August 24, 1959

Aviation Week

Including Space Technology

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SPECIAL REPORTS:

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- **MATS C-133s**

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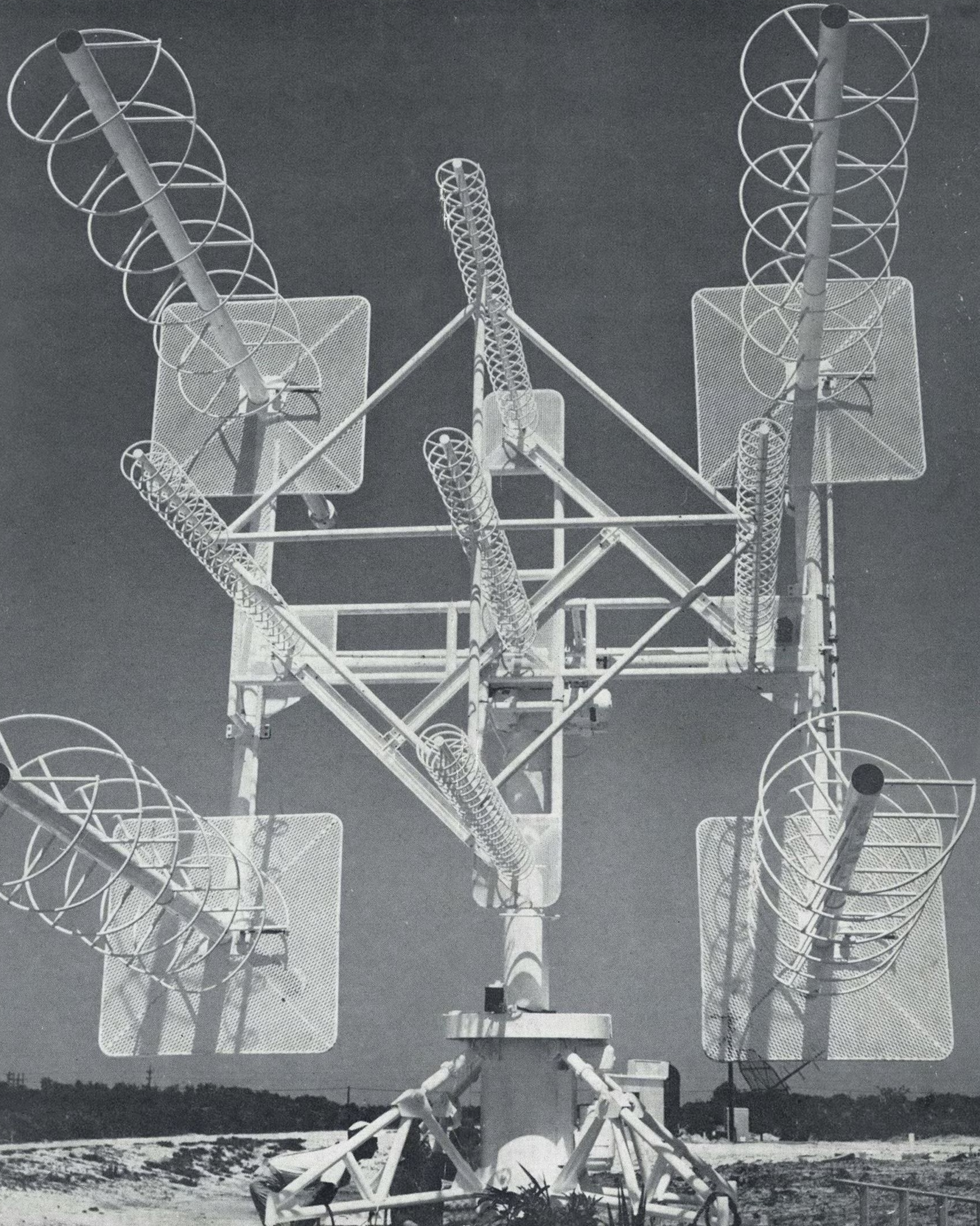

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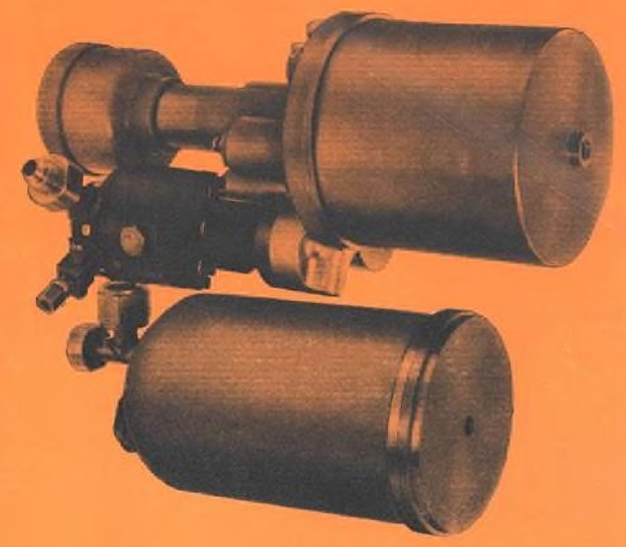
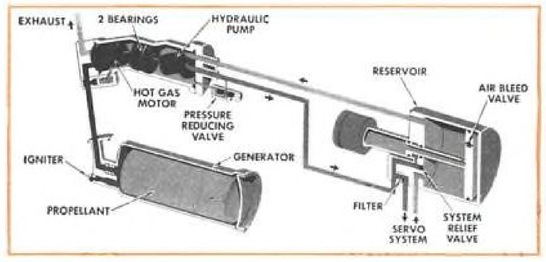
VICKERS HOT GAS AUXILIARY POWER SYSTEMS

for missiles and spacecraft



CONCEPT

Vickers piston motors — as used in virtually all existing commercial and military aircraft — are now modified to operate efficiently on propellant-generated hot gas, or bleed gas from the main propulsion system. Minimum weight is achieved by mounting the hot gas motor "shaft-to-shaft" with a Vickers piston hydraulic pump in a common housing. The motorpump, a simple gas generator, hydraulic reservoir, filter, and relief valve are integrally mounted to form a complete Auxiliary Power System in a compact package.



DEVELOPMENT

Production line Vickers hydraulic motors have been operating on hot gas for over 2 years. Units have run on gases as hot as 2300°F without modification.

The present flight hardware was built and tested after an intensive prototype development effort. Test program motorpumps have accumulated over 100 runs each for 1 minute of operation cycle. Since the current development program is aimed at meeting known APS requirements, no limits have been established on the operating cycle duration for this type of equipment.

