-copper, stainless steel screen, asbestos, brass screen and nylon following in order.
- **Nozzle life** appears to be inversely related to the thermal conductivity of the reinforcing agent. The better reinforcing agents, it is believed, form a protective surface layer which acts as a heat-absorptive thermal barrier.
- **Fabric reinforcements** are more promising than random fibrous materials.
- **Fibrous fillers** are preferable to non-fibrous fillers, probably owing to their influence in reinforcing the mechanical strength of the structure.
- **Reinforcements** laminated parallel to the gas flow tend to fail because of interlaminar stresses and successive peeling of reinforcement layers. Edge-grain reinforcements, which permit gaseous decomposition products to escape more easily without disrupting structural integrity, are more desirable.
- **Thin, sprayed, refractory** coatings investigated were detrimental to plastic nozzle performance. It was postulated that the heat conducted through the coatings caused the plastic to decompose with the generation of gases at the plastic-refractory interface. Because the gases could not escape through the relatively non-porous coating, the pressure built up to a point where it ruptured the coating.

One listener questioned Epstein and King's optimistic outlook on the use of plastic nozzles on the basis that the tests were run with a gaseous propellant and would not be valid for a solid propellant rocket which would throw solid particles into the exhaust. Avco, the listener said, had tried it with solid particles in the exhaust and had found that the ablation rate was much greater.

Another listener disagreed with the authors' low rating for the phenolic-impregnated nylon fabric nozzle. Results of work at General Electric indi-

Aluminum Trailer Carries Liquefied Gases

Up to 3,990 gal. of liquid oxygen or liquid nitrogen can be carried or stored in this all-aluminum semitrailer. Constructed like a Dewar flask, trailer consists of two aluminum shells, separated by a six-inch vacuum space filled with an expanded silica insulator. Evaporation loss is said to be 0.8% per day. Design and construction of six trailers was a joint project of Beech Aircraft Corp. and Kaiser Aluminum & Chemical Corp. for the National Cylinder Gas Division of Chemetron Corp.

cated a better performance for the nylon-phenolic type.

Epstein, who delivered the report, noted that more definitive work was now under way at Aerojet and, among other things, that the SPAR motor will be modified to permit the injection of solid particles into the exhaust stream.

Closely related to the use of plastics in rocket nozzles is the use of plastics as heat insulators in solid propellant rocket motors, which was discussed by Walter Hourt of Atlantic Research Corp. While plastics at first glance may appear to be the least promising candidates for a job where temperatures may range from 3,000 to 9,000F and pressures sometimes exceed 100 atmospheres, Hourt said, they are actually well suited to the task because of their ability to resist castastrophic destruction and ablate uniformly at rocket motor temperatures. This permits the rocket engineer to resolve his problem by allowing controlled destruction of the insulating material without actual breaching the insulation wall.

Not all plastics are good insulators. The answer, Hourt said, lies in a unique combination of properties which some reinforced plastics possess. Just what these properties are and which ones are most significant are questions that still haven't been answered completely. Enough results are now available to provide a basis for predicting the essential properties of plastic heat insulators. Among them are:

- **Plastic** must form a carbonaceous or other stable residue.
- **Char** should be hard and strong to resist erosion due to shear stresses and should be porous to allow transportation of the cool products of substrate decomposition.
- **Char** should form a framework for deposition of carbon from "cracking" reactions, and it should stay attached to the substrate materials.
- **Char** should be amorphous rather than graphitic, in order to provide minimum thermal conductivity.

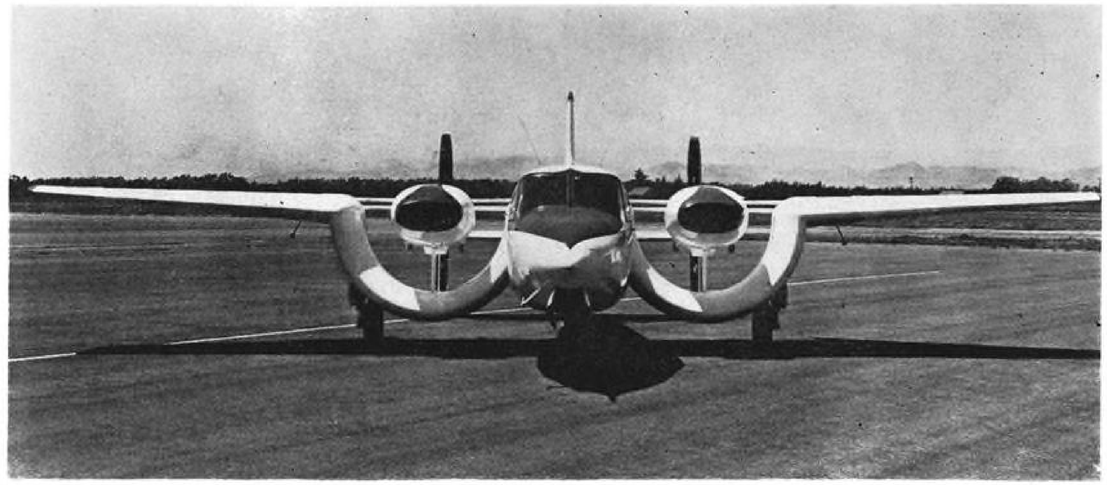
High yield, char-forming plastics, Hourt said, are usually highly crosslinked thermoset resins. Some examples are the phenolic, epoxy-anhydride, polytrivinylbenzene and polyacrylonitrile systems. On the other hand, melamine, urea-formaldehyde and the thermoplastic resins are generally low yield, char formers.

Warren Murbach and Arnold Adicoff of the Naval Ordnance Test Station reported on their group's search for better solid propellant polyurethane elastomers with good mechanical properties, particularly tensile strength and elongation. While this work is not yet finished, the NOTS scientists have found a promising polyurethane prepolymer which contains little or no unsaturation.

At present, propellant experts are able to prepare polyurethane polymers with good low temperature mechanical properties (namely, tensile strength and elongation) from a diisocyanate and polypropylene glycol. But commercial polypropylene glycol suffers from a small but significant amount of terminal unsaturation, according to Adicoff.

The unsaturated molecules act as chain stoppers in the reaction to form a long polyurethane polymer or chain, necessitating the use of large amounts of crosslinking agents to obtain a resin with good mechanical properties. They are also susceptible to oxidative degradation, and this may contribute to poor storage stability.

To solve this problem, NOTS has concentrated on the synthesis and characterization of new, liquid polymeric diols that could be used in place of polypropylene glycol. The group extensively investigated the copolymerization of ethylene oxide and tetrahydrofuran, initiated by boron trifluoride with ethylene glycol as the "co-catalyst" and from this obtained their promising prepolymer. The other part of the program at NOTS is preparation of soluble polyurethanes by reacting the new and other commercially available prepolymers with diisocyanates.