CONCLUSIONS

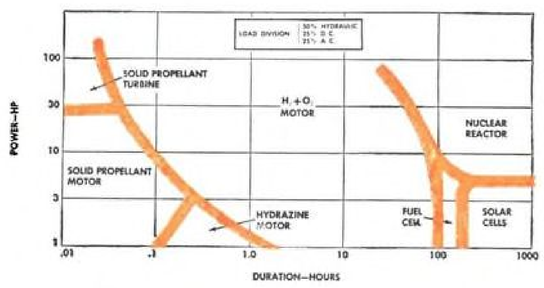
Performance and reliability goals for this concept have been met successfully. A complete hot gas APS package in the 2 - 8 horsepower range, shown above, is available within 90 days. Customer specifications for these and larger systems are invited. Write for Bulletin A-5223B.

APPLICATIONS

Because of the increasing scope of APS applications, Vickers conducted a series of studies to establish criteria for APS selection. Recent study results (published in March, 1959) indicate that for short duration operation, hot gas motors offer the best weight advantage in the 1 to 30 hp range. See curve below.

Attractive reliability and early delivery resulting from extensive use of proven hardware may extend the application of these systems to an even greater range of second and third generation missiles and spacecraft. Additional advantages include: low speed equipment (up to 10,000 rpm), convenient ground checkout, growth potential, and no alert time required.

OPTIMUM WEIGHT NON-PROPULSIVE POWER SYSTEMS



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AVIATION CALENDAR

Aug. 31-Sept. 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex.

Aug. 31-Sept 3—Conference on Stratospheric Meteorology, American Meteorological Society, Curtis Hotel, Minneapolis, Minn.

Aug. 31-Sept 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 1-2—Conference on physical chemistry in aerodynamic and space flight, University of Pennsylvania, Philadelphia, Pa. Sponsors: Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Dept.

Sept. 2-4—1959 Cryogenic Engineering Conference, University of California, Berkeley, Calif.

Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences; Office of Naval Research; National Science Foundation.

Sept. 10-11—14th Annual Meeting, Armed Forces Chemical Assn., Hotel Statler-Hilton, Washington, D. C.

Sept. 14-15—Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Society of Automotive Engineers, Milwaukee Arena, Milwaukee, Wis.

Sept. 14-16—14th Midwest Quality Control Conference, American Society for Quality Control, Sheraton Hotel, French Lick, Ind.

Sept. 16-17—Western Regional Meeting on Frontiers of Science and Engineering, In-

(*Continued on page 6*)

AVIATION WEEK Including Space Technology

August 24, 1959

Vol. 71, No. 8

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AVIATION CALENDAR

(*Continued from page 5*)

stitute of the Aeronautical Sciences, Los Angeles, Calif.

Sept. 17-18—Conference on Effects of Nuclear Radiation on Semiconductors, Western Union Auditorium, New York, N. Y. Sponsor: Army Signal Corps.

Sept. 19-20—National Air Races (190 cu. in. airplanes), Baer Field, Ft. Wayne, Ind.

Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago Amphitheater, Chicago, Ill.

Sept. 21-22—Conference on Planning and Designing of Urban Helicopter Facilities, Institute of Aeronautical Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.

Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.

Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 28-30—1959 National Symposium on Telemetering, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers' Professional Group on Space Electronics & Telemetry.

Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.

Oct. 1-3—23rd Annual Convention, International Northwest Aviation Council, Multnomah Hotel, Portland, Ore.

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

Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

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

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

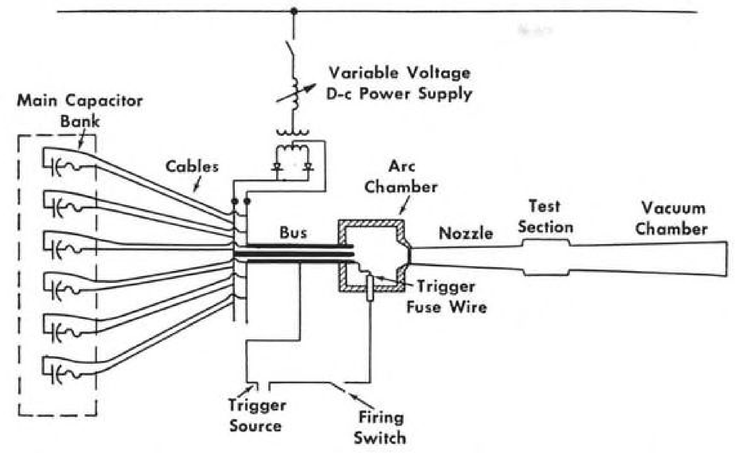
Oct. 7-10—Fourth Annual National Meeting, Air Traffic Control Assn., Biltmore Hotel, Oklahoma City, Okla.

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

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

Oct. 12-16—15th Annual General Meeting of the International Air Transport Assn., Imperial Hotel, Tokyo, Japan.

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



General Electric capacitors supply 5-million amp arc to create Mach 27 conditions in wind-tunnel research of missile and space vehicle design. Vaporized fuse wire shorts electrodes in pressure chamber, dumping capacitors' charge of 7-million watt-seconds in brief arc. Diaphragm bursts, releasing hypersonic shock wave past model in tunnel's test section.

Shown above is a section of a 2-million joule capacitor bank, specially designed and built by General Electric for the investigation of controlled thermo-nuclear reactions.

General Electric Capacitors Power Space-age Research

Capacitive energy-storage and discharge systems energize man-made thunderbolts for scientific studies

A NEW "HOT SHOT" WIND TUNNEL, being installed by the Boeing Airplane Company of Seattle, Washington, will be powered by a General Electric capacitor system. This installation will provide temperatures up to 25,000 F and pressures of 30,000 psi to create a hypersonic blast of air for missile and space-vehicle research. Electric energy for winds up to 27 times the speed of sound will be stored in a bank of over 2000 General Electric capacitors.