CCW-5 AIRCRAFT demonstrated by Custer Channel Wing Corp. is a Baumann Brigadier fitted with channel wings.

Channel Wing Flown in Demonstration

Washington—New plans for military and commercial application of the Custer channel wing CCW-5 aircraft were reported here last week by its designer, Willard R. Custer.

Following a demonstration flight of the CCW-5, Custer said the commercial channel wing aircraft will be built in Canada and Florida within eight months.

Air Force's Air Research and Development Command is scheduled to begin an evaluation of the aircraft within the next three to four months.

William Spence, president of Custer Channel Wing of Canada, Ltd., said recently that his firm is establishing a production line at Granby, Quebec, near Montreal, and plans to produce 40 of the CCW-5 channel wing aircraft within the next year. According to Spence, 120 firm orders have been received by his company, with an average deposit of $5,000 for the $55,000 aircraft. Spence said that funds available to the company from a variety of Canadian investors total $5 million.

Plans to use the channel wing in Florida are being made by American Airmotive Corp., of Miami, which specializes in aircraft and engine overhaul and modification. The first conversion to channel wing design by this firm is scheduled to be made on a C-46 transport. Flight demonstration of the conversion is planned for next spring, according to Charles E. Lewis, a member of the board of American Airmotive.

Lewis estimates that the channel wing will increase the C-46 cruise speed by 15 to 20%, the range by 5 to 12% and the payload by at least 45%.

One model of the CCW-5 to be built in Canada is flying and was demonstrated earlier this month to representatives of the three military services at the Marine Corps Base at Quantico, Va.

This six-year-old short takeoff and landing aircraft is essentially a five-place Baumann Brigadier with channel wings added.

During the demonstration at Quantico, it showed an ability to climb out of a field at an angle of more than 30 deg. after a ground roll of less than 200 ft. and at about 93% of its 5,000 lb. gross weight. Full stops were accomplished within the same distance on landings.

The flights were made with a strong wind coming in at 90 deg. to the runway, and it was apparent that considerable pilot skill is required to make maximum performance takeoffs. The nose has to be rotated upward at precisely the right moment or the high velocity air stream passing through the channel will bounce off of the ground and strike the bottom of the tail, forcing it up and the nose back down. If proper rotation is made, the horizontal

COMMERCIAL production of the CCW-5 will begin in Canada, according to Custer.

tail can get under the wash from the channel and will be held down.

The company pilot aborted one takeoff during the demonstration, apparently because he had waited too long to make his rotation.

Delivery of the CCW-5 to ARDC is scheduled to be made within the next 60 days after Custer has made a final propeller selection.

Upon delivery to ARDC, the aircraft will be instrumented by the National Aeronautics and Space Administration. Flight testing probably will be conducted at a civil field at Canton, Ohio. Results of the ARDC investigation will be made available to all three military services.

The channel wing idea originated with Willard Custer over 20 years ago. Interest in the unusual wing has been sporadic, and there have been sharp differences of opinion among aeronautical engineers as to its value. In 1953, the National Advisory Committee for Aeronautics evaluated a Piper Cub which Custer had fitted with channel wings (AW June 15, 1953, p. 23).

PRODUCTION BRIEFING

Hamilton Standard Division of United Aircraft, Windsor Locks, Conn., will develop and produce the temperature control systems for the Grumman A2F attack fighter and the North American T-39 jet utility transport. Temperature control system for the A2F regulates temperature in the cabin, electronics compartment, water separator for deicing, windshield defog and pilot's suit, while the T-39 requires only cabin temperature regulation.

Nuclear Products—Erco Division, ACF Industries, Inc., Riverdale. Md., will produce two additional flight simulators for the Republic F-105D fighter-bomber under $1.9 million USAF contract. The trainers will simulate the F-105D's complete mission capabilities, including the integrated automatic navigation radar, bombing and fire control and flight control systems.

Astro Metals Corp., Hawthorne, N. J., will study the feasibility of fabricating refractory metals into space vehicle components under $100,000 contract from the National Aeronautics and Space Administration. Metals to be studied under the contract include molybdenum, tungsten, columbium, niobium and beryllium.

North American Aviation has awarded B-70 and F-108 tool design and fabrication contracts totaling $3.5 million to Arrowsmith Tool and Die Corp.; Artcraft Engineering and Manufacturing Co.; Basic Tool Industries, Inc.; BMW Manufacturing Co.; Production Service Co. and Tool Research Co. North American Aviation will subcontract approximately half of the tooling effort in the B-70 and F-108 programs.

Radioplane Division of Northrop Corp. will supply the parachute escape and survival kit packs for the Convair F-106A all-weather interceptor. Initial order is for 134 packs, consisting of drogue parachute, main chute and one pilot survival kit.

Summers Gyroscope Co., Santa Monica, Calif., has received follow-on orders totaling over $525,000 from Beech Aircraft Corp. for flight control systems and parts for the Navy KDB-1 target aircraft. The target is used for surface-to-air and air-to-air weapon systems evaluation and training.

Firewel Co., Buffalo, N. Y., a subsidiary of Aro Equipment Corp., will develop and produce the liquid oxygen breathing system for both the North American B-70 Mach 3 bomber and the F-108 interceptor. Contract includes development of a liquid oxygen converter system, pilot's personal breathing equipment, supporting gaseous oxygen equipment and capsule pressurization.

PIAGGIO P.166 has a range of 1,155 stat. mi., with 30 min. fuel reserve. Cruising speed runs to 208 mph. Gross weight is 8,100 lb.

Aviation Week Pilot Report:

Piaggio P.116 Twin Shows Good Stability

By Robert I. Stanfield

Finale Ligure, Italy—Piaggio's P.166 six to eight place twin-engine executive transport, almost identical in appearance to the company's P.136 Royal Gull amphibian from which it was derived, is roomy, comfortable and stable—a good instrument airplane in the 200-mph. long-range cruise category.

Built in the Finale Ligure plant of Piaggio & Co., Societa per Azioni, Genoa, the P.166—the prototype of which was first flown in September, 1957—is assembled to U.S. standards with U.S. components and marketed in the United States by the Trecker Aircraft Corp., Milwaukee, Wis.

Cost of equipped airplane in the United States approximates $114,500. The Trecker prices for the basic airplane start at $104,490 for the six-place model and run to $105,860 for the 10-place (high-density) version. Costs of basic aircraft do not include exterior paint, interior upholstery and trim, buffet and lavatory.

The airplane incorporates the same gull wing, horizontal tail, gear and pusher powerplant installation of the P.136 Royal Gull amphibian, also marketed by Trecker and first evaluated by AVIATION WEEK two years ago (AW Sept. 10, 1957, p. 123).