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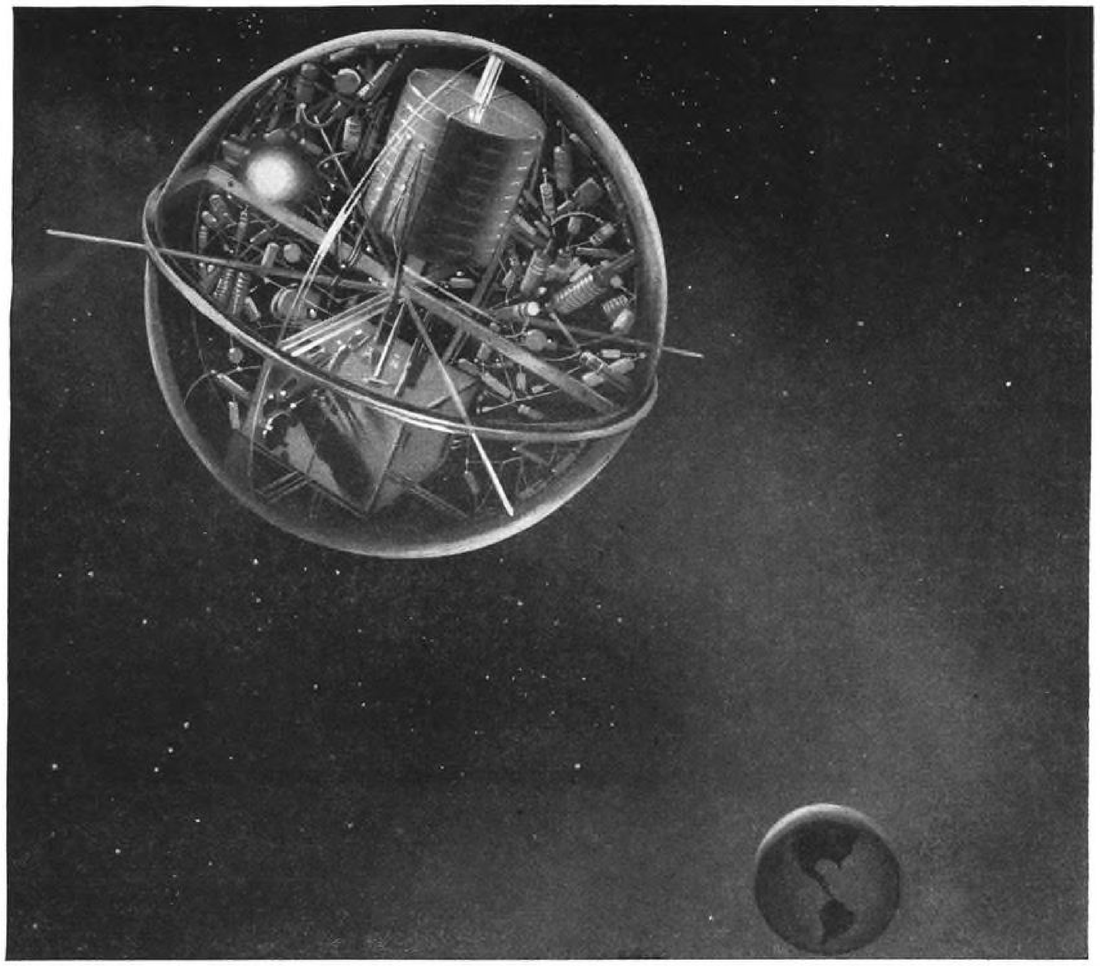

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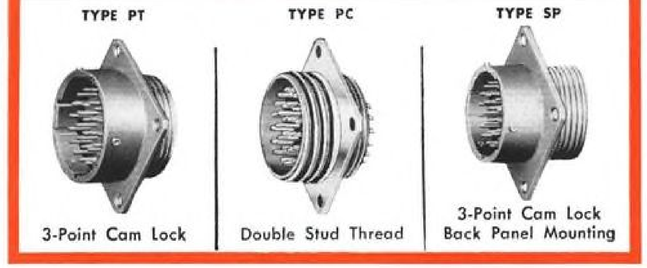

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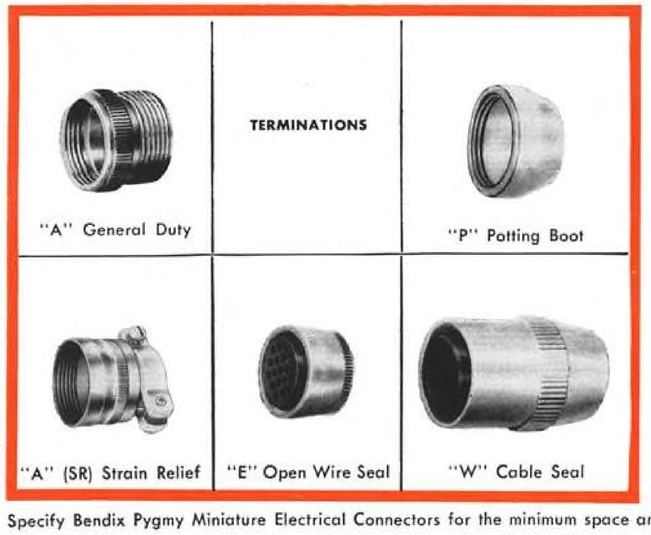

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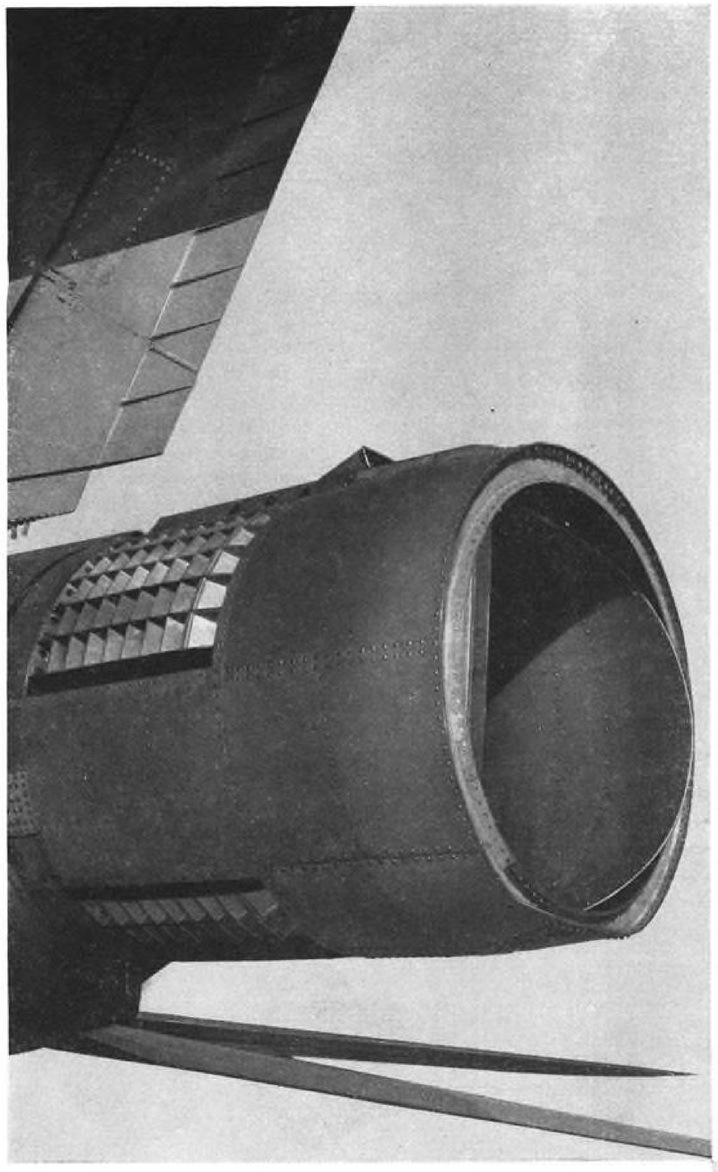