Engines are two supercharged, horizontally opposed, six-cylinder Lycoming GSO-480-B1C6s developing 340 hp. each at 3,400 rpm. at sea level. Propellers are three-bladed, metal, constant-speed Hartzells with diameter of 93.6 in. For European sales Piaggio offers its own propeller.

P.166 incorporates the same gull wing, horizontal tail, landing gear and pusher powerplant installation of the P.136 Royal Gull amphibian.

P.166 Characteristics

Features evidenced by AVIATION WEEK during a flight evaluation at Piaggio's Villanova d'Albenga airport include:

• **Takeoff and climb.** Grossing about 7,040 lb., and into a 40-deg. crosswind of 8 kt. with outside air temperature 26C, the P.166—with 25 deg. flaps lowered and brakes held until throttles were fully advanced—was pulled off after a roll of but 600 ft. Rate of climb averaged 1,200 fpm. up to 10,000 ft. Engines deliver maximum continuous power of 320 hp. each at 3,200 rpm., which holds constant up to 10,800 ft. altitude.

• **Comfort and noise level.** The P.166 is comfortable and roomy, both from the standpoint of pilot and passenger. Its accommodations include lavatory and galley. Cabin, large for this class of airplane, has a width of 5 ft. 1¾ in., a height of 5 ft. 9¾ in. Volume is 300.2 cu. ft. Vibration during climb and cruise is at a minimum and, with pusher engines located high and to the rear, the airplane is relatively quiet.

• **Cruise speeds.** At 8,000 ft., outside air temperature 8C, the P.166 indicated 168 mph. with engines turning 2,800 rpm. at 38 in. manifold pressure. True airspeed was 193 mph. At 32 in. and 2,800 rpm. the airplane indicated 158 mph. for a true airspeed of 181 mph. Reducing propellers to 2,600 rpm., airspeed indicated 155 mph. (177 mph. TAS). Specifications call for maximum speed of 226 mph. at 11,000 ft. and a cruise speed with 70% METO (maximum except takeoff-power) of 208 mph. at 12,800 ft.

• **Stalls and single-engine.** At 8,000 ft., pulling 12 in., the airplane stalled "clean" at 70 mph. and "dirty" (gear and full flaps) at 60 mph. indicated. Stall characteristics are docile, with light buffeting and Safe Flight stall warning preceding the "break." With the left engine feathered, right engine to 42.5 in. and 3,200 rpm., the airplane indicated 135 mph. Slight aileron application holds directional control. Lateral control was good during banks.

The P.166 is an attractive looking airplane, not unlike an amphibian in appearance. In addition to its executive transport capabilities it may be used as an all-cargo, ambulance or aerial survey airplane. For short-stage shuttle service, with two extra seats installed in the utility compartment (of 76.7 cu. ft. volume), the seating may be increased to 9-10 units.

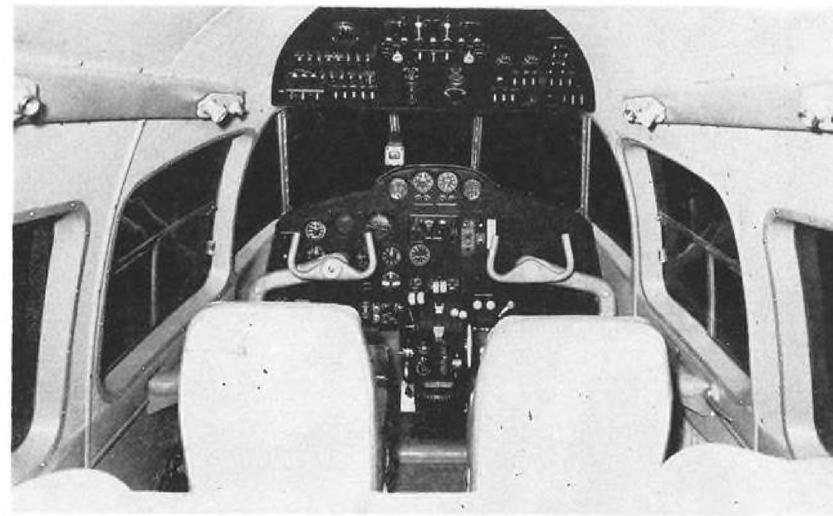
The demonstrator flown by AVIATION WEEK, first prototype, owned by Piaggio, was number I-PIAK. Goodrich deicer boots covered the leading edges of the wings and horizontal and vertical stabilizers. Engines are installed on the rear section of nacelles placed on the top surface of each outer wing, and are mounted on rubber bushings aimed at absorbing vibrations.

Fuel is supplied from four rubberized, bladder-type cells, one placed in the central section of each wing between oil reservoir and aileron push-pull rod, the other placed in the spindle-shaped nacelle at the wing tip. Refueling is via separate filler caps located on top of each tank.

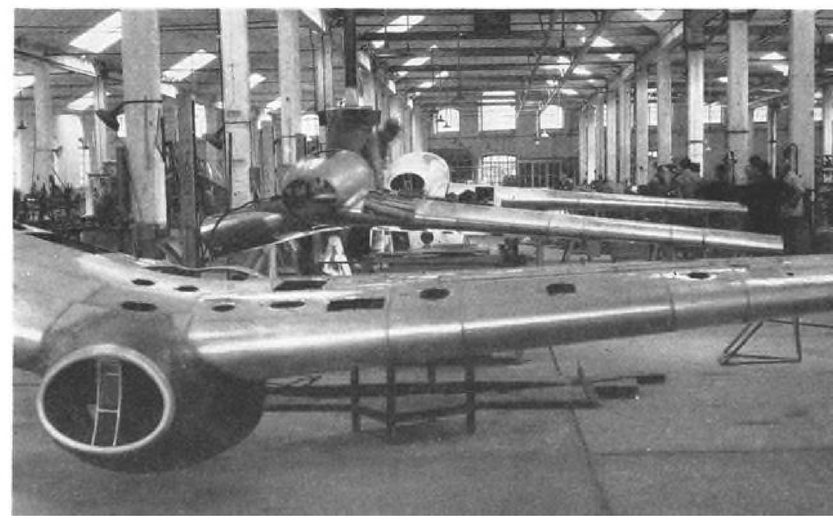
Each wing tip tank has a capacity of 59.5 gal.; each main fuel tank has a 56.5-gal. capacity. Total fuel—232 gal.—allows a range of 1,155 mi. at 15,000 ft., with 30 min. reserve, at 50% METO power.

Split flaps, formed by two outer and

EXTERIOR VIEW of the P.166 fuselage points up aircraft's similarity to the amphibious P.136, from which it was derived. Structure is semi-monocoque, without longerons. Aluminum coated, flush-riveted light alloy skin is used throughout.



COCKPIT of the P.166, with control pedestal located between pilots' seats. Right-hand control column is easily removable. Gull wing (below) is built in two sections and bolted to the fuselage. Washout adds to efficient stall characteristics.



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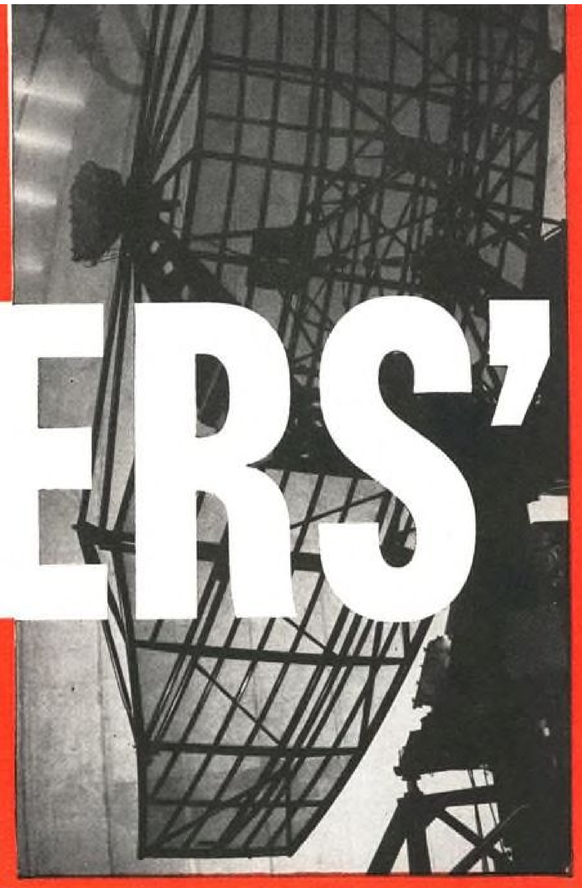

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Aviation Week
Including **Space Technology**

INTERIOR of the P.166 looking toward cockpit. Note window, pilots' door cutouts.

AIRPLANE'S luggage compartment is of 63.6 cu. ft. capacity; takes 300 lb. of cargo.

two inner parts, can be extended in increments down to 45 deg. maximum. Flap area is 29.6 sq. ft. With the aircraft fully loaded, full flaps will lower power-off stalling speed about 10 mph. Maximum airspeed for full extension is 130 mph. Between 130-150 mph., extension to 20 deg. is authorized.

Tricycle gear is hydraulically operated. When retracted, the nose wheel breaks the fuselage bottom streamline, projecting down about 4 in. With the main wheels retracted, only the fuselage sidewalls are closed by proper doors. Wheel outer sides are visible, the wheels being seated by inner face in wells provided in the fuselage side area adjacent to the wing-root bottom.

Passenger entrance to the tastefully furnished P.166 is via left-side cabin door, ahead of the wing leading edge. The door is 26 in. wide x 53 in. high. The pilots' door, located on the right side, forward, is 25 in. wide x 42 in. high. It can also be used as a passenger emergency exit.

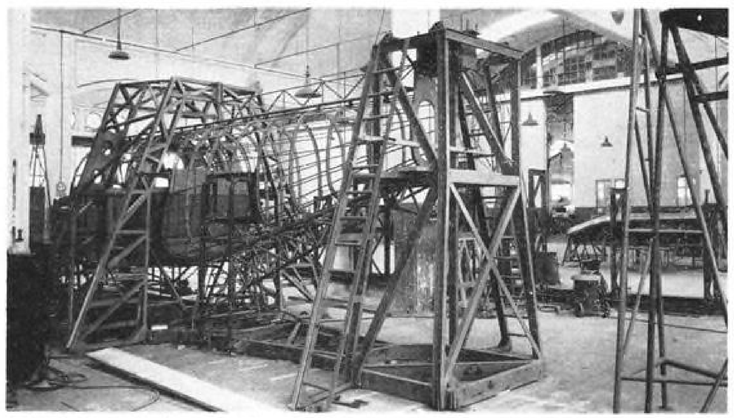
Two collapsible desks—concealed when collapsed—are installed in the passenger compartment, one in the fuselage right side and the other on the passenger door. Oxygen outlets, lighting, ventilation and heating points are provided for each passenger.

Aft of the walk-around passenger compartment is the lavatory, of 50-cu.-ft. volume. Part of this area is partitioned off for use as a buffet. Behind the lavatory is a cloakroom (or front cargo room) of 23 cu. ft. The rear cargo compartment, only reached when the airplane is on the ground, is of 63.6 cu. ft. capacity and takes 300 lb. of luggage. It is accessible through a door 35 in. high by 20 in. wide, aft of the cabin door.

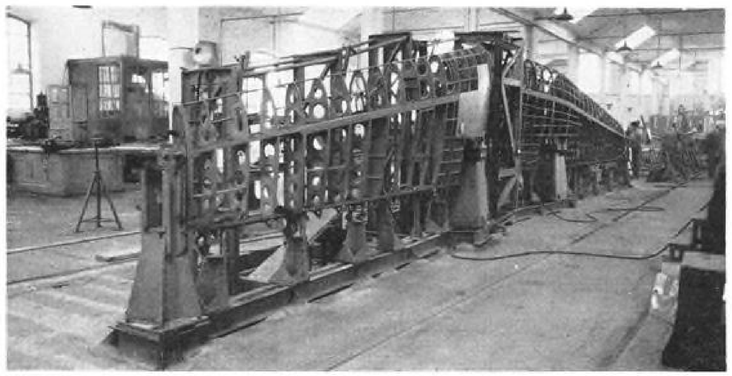
The cockpit floor sits on a higher level than the passenger floor. Large windshield area and side windows afford good visibility. Pilots' seats may be adjusted fore and aft; levers also regulate seat-back tilt. Controls are dual, with the right-hand column easily removable.

The control pedestal, located between the pilots' seats, contains engine control levers, gear-flap controls, friction lock, and manually operated control wheels for rudder, elevator and aileron trim (latter item is optional and was not included in the demonstrator).

Flight instruments are located to the left and right, and engine instruments centered, on the main panel. Equipment in the demonstrator included Safe Flight speed control, 12-channel



CONSTRUCTION of the P.166 at Piaggio's Finale Ligure, Italy, plant. Note location of baggage compartment door. Tailplane is bolted above top line of fuselage.



RUGGED wing construction incorporates original amphibian design. Separation of fuel tanks tends to relieve bending stresses. Assembly is to U. S. standards.

VHF, Lear ADF, and omni. Circuit breakers, switches for battery and generator, lights (navigation, landing and Grimes "eyebrow" individual instrument lighting) and fuel selector are located on an overhead panel.