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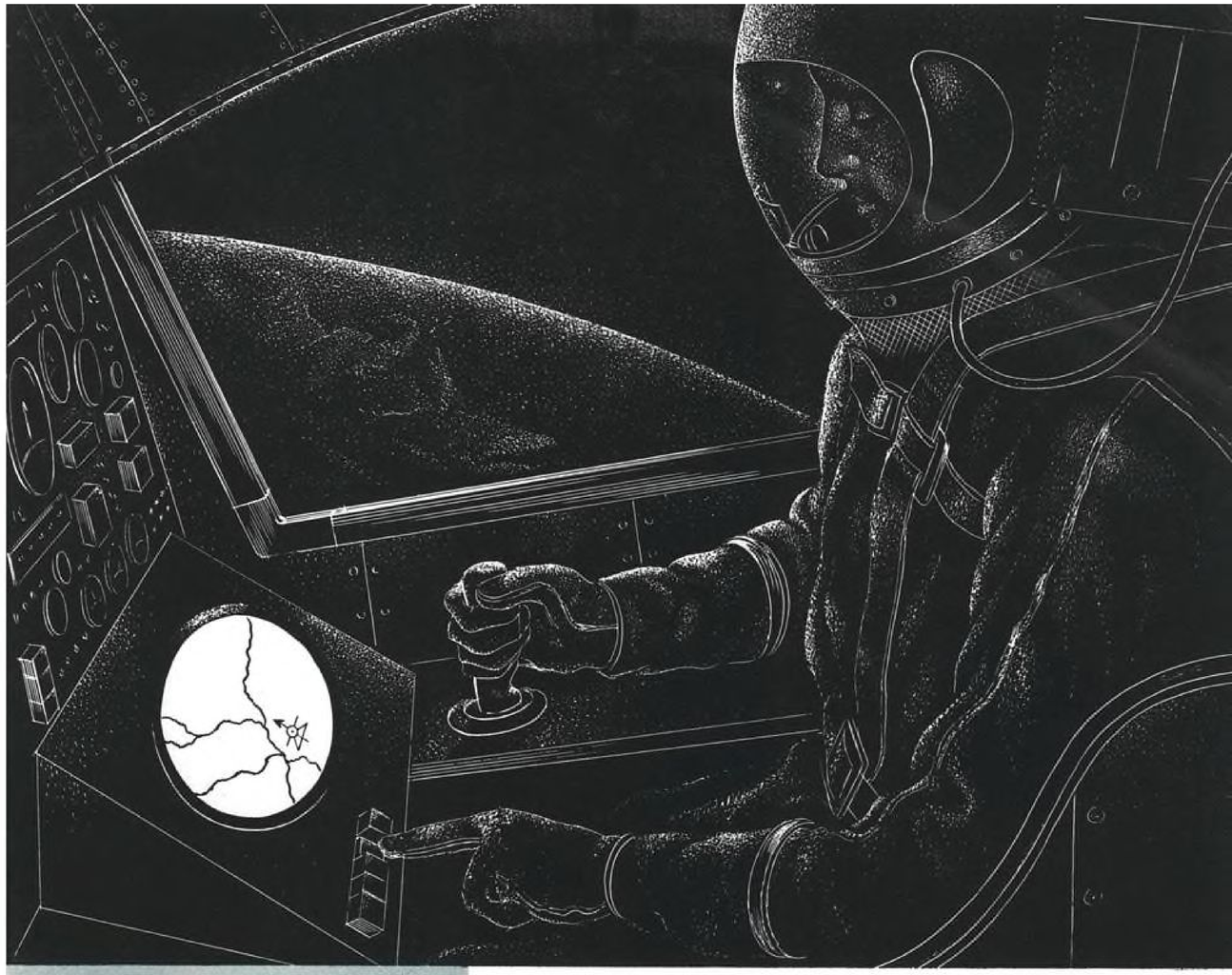

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August 24, 1959

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Including Space Technology

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COVER: Rantec antenna at USAF Missile Test Center, Cape Canaveral, Fla., was designed to track satellite and space probe vehicles and is now tracking NASA's Explorer VI. Built by the Rantec Corp., Calabasa, Calif., under contract to Space Technology Laboratories, Inc., the antenna has four outboard and five inboard helical elements. Outboard elements are for VHF with a gain of 20 db.; inboard elements are UHF with a gain of 17 db. Similar antennas are located in Singapore; Manchester, England, and Hawaii. For the first in a series of two articles detailing the impetus space and satellite probes have given to the growth of the Cape Canaveral missile complex, see p. 52.

PICTURE CREDITS

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78,084 copies of this issue printed

EDITORIAL

Mr. Khrushchev's Visit

The visit of Soviet Premier Nikita Khrushchev to the United States and the reciprocal visit to the Soviet Union of President Eisenhower are certain to add an interesting chapter to the era of top level interchanges that began in 1956 with the visit of General Twining and other top USAF leaders to the Tushino air show and has grown livelier ever since with the Mikoyan, Kozlov, Tupolev visits to this country and the sallies into Muscovy by Senator Hubert Humphrey, Adlai Stevenson and Vice President Nixon. In fact, the traffic of visiting U.S. dignitaries to the Soviet Union has grown so heavy this year that it will be difficult for any candidate in the 1960 presidential race to make much of a case without at least a standard Intourist whirl around Russia under his belt.

What the climate for these interchanges will be like after the Eisenhower-Khrushchev exchange, one can only guess. But we predict that, far from producing a thawing of the cold war and an apparent era of peaceful existence, it may have exactly the opposite effect and throw the basic intransigence of the Soviet position into a much sharper focus for the American people and the rest of the world.

Khrushchev: Blurred Vision

For Mr. Khrushchev is approaching his U.S. visit in a mood of supreme confidence in the economic, military and political power of his country that has probably blurred the reality of genuine Soviet achievements into over-confidence. It is doubtful if he will be in any mood to back down a fraction of an inch from the standard Soviet position that what happens within the Soviet satellite bloc is none of our business but what happens anywhere else in the world is most certainly Soviet business. We predict that Mr. Khrushchev will be unable to conceal this basic attitude from the American people during his travels no matter how hard he tries to maintain the illusion of "genial Uncle Nick."

Mr. Mikoyan almost turned the trick during his U.S. tour but finally lost his composure at a National Press Club luncheon over questions on Soviet actions during the Hungarian revolution and left with the snarling threats of force unless Soviet demands were met. Mr. Kozlov was blunter from the start of his visit and judging from Mr. Khrushchev's encounters with Vice President Nixon and Averell Harriman, increasing belligerency is the current Soviet policy.