Both engines fired up quickly and, turning 700 rpm., the airplane was taxied to runup position. Placement of engines minimized ground noise and we didn't have to shout during the taxi run. The nose wheel is linked to the rudder pedals and with wheel travel 13 deg. left or right the airplane can maneuver with 85 ft. minimum radius.

Along with this AVIATION WEEK pilot was Piaggio chief test pilot Aldo Gasperi and two passengers. Takeoff weight, with fuel in main tanks only and some test equipment aboard, was about 7,040 lb. Field elevation of Villanova d'Albenga is 140 ft. Outside air temperature was 26C. Sea level pressure was 30.12 in. Wind was from 60 deg. at 8 kt. The airplane was moved into position on Runway 10, which is 3,500 ft. long and faces the bordering Mediterranean Sea.

Before rolling, 25 deg. of flaps were dropped (maximum for takeoff), nose-down trim of 6 deg. set, and engines run up to 48 in. manifold pressure and 3,400 rpm., while the brakes were held. With brakes released the P.166 moved fast and at 80 mph., after rolling about 600 ft., the airplane was yanked off. For short takeoff at maximum gross weight, installation is provided for two JATO (jet-assisted takeoff) rocket units which would project from the fuselage bottom skin under the rear cargo hold.

With gear up and power reduced to 44 in. and 3,200 rpm., flaps were retracted with no sink. At 500 ft., ascending, the P.166 indicated 120 mph. Climb angle was shallow, visibility good, and initial rate of climb 1,000 fpm.—a medium rate, due to the shallow climb angle.

Holding this power setting, the aircraft was climbed to 10,000 ft. Controls were light, yet firm, and the P.166 was quickly trimmed for hands-off ascent. Noise level remained good during climb. At 5,000 ft. rate of climb was 1,200 fpm., which held until the airplane was leveled off. Two-engine service ceiling of the P.166 is 27,500 ft. With one engine inoperative the ceiling is 13,500 ft.

The airplane was flown through a series of varied banks, with little difficulty in holding altitude and rate of turn. Controls take little effort to operate; stability of this airplane is good and precision flying is easy. From the working level, the P.166 would be comfortable over long haul.

Working down to 8,000 ft., where the airplane was again leveled off, varied power settings were applied which generated the earlier-mentioned cruise speeds. In addition, at settings of 32 in. and 2,600 rpm., the airplane indicated 155 mph.; at 25 in. and 2,400 rpm., 135 mph. Respective true airspeeds were 178 mph. and 155 mph. Maximum TAS at 10,000 ft., pulling 43 in. and 3,200 rpm., is 220 mph.

Efficient stall characteristics of the P.166 stem from its wing incidence,

P.166 Specifications

Span	46 ft. 9 in.
Length	38 ft. ¾ in.
Height	16 ft. 4¾ in.
Wing area (including ailerons and flaps)	285.9 sq. ft.
Wing loading	27 lb./sq. ft.
Power loading	11.3 lb./hp.
Track	8 ft. 8¾ in.
Mean aerodynamic chord	77.126 in.
Aspect ratio	7.65
Aileron Area	21.3 sq. ft.
Flap area	29.6 sq. ft.
Stabilizer area	37.1 sq. ft.
Elevator area	27.7 sq. ft.
Tail fin area	17.5 sq. ft.
Rudder area	13.2 sq. ft.
Transverse wing dihedral (fuselage to nacelle)	21 deg. 30 min.
Transverse wing dihedral (nacelle to wing tip)	2 deg. 8 min.
Cabin:	
Length	11 ft. 7¾ in.
Width	5 ft. 1¾ in.
Height	5 ft. 9¼ in.
Volume	300.2 cu. ft.
Door size	52¾ in. by 26 in.
Luggage compartment volume	63.6 cu. ft.
Utility compartment volume	76.7 cu. ft.
Equipped empty weight	5,104 lb.
Maximum useful load	2,996 lb.
Gross weight	7,716 lb.
Maximum gross weight	8,100 lb.
Fuel capacity	232 gal.
Oil capacity (useful)	18 qt.

Engines: Two Lycoming supercharged, six-cylinder (horizontally opposed) GSO-480-B1C6s developing 340 hp. each at 3,400 rpm. and 48 in. manifold pressure at sea level.

Propellers: Two three-bladed, metal, constant speed Hartzell with diameter of 93.6 in. Governor is Woodward, CSSA.

P.166 Performance*

Maximum speed (normal rated power, 11,000 ft.)	226 mph.
Cruise speed (70% METO power, 12,800 ft.)	208 mph.
Cruise speed (55% METO power, 15,000 ft.)	188 mph.
Stall speed, flaps and gear down	68 mph.
Stall speed, clean	78 mph.
Rate of climb, sea level, two engines	1,305 fpm.
Rate of climb, sea level, one engine inoperative	263 fpm.
Service ceiling, two engines	27,500 ft.
Service ceiling, one engine inoperative	13,500 ft.
Takeoff distance (over 50 ft. obstacle)	1,550 ft.
Landing distance (over 50 ft. obstacle)	1,312 ft.
Range, 30-min. reserve, 15,000 ft., 50% METO power (six-place)	1,155 mi.
Range, 30-min. reserve, 15,000 ft., 50% METO power (eight-place)	705 mi.

* (Based on a gross weight of 7,716 lb. and standard atmospheric conditions. Alternate gross weight is 8,100 lb.)

which is 3 deg. constant from rib No. 1 to No. 8. From No. 8 to the wing tip, incidence decreases gradually due to wing warping to attain 1 deg. at No. 25 rib.

The airplane was quite docile during the stalls described earlier, at 70 mph. "clean" and 60 mph. "dirty," the nose dropping straight ahead in each instance. Recovery is rapid, the nose coming up with increase in speed. Lateral stability is good.

Angular travel of the P.166 control surfaces is as follows: ailerons, 25 deg. up, 19 deg. down; elevator, 30 deg. up, 16, deg. down; rudder, 27 deg. left and right. Elevator trim tab travels 20 deg. upward and downward; rudder trim tab runs 21 deg. left and right.

Single-Engine Performance

The left engine was feathered at 7,500 ft. and the right engine advanced to 42.5 in. and 3,200 rpm. At this power setting the airplane indicated 135 mph. and directional control was held with aileron. With 7 deg. of rudder trim cranked in, the P.166 flew straight and level by itself. Airplane was banked up to 45 deg., left and right, control and stability remaining good.