We think President Eisenhower and Defense Secretary McElroy have been well advised to offer Mr. Khrushchev a reasonable look at some aspects of U.S. military might. For it is on this point that Mr. Khrushchev is apt to make his most dangerous miscalculation and become a victim of his own propaganda. We think the sight of the Atlas production line at Convair's Astronautics Division; a look at the Atlantic Missile Range's Cape Canaveral, and a tour of a Strategic Air Command base might provide Mr. Khrushchev with some more realistic data than is currently cranked into his military computations.

It is extremely interesting that all indications so far from Soviet official sources indicate that Mr. Khrushchev will decline to visit any military installations or production facilities. This may stem from several reasons.

It may be that the Soviet premier wants to be in his best "Moscow peace dove" mood and feels that any exposure to military facilities would mar this illusion.

It may also be that the stringencies of the Soviet security system, which have really changed little since the days of the czars, preclude even Mr. Khrushchev's throwing open any Soviet missile or aircraft production facilities to U. S. visitors in reciprocity for such visits over here.

The Soviets are usually sticklers for reciprocity on such exchange visits. Until this summer it appeared that U. S. practices were actually more restrictive for Russian visitors than those of the USSR. But this summer the Soviets balked at allowing two Americans to do things that the U. S. had allowed their visitors to do in this country.

The first occasion was the refusal of the Soviets to permit Jacqueline Cochran to fly her personal Lodestar across Siberia to Alaska. It was interesting to note that when Mr. Mikoyan indicated to the Federation Aeronautique Internationale delegates in Moscow that he thought this restriction might be silly and that airmen should be allowed to fly everywhere, Soviet censorship clamped down and bottled-up attempts to file this story to the outside world by American correspondents. This, despite the fact that some 400 people from 34 countries heard Mr. Mikoyan's remarks in both English and Russian at the FAI dinner. Yet, Mr. Mikoyan, Mr. Kozlov and Andrei Tupolev were permitted to range from the Atlantic to the Pacific coasts in this country.

Stringent Soviet Restrictions

Mr. Tupolev and his group of technicians also were permitted to see the production lines of the Douglas Thor IRBM and the Convair F-106 Mach 2 interceptor during their tour of West Coast aircraft plants. Vice President Nixon recently revealed that a request for his party to view similar Soviet installations was rejected. It is also evident the Soviets hope to avoid letting President Eisenhower see similar sights.

So it is evident that the much-publicized Soviet protestations of reciprocity have practical limitations. Few Americans realize that more than half of the Soviet Union is still off limits to travel by foreigners. And that, even in the open areas, foreigners are not allowed to travel between cities without an accompanying Soviet escort. Few Americans also realize the heavy hand of censorship that lies on every news dispatch filed by foreign correspondents in Moscow or the severe limitations placed on the movements and contacts of resident U. S. diplomats and correspondents, including constant shadowing by police agents and wiring their living and working quarters "for sound."

Mr. Khrushchev's visit should prove interesting both for himself and the American people to whom he will be exposed.

—Robert Hotz

WHO'S WHERE

In the Front Office

Lockheed Aircraft Corp., Burbank, Calif., has formed separate aircraft and missile-electronics combinations and made the following appointments: **L. Eugene Root**, group vice president-missiles and electronics; **A. Carl Kotchian**, group vice president-aircraft. **Herschel J. Brown** succeeds Mr. Root as vice president and general manager, Missiles and Space Division, Sunnyvale, Calif.; **W. A. Pulver** succeeds Mr. Kotchian as vice president and general manager, Georgia Division, Marietta, Ga.

Robert C. Jackson, executive vice president, Ryan Aeronautical Co., San Diego, Calif., succeeding **George C. Woodard**. Mr. Jackson will continue as vice chairman of the board; Mr. Woodard is now vice president and executive adviser to the company on financial and business matters.

Floyd W. Jones, president and board chairman, Ozark Air Lines, Inc., succeeding **Laddie H. Hamilton**, resigned because of ill health.

John J. Dempsey and **William T. Smither**, vice presidents, Servomechanisms, Inc., Hawthorne, Calif. Mr. Dempsey continues as manager of the company's Mechatrol Division, Westbury, N. Y.; Mr. Smither continues as general manager of the Los Angeles Division.

Jerome I. Davis, vice president, Aircraft Equipment Division of Consolidated Diesel Electric Corp., Stamford, Conn.

Charles R. Abrams, Jr., **Dr. George Kozmetsky**, and **Harry J. Gray**, vice presidents, Litton Industries, Beverly Hills, Calif. Also: **William L. Reynolds**, secretary.

Robert Martin, vice president and general manager, Ling Electronics, Los Angeles, Calif., division of Ling-Altec Electronics, Inc. Also: **James Ross**, vice president-research and development; **Paul Goodwin**, chief engineer.

Richard A. Wilson, vice president, General Mills, Inc., Minneapolis, Minn., and general manager of the Mechanical Division.

William E. Jackson, head, Development Division, Bureau of Research and Development, Federal Aviation Agency, Washington, D. C.

Honors and Elections

Westinghouse Electric Corp. has named an advisory committee on research to counsel top management, particularly in the area of basic research. Named to the committee are: **Dr. Cyril Stanley Smith**, professor of metallurgy, Institute for the Study of Metals, University of Chicago; **Dr. Julius A. Stratton**, president, Massachusetts Institute of Technology; **Dr. J. C. Warner**, president, Carnegie Institute of Technology.

Maj. Gen. Ben I. Funk, Commander of Air Materiel Command's Ballistic Missiles Center, has been selected as winner of the Air Force Assn.'s Distinguished Management Award for making the most distinguished contribution to management in a position of great responsibility.

(Continued on page 144)

INDUSTRY OBSERVER

► Watch for some of the old-line firms that bought up small electronic companies several years ago to start selling off these properties. ACF Industries, for example, reportedly is looking for possible purchasers of one or more of its electronic operations which include the Avion Division in Paramus, N. J., and its Nuclear Products-Erco and Electronics Divisions near Washington. Companies with previous experience in the relatively stable consumer or industrial products industries are frequently disillusioned by the consistently high percentage of profits which must be plowed back into development in the electronics industry to keep abreast of fast-moving competition.

► **Lack of funds may force Air Force to cancel several important support system development programs now in their early phases. One such cancellation may be the 460L weather surveillance project being developed by Bendix Aviation (AW Oct. 6, 1958, p. 80). Project would make use of a Boeing 707 jet transport.**

► Latest Air Force thinking on the Dyna-Soar program is to merge the efforts of the two competitive teams headed by Boeing and Martin for a joint attack on the second phase of the program with Boeing as the project manager.