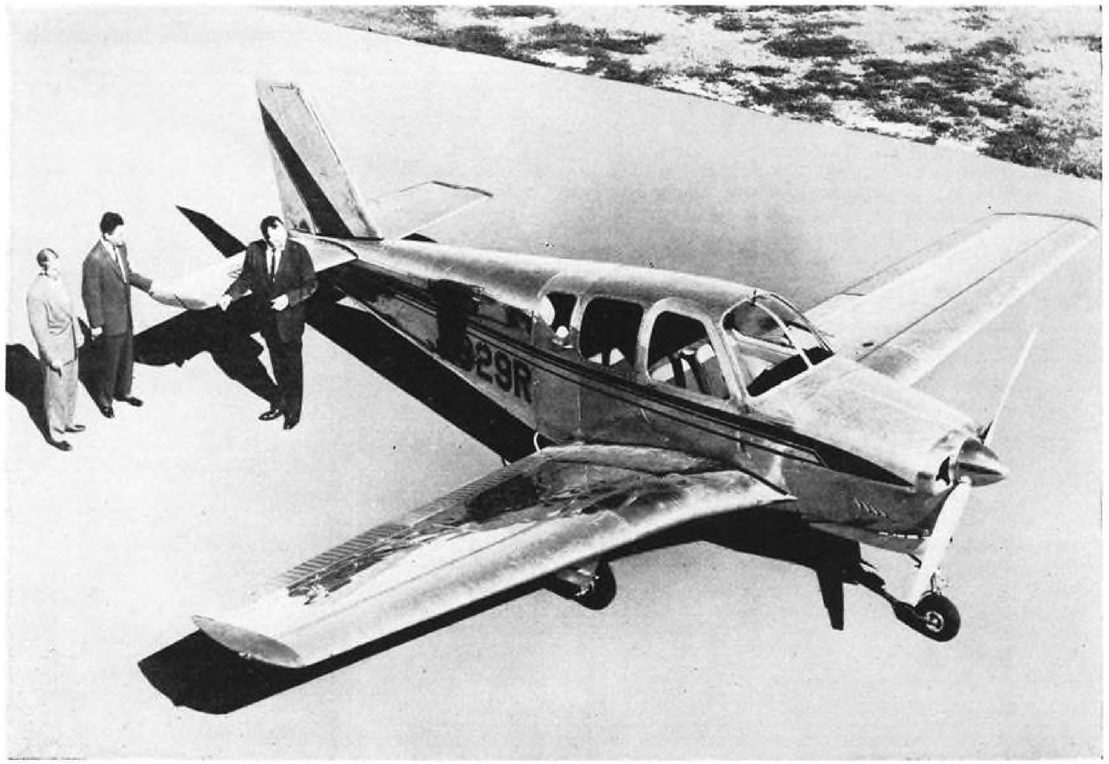
Demonstrator airspeed was redlined at 225 mph. Prior to normal descent, with left engine brought back in, test pilot Gasperi took the wheel to demonstrate the ruggedness of the P.166.

Power on both engines was set to 38 in. manifold pressure and 2,700 rpm. At this setting the airplane was abruptly nosed down until the airspeed crept past redline and indicated 230 mph. Rate of descent moved to 5,000 fpm. Gasperi smiled broadly and pointed to both these instruments, following which a normal descent was initiated at 15 in. and 2,500 rpm. Speed fell off to 170 mph.; rate of descent to 1,500 fpm.

Rectangular pattern speeds in the P.166 run to 130 mph. with 10 deg. of flaps on downwind; 120 mph. on base.

Spraying Gear Designed for HU-12E

Crop spraying equipment for the Hiller HU-12E has been developed by the Agricultural Aviation Engineering Co. (AGAVENCO) which features lightweight tanks with 150 gal. total capacity. Equipment is mounted for easy removal by use of quick release pins. Spray booms are foldable for over-the-road transport. Spray pump, built by Picknell and Associates, is belt driven from an engine driven power-takeoff arrangement. Present equipment is designed to be compatible with new boom type dry dispersal equipment under development at AGAVENCO.



First Photo of Beech Four-Place Model 33

Highlight of Beech dealers' and distributors' meeting in mid-November will be first showing of four-place business plane in the "$20,000 price category" aimed at providing the company's sales force with a product competitive with Piper's Comanche and Cessna's new 210 (AW July 6, p. 31). Also significant: The Model 33 will enable Beech to broaden its sales outlet structure by making it possible for more dealers to enter the organization due to the airplane's price, and heightening competition with other manufacturers. Primary external feature of the Beech 33 is the swept vertical tail, which distinguishes it from the Bonanza. Indications are that lower price (current standard Bonanza K35 lists at approximately $25,300) of the Model 33 was attained by using a considerable amount of Model 35 tooling and by deleting many of the other airplane's more luxurious features, such as plush interiors and multi-color paint schemes. Powerplant is a 225-hp. Continental IO-470-J fuel-injection engine. Model 33 is scheduled to fly later this month; is expected to be certificated in time for showing to dealers and delivery hauls begin soon after the showing.

with appropriate flap extension; and 110 mph. on final approach, with 40 deg. of flaps best for power-on, short-field landing (30 deg. of flaps for normal landing).

The short-field approach was used, with engines turning 3,000 rpm. The airplane was indicating 90 mph. over the fence and touched down about 78 mph. Full stop was made after a roll of about 700 ft.

All utilization circuits of the airplane's electrical equipment are fed through a bus-bar by two 28-v., 75 amp.-hr., parallel connected, engine-driven generators and by two 12-v., 33 amp.-hr., five-hour charge batteries connected in series and located over the nose gear wheel well. Both nose and main gears are provided with hydropneumatic type Magnaghi shock absorbers and Goodyear wheels, tires and single-disk brakes. Emergency extension is through a hand hydraulic pump.

Hydraulic system is composed of a pressure feeding set which supplies landing gear, nose-wheel steering, flaps, brakes, and nose-wheel unlocking circuit. Cabin ventilation is via two systems. The first provides (via a South Wind 35,000 Btu. heater), both on the ground and during flight, for circulation of temperature-controlled hot or cold air which cannot be recirculated in the heater system. The second, operative only in flight, feeds cold air through six hand-adjustable inlets feeding to pilots and passengers.

Six-station oxygen system is optional. A 63 cu. ft. high-pressure cylinder would be installed under the left-hand wheel well structure. The aircraft's windshield wiper is electrically operated. Weather radar can be installed in the nose.

To date Piaggio has had 12 firm orders for the P.166. Six of these have been from Trecker, to which three aircraft have been delivered. The remaining six orders are divided as follows: one to Switzerland, one to New Guinea, two to Germany and two to England. Average European price of the basic (standard) airplane is about $80,000. Price does not include radio, navigation and de-icing equipment, autopilot, weather radar and oxygen equipment. It does include the lavatory and buffet.

Foreign marketing organizations, in addition to Trecker, include Australian Bristol Aviation and, in England, Aero-Enterprises, Ltd. Piaggio itself services Italy. Deliveries follow orders by two-three months, AVIATION WEEK was told. Four aircraft per month are produced at the Finale Ligure plant. The rate would jump with an increase in orders.