► **The Martin Co., if it can gain Air Force and NASA permission, hopes to try and intercept an orbiting satellite sometime next month with one of its test vehicles developed during Air Force's air launched ballistic missile competition which was subsequently won by Douglas. Object would be to miss the satellite by a predetermined distance rather than try for actual impact. Test would be used to demonstrate the accuracy of the Martin Domar guidance system developed for its ALBM entry.**

► Douglas, meanwhile, has submitted its recommended choice of avionic contractor to develop the inertial guidance system for the WS-138A ALBM for Air Force approval. One report says that Douglas has recommended American Bosch Arma Corp., although Douglas originally had worked with General Electric in its bid for the ALBM prime contract.

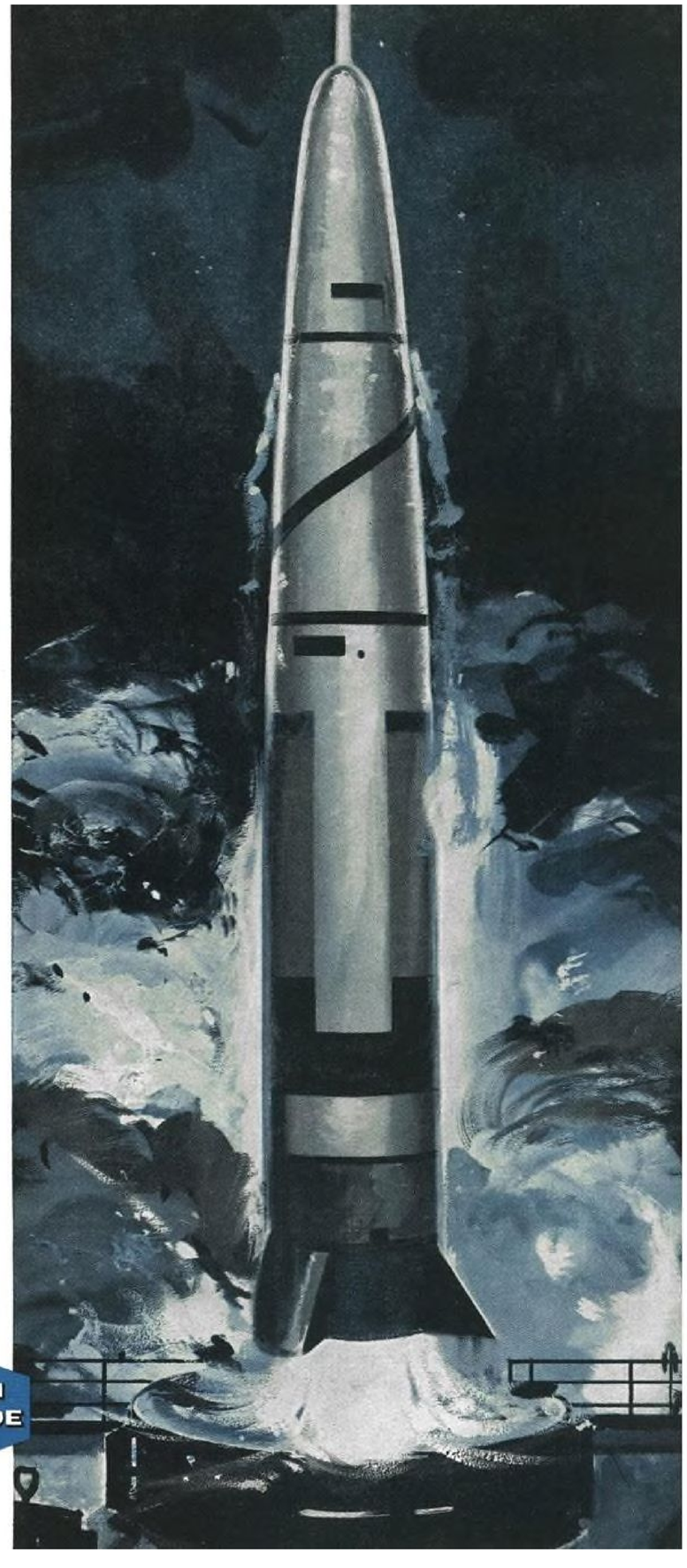
► **Omega Aircraft Corp. is designing a triple-turbine version of the BS-12D cargo helicopter (AW July 27, p. 41) using Allison T63 turbine engines. Bernard Sznycer, president, says use of the triple-engine configuration will raise payload from 1,000 lb. to 2,500 lb. Company is now negotiating with Allison Division of General Motors Corp. for three engines.**

► The Tart, a small solid-propellant countermeasures rocket, is now being produced in large quantities at Thiokol Chemical Corp.'s Elkton, Md., plant for use by both Air Force and Navy.

► **Mergenthaler Linotype Co. is negotiating with Computing Devices of Canada for the latter to obtain license rights to build Mergenthaler's M-2 integrated bombing system used in Lockheed F-104G jet fighters to be built in Canada. Mergenthaler also has begun negotiations with a West German avionics group (Lorenz) for M-2 license rights.**

► Air Products, Inc. will produce 7,500 lb. of a new, high energy liquid rocket propellant oxidizer, nitrogen trifluoride, for the Air Force. Material will be fired in small rocket engines in an effort to determine nitrogen-to-fluorine bond energies. A cryogenic liquid, NF3 is expected to prove less powerful than straight liquid fluorine but less corrosive and easier to handle. On a purely research level, NF3 also is of interest as an intermediate step in the development of high energy, solid fluorine rocket oxidizers.

► **National Research Corp. has received a $100,000 Navy Bureau of Ordnance contract for the preparation and "determination of properties" of ultra fine aluminum powder (AW July 7, 1958, p. 23). Fineness of the particles—no more than a millionth of an inch in diameter—enables them to absorb large amounts of liquid fuels and to convert liquids to gels. High surface energy of the ultra fine aluminum also makes the material attractive as a solid propellant additive (AW Aug. 3, pp. 26, 69).**



Washington Roundup

Soviet Missile Submarines

Adm. Arleigh A. Burke gave first official U.S. recognition last week to the appearance of operational Soviet ballistic missile submarines approximately a year and a half before the U.S. is scheduled to have a similar capability. Adm. Burke, who also was sworn in last week for an unprecedented third term as Chief of Naval Operations, indicated, however, that the missiles and their conventional-powered submarines are inferior in range and accuracy to the forthcoming Polaris nuclear submarine weapon system scheduled to become operational in the fall of 1960.

Sketch and picture of two types of Soviet ballistic missile submarines, both modified versions of the long-range "Z" class, were carried by AVIATION WEEK in the June 15 issue (p. 26). One of the submarines was sighted in an area south of Iceland; the more refined version was seen near Rio de Janeiro.

Twenty-four hours after Adm. Burke's statement, Soviet Fleet, official newspaper of the Russian navy, followed up with a warning that Soviet missile submarines could enter Hudson Bay while hidden by Arctic ice and then strike U.S. industrial targets from that point. Nearest Hudson Bay point is approximately 650 mi. from the northern U.S. border.

High Energy Fuel

Hearings will be scheduled soon by the House Committee on Science and Astronautics on the Pentagon's decision to abandon its program for the development of a high-energy aircraft fuel (AW Aug. 17, p. 26). Rep. Overton Brooks (D.-La.), committee chairman, said it was reported that the Air Force and Navy based their decision in part on the ground that they had no further requirement for the project. "Our committee," he said, "is interested in determining why it took the services five years and some $200 million to determine they had no requirement for the fuel." Brooks added that it was his understanding the National Aeronautics and Space Administration was still interested in the project, and one of the purposes of the committee's action is to determine NASA's plans now that the services have canceled their program.

Soviet Space Equality

Creation of a joint committee on peaceful use of outer space with equal participation by the Western powers and members of the Soviet bloc will be proposed by Rep. Victor L. Anfuso (D.-N.Y.) at the annual conference of the International Astronautical Federation in London, Aug. 31 to Sept. 5. Anfuso maintains that to deny equal participation would be virtually inviting the Soviet Union to engage in full-scale competition against the U.S. in space exploration, which could lead to the creation of more menacing ways of destroying the world than are in existence today. He also suggested his proposal be brought to the attention of both President Eisenhower and Premier Khrushchev as one item of discussion and possible agreement when they meet next month. Prior to their meeting, however, he suggested that the proposal be given consideration by the United Nations and NATO powers.

Another of Anfuso's scientific projects moved ahead last week when the House approved a bill he sponsored to create a presidential award for scientists. The bill would have the President award up to 20 medals a year to scientists chosen by the National Academy of Science for outstanding achievements in their fields.

Missile Management Reports

House Government Operations Committee is scheduled to release a report evaluating the management of missile programs this week. Extensive hearings on Army's programs and on USAF programs under the technical direction of Space Technology Laboratories were held earlier this year by a subcommittee headed by Rep. Chet Holifield (D.-Calif.).

Meanwhile, General Accounting Office has abandoned its aim of getting a report on its investigation of USAF management of ballistic missile programs to Congress before adjournment. A draft will go to USAF late in September for comment. GAO launched the investigation after USAF refused to let it review the full report on an investigation by the USAF Inspector General (AW Nov. 16, 1958, p. 34). The USAF missile investigation has been GAO's top-priority project.

SAGE Traffic Facility

Look for the early announcement of contracts between the Federal Aviation Agency, the Air Force, and Mitre Corp. for design and operation of the SATIN–SAGE Air Traffic Integration–experimental facility. SATIN will employ the AN/FSQ-7 (XD-1) SAGE-type computer in Lexington, Mass., recently turned over to Mitre by Lincoln Laboratories. The AN/FSQ-7 (XD-1) is one-half of the normally duplexed AN/FSQ-7 SAGE computer installed in direction centers throughout the United States. The computer will be used to test all air traffic control functions planned for the SAGE super combat centers in operation of an integrated air traffic system. Track capacity, however, will be limited to 100 aircraft because the AN/FSQ-7 does not have the capacity of the AN/FSQ-7A transistorized SAGE computer now under development for 10 super combat SAGE centers by International Business Machine Corp. Centers are not expected to be completed before 1963-64.

MATS Jet Fund Gone

Military Air Transport Service lost its second try of the year for jet transport funds last week. Congressional conference committee cut from the supplemental appropriations bill $30 million which had been added by the Senate after MATS failed to get money for turbine transports in the regular Defense Department appropriation (AW Aug. 17, p. 45). Part of the $30 million was for development of a powerplant for a workhorse cargo transport, the rest for purchase of turbojet transports.

Conference report cited confusion among proposals and programs for the cargo transport powerplant development as cause for dropping the appropriation. It also sharply attacked Air Transport Assn.'s opposition to MATS. Contending that MATS is necessary and must be preserved and modernized, the conference committee observed that civil aviation "has grown by virtue of the generous subsidy it has received from the government. It is now a giant grown fat by government subsidies and high rate charges." —Washington staff

NASA May Propose Revised Patent Law

Regulations giving industry greater protection may be asked during next session of Congress.

By Ford Eastman

Washington—Changes in the patent provisions of the 1958 Space Act to ease government control of inventions probably will be recommended to Congress by National Aeronautics and Space Administration during its next session, the House Committee on Science and Astronautics was told last week.

John A. Johnson, NASA general counsel, told the Subcommittee on Patent Law and Scientific Inventions of the House Space Committee that his agency is carefully studying the patent section and probably will submit recommended changes to the Budget Bureau as part of its 1960 legislative program.

Johnson told Rep. Erwin Mitchell (D.-Ga.), subcommittee chairman, that, from his personal viewpoint, it is undesirable for an agency such as NASA to be held to a patent law different from that of the Defense Department. He said that, rather than an outright repeal of the patent section, he would favor substitution of the general principles of the National Science Foundation law regarding patents which is similar to Defense Department policy.

The 1958 Space Act provides that patents obtained on inventions connected with work on space projects by private industry under contract to NASA shall be the property of the government unless a waiver is granted.

Defense Department patent practice, which is not prescribed by law, permits the inventor or the company which is awarded the contract to retain ownership of the patent, subject to free license for government use.

Under the National Science Foundation patent clause, ownership of patent rights is left to the discretion of the agency, which is directed to take whatever action is in the public interest. Johnson said that as a lawyer, he would prefer legislation along similar lines in which government concern over its interests in patents is expressed but ownership rights are left to the discretion of the administrator, who is held responsible to protect public interests.

In this way, he said, title to an invention which would have little or no government use would be retained by the inventor or the company with the understanding that it be developed for full commercial use. By the same token, Johnson added, the government would be able to hold title to an invention in which it has great interest.

During congressional consideration of the National Aeronautics and Space Act of 1958, industry representatives, scientists and engineers strongly protested the patent provisions as a bad precedent in government control of inventions. Contractors complained that these provisions would offer little incentive for them to bid on NASA contracts unless they received additional compensation for the loss of patent rights to the government and that such provisions might result in delays in the over-all space program.

As a result of these protests, the law passed by Congress contained a provision to waive all or part of the government rights to inventions under certain conditions if the action was found to be in the public interest. This, however, did not satisfy industry objections, and the Administration has been repeatedly urged to modify the entire section.

Johnson told the subcommittee he did not know whether the space program has been held back by the strict patent provision. He added, however, that a number of contractors have been reluctant to enter contracts with NASA or had requested added compensation for the loss of patent rights. He also said he had heard reports of still others who said they would accept no NASA contracts because of the patent provisions.

The NASA official said there are ways in which the intent of Congress regarding the patent regulation could be circumvented but that NASA had administered the provision in line with congressional intent.