During the AVIATION WEEK visit aircraft numbers seven, eight and nine were on the line at the Finale Ligure plant. These have since moved to England, the U.S. (Trecker) and to New Guinea, respectively.

Deliveries to Milwaukee average 20-

25 days en route. Aircraft are shipped complete to Trecker for assembly and painting, minus engines and propellers, wheels, tires and instruments. All fittings are geared for easy installation and tagged both in Italian and English (Piaggio also has a technician at the Trecker plant).

First delivery of a P.166 demonstrator to the United States was in December, 1958. Trecker's first sale was to Drilling Tools, Inc., of Houston, Tex. (AW May 4, p. 167). The second is earmarked for a Long Beach, Calif., company.

Piaggio's Finale Ligure plant has a total area of 581,260 sq. ft., of which 441,320 sq. ft. is covered. In addition to the P.166 and P.136-L amphibian, the company produces the P.148 primary trainer, the P.150 advanced trainer, the P.149-D training-liaison aircraft which is being reproduced in West Germany, and constructs under license Lycoming 190 hp. and 260 hp. piston engines.

Company also produces its own all-metal, constant-speed propellers for medium-power engines, including one model fitted with an elastic coupling and intended for installation on engines with no dampers, ranging up to 220 hp.

PRIVATE LINES

Production of Aerocar I flying automobile is dependent upon receipt of deposits for $1,000 covering 100 orders, the Longview, Wash., manufacturer reports. Plan is to put deposits in escrow, payable to Aerocar on delivery, which could begin by October, 1960. If delivery dates are not met, deposit would be returned to customer with 4% interest. Payment plan provides for payment of balance over 36 months. Guaranteed price, at the factory, is $9,500. Aircraft has been fully approved by Federal Aviation Agency.

Electronic Equipment Engineering, Inc., Dallas, Tex., acquired full control of Pan-Air Electronics Corp., Burbank, Calif. Both firms specialize in design, engineering and manufacturing of complete electronics packages for aircraft. EEE has current backlog of over $400,000; Pan-Air has contracts for DC-8 from Douglas and KLM for approximately $190,000. Parent firm recently moved into new 8,000-sq.-ft. facility, four times larger than previous plant.

New York State Department of Commerce will purchase a four-place light twin to replace it's single engine aircraft which was wrecked in an accident recently at Clyde-Lyons Airport, N. Y. Type of aircraft the Department will acquire was not disclosed.

WHO'S WHERE

(*Continued from page 23*)

Changes

Norair Division of Northrop Corp., Hawthorne, Calif., has made the following appointments in the Division's Astro Systems and Research Laboratory: **Dr. Elliott T. Benedikt**, head of the Astro Science Laboratory for Astrodynamics and Theoretical Physics; **Dr. Robert G. Lindberg**, head of the Astro Science Laboratory for Bio-Astronautics.

Richard W. Harbison, assistant to the executive vice president, Lear, Inc., Santa Monica, Calif.

George W. Weiler, chief electronic engineer, Bendix Products Division-Missiles, Bendix Aviation Corp., Mishawaka, Ind. Also: **Lathan E. Baker**, chief inspector, and **Bert F. Prentiss**, assistant chief inspector.

Dr. Peter D. Shroff, manager-product engineering, Narmco Resins and Coatings Co., Costa Mesa, Calif.

T. E. Beresford, assistant to the vice president-engineering, Radioplane, a division of Northrop Corp., Van Nuys, Calif. **W. H. Freeman** succeeds Mr. Beresford as chief of the Paradynamics Group.

Theodore F. Eserkaln, chief engineer, Onsrud Machine Works, Inc., Niles, Ill.

Simmonds Aerocessories, Inc., Tarrytown, N. Y., has announced the following appointments: **Alex Hossack**, chief engineer, Product Engineering Division; **Eugene Caputo**, East Coast regional manager, Contracts and Service Division; **Harvey Senft**, applications engineering manager-fuel metering; **Robert W. Richardson**, field engineer in charge of the company's Detroit office; **Baird W. Hodgkinson**, staff assistant.

William B. Rieke, assistant general manager, Georgia Division, Lockheed Aircraft Corp., Marietta, Ga. Also: **Robert I Mitchell**, director of sales and **T. R. May**, sales manager.

Donald L. Brown, Jr., assistant purchasing manager, P&W Aircraft, a division of United Aircraft Corp., East Hartford, Conn.

Werner G. Holzbock, assistant manager, Instrumentation and Controls Systems Laboratory, Sanders Associates, Inc., Nashua.

Dr. Martin Schilling, assistant for program planning, Raytheon Co., Waltham, Mass. Also: **Thomas L. Phillips**, assistant manager, Raytheon's Missile Systems Division.

Harold A. Cheilek, assistant tehnical director, Cornell Aeronautical Laboratory, Buffalo, N. Y.

Charles J. Schmidt, director, Radiation Laboratory, Research and Development Division, The W. L. Maxson Corp., New York, N. Y.

J. P. Fosness, assistant to the general manager and in charge of the A3J program, North American Aviation's Columbus, Ohio, Division.

Robert Geiger, project development manager, Aircraft Division, Twin Coach Co., Buffalo, N. Y.

Fred A. Klemach, missile systems manager, Vickers, Inc., Detroit, Mich.

S. Michael Treman, manager of design and technical engineering, Missile Systems Division, Republic Aviation Corp., Farmingdale, N. Y.

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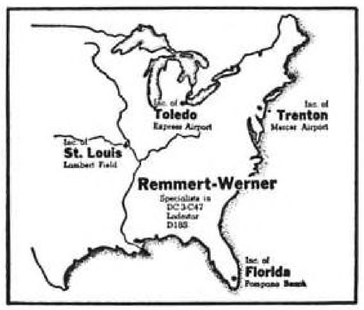

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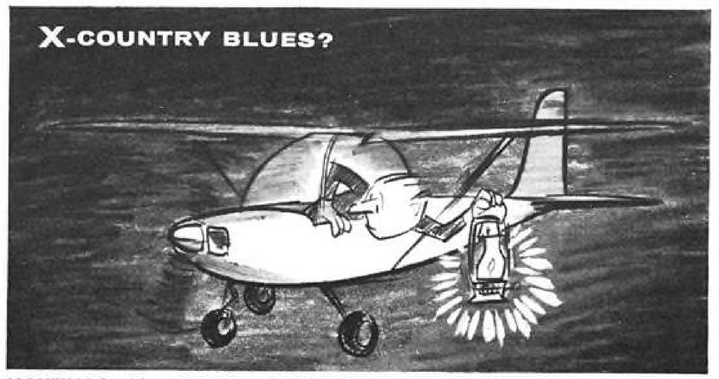

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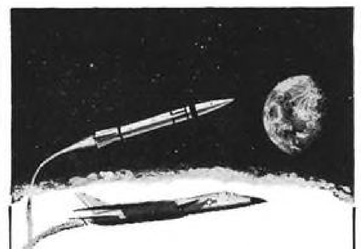

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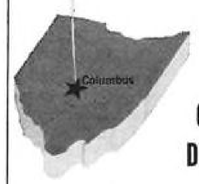

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LETTERS

Pentagon Censorship

I am not a writer of fan letters.

However, I have been impressed week after week—as a newsman-turned-advertising man—with the quality of the editorial coverage in AVIATION WEEK. And, most specifically, I have been impressed with the solid common sense of your editorials. Thus I think it's worth a fan letter.

Your editorial of Sept. 7, "More Pentagon Censorship," is just the sort of thing many of our federal bureaucrats need to return their perspective. I have no doubt that Murray Snyder will pointedly ignore your advice. But, then, he always has ignored the advice of anyone who does not believe that "What the people don't know won't hurt them."

Keep fighting. There are few others who will.

F. T. VAN DYK
390 Riverside Drive
New York, N. Y.

P. S. My advertising clients think as highly of AVIATION WEEK as I do.

Missile Photos

The recent two-part article describing the Atlantic Missile Range (AW Aug. 24, p. 52 and Aug. 31, p. 54) was studied with great interest. It is most enlightening, particularly to the person who has been to the Cape.

Relative to utilization of this sort of reporting in engineering work, I might cite an incident. All summer I gleaned issues of AW, M&R, etc., in hopes that a photo of the revamped Atlas service tower would be forthcoming. In an advanced design study of a manned system it was important that we know how well our design would fit into the existing launch pad facility. We wanted to know what provisions had been added for Mercury. I finally resorted to sketching the launch pad from a description given over the telephone by the Atlas test manager. M&R finally came through with a partially obliterated view used in an advertisement which revealed that our rendering was not entirely accurate.

AW in the past two years has released a profusion of eye catching and informative photos of missile systems. In fact, AW missile reporting far exceeds any other publication that I know of. In order to confirm the statement just made, I checked through my file folders of accumulated clippings (such data is indispensable to the engineer contributing to advanced design concepts).

Now to comment on some missile system photos from the press used for internal purposes here. Note that most of them are from AW. Among the enclosures, Fig. 6 is considered by many of us to be a classic. From it we prepared a rendering of the Atlas complex updating the hardware shown for use in a recent proposal report. Fig. 12 serves adequately to illustrate in a single photo the Titan complex. Fig. 3, on the other hand, does not clearly depict the Polaris launch complex. It took two photos to begin to convey the story. Fig. 1 is the only record I have of the Polaris Ship Simulator and it came mostly from an advertisement. Fig. 2 shows the Polaris transporter erector. The Lockheed GSE brochure informs me that the Tooling Division built it. In the AW Dec. 30, 1957, issue the Locomotion Engineering, Inc., prototype was shown. Table 1 indicates other gaps in up-to-date data on support equipment generally available from press sources.

Figs. 16 and 17 illustrate that in early 1959 the only outside source of photographic airlift data for Titan was the newspapers. In recent months AW has come through nicely with photographs of Atlas and Titan stages being loaded into the C-133. You may be impressed with the fact that a Martin-Baltimore task team used my file of AW pictures plus other data in developing a special airlift vehicle for the display version of Titan recently shipped to Miami for the National Convention and Aerospace Panorama, Air Force Assn. (I'm told there was slight interference in loading, and C-133 drawings and photos will be needed a little longer in order to effect a fix.)

When a number of representative pictures of Atlas, Titan, Thor, Jupiter, Minuteman, Polaris, etc., systems are viewed concurrently, that which may be derived has tremendous impact upon the designer type individual. I have noted that if one waits long enough, AW will eventually run all of the available photos of a particular weapon system. (Certainly a whole set on a particular system in one issue would be boring to the majority of subscribers, also it would leave little for a subsequent issue.) Perhaps such material merits a reprint issue similar to the M&R Guided Missile Encyclopedia.

The only flaw appearing in this suggestion is that such a visual aid approaches security complications.

Your documentation of the space systems support picture should be most interesting in the months to come. A lot will happen in 1960.

JOHN G. WORMAN
Advanced Design GSE
The Martin Co.
Baltimore, Md.

Solar Modules

In the Aug. 17 article entitled "Paddlewheel Satellite Probes Radiation" (p. 30), credit for construction of the solar converter modules was incorrectly given to Hoffman Electronics. Spectrolab, Inc., of North Hollywood, Calif., constructed the solar converters for Explorer VI as well as for a number of other space vehicles soon to be launched.

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.

Each paddle of Explorer VI was formed of 20 modules on which were mounted 100 cells each.

The cells were coated by a Spectrolab process known as "Solakote," whose primary function is to increase operating efficiency.

The efficiency of silicon cells is strongly temperature dependent. Solakote increases the thermal emissivity from approximately .32 for bare cells to .9 for coated cells.

The wavelength selective coating can also reduce solar absorptivity from .92 to below .7, with only very small losses of actinic energy.

The ensuing reduction of the alpha/epsilon ratio by a factor of almost 4, can in many cases produce a temperature drop of about 200F.

The cell output would be approximately doubled for such a temperature reduction. In addition, the coatings filter out ultraviolet radiation, and offer some micrometeorite protection.

Spectrolab is also currently working on processing, fabricating, coatings and other problems associated with solar energy conversion.

ALFRED E. MANN
Spectrolab, Inc.
North Hollywood, Calif.

Polaris Development

As a regular reader of AVIATION WEEK, I know that you have a keen interest in reportorial accuracy exhibited often in your stories about portions of naval aviation with which I have been directly concerned. Accordingly, I feel compelled to call your attention to a garbled story accompanying the Operation Fishook pictures on P. 69 of the Aug. 17 issue of AVIATION WEEK.

As commanding officer of the Naval Air Engineering Facility (SI), I can assure you that the Fishook concept was born in our own Engineering Department, first investigated by us in model form, then designed, developed, and tested full scale as "Sky-Catch" at San Francisco, then duplicated in essence for "Fishook" at San Clemente. It is in fact an adaptation, in each case, of an aircraft carrier arresting gear. My agency has sole responsibility for development and maintenance of fleet catapults and arresting gear.

Although we, as an agency, do not habitually seek publicity for our developments, we are proud of our development accomplishments and would like to see our handiwork properly credited where it is chosen for public review. Our Polaris work had to do not only with recovery of the missile, but with development of the underwater launcher control system as well. Both these efforts were off-shoots of our primary mission of carrier catapult and arresting gear developments.

P. G. HOLT
Captain, USN
Naval Air Materiel Center
Naval Air Engineering Facility
Philadelphia, Pa.

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