Johnson said, for example, that the waiver provision could be used in almost every instance where secrecy was not required but that this was clearly not the intent of Congress. Another possible evasion, he said, would be to do all contracting with the Defense Department, which, in turn, would place the contracts with private industry. Since the Defense Department is not bound by law to obtain patent rights to inventions made while under government contract, it could permit the inventor to retain patent rights to a discovery, subject to free license for government use.

However, Johnson said, NASA as a matter of policy has required the patent clause to be placed in all contracts let by the Defense Department for the agency. Excluding the provision, he said, would leave the door open for wholesale evasion of the patent section.

Johnson said the patent requirement leaves NASA in a poor position in contracting. Most of the companies that do work for the Defense Department are the same firms that are capable of handling NASA contracts and are working on these projects side by side. There are cases, Johnson said, where a company may be working on a contract placed by the Defense Department on its own and, at the same time, on a contract NASA had asked the Defense Department to place. He said that, as a lawyer, he regarded this as basically unfair.

Rep. James G. Fulton (R.-Pa.), subcommittee member and also a member of the select committee which helped draft the Space Act last year, said that at the time the act was drafted, space exploration was new and that the patent section was provided to protect government interests.

Now that the situation has changed somewhat, Fulton agreed that it might be well to review the patent provisions and clarify sections where the language is broad and leaves doubts as to the meaning. He indicated, however, that government interests in inventions with large potential use by the government should be protected by law.

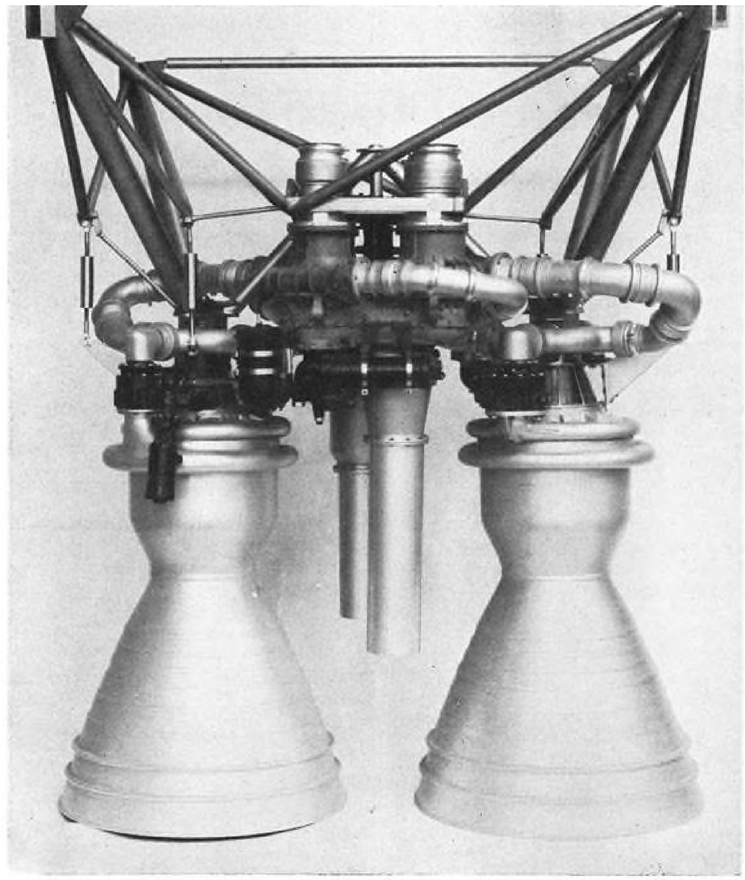
NASA Budget

Washington—Congress last week voted National Aeronautics and Space Administration a $500 million budget for Fiscal 1960—$29.7 million less than NASA requested.

Research and development took the major cut, $18.5 million. Funds for construction and equipment were cut $8.2 million and funds for salaries and expenses by $3 million.

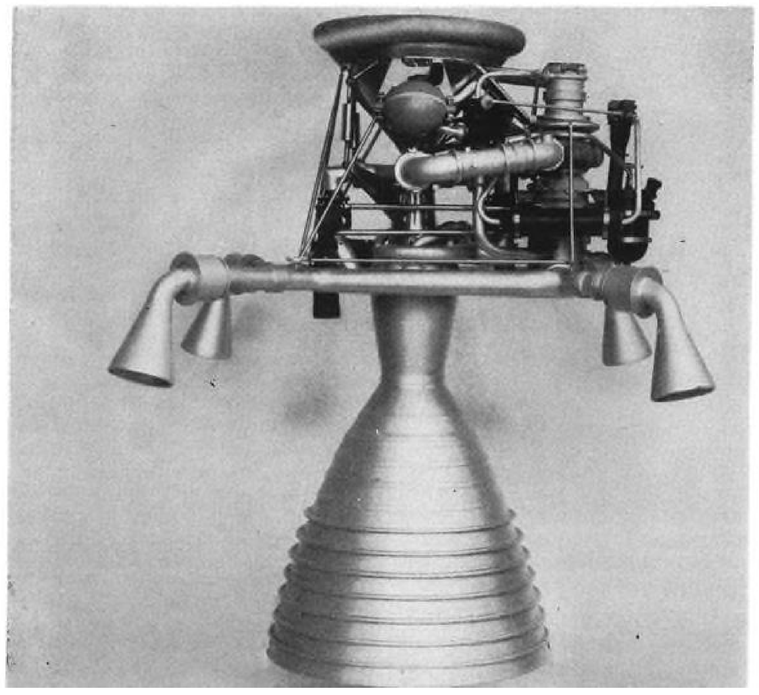
Here's how the budget now stands: research and development, $335 million; construction and equipment, $73.8 million; salaries and expenses, $91.4 million.

The House originally made a total $68.2 million cut. The Senate restored this in full. Conferees of the two legislative bodies compromised on the $29.7 million reduction.



Models Show Configurations of Titan Engines

Aerojet-General 300,000 lb. thrust LR-87 liquid engine (model above) is for first stage of Martin-USAF Titan ICBM. Modified 360,000 lb. thrust versions are programed as second-stage powerplant in ARPA's Saturn space vehicle. Aerojet second-stage LR-91 liquid engine (model below), designed for altitude ignition in Titan, produces 80,000 lb. thrust at altitude. Turbopump gas generator exhaust passes through four small nozzles ducted together to provide vernier power. Titan engines have been 100% reliable to date, according to Aerojet.



Sodium Cloud Rocket Launched by NASA

Washington—Investigation of wind activity at altitudes up to 150 mi. began last week when National Aeronautics and Space Administration launched the first of a series of sounding rockets in a sodium cloud experiment.

Nike-Asp rocket fired from NASA's Wallops Island, Va., station reached an altitude of 148 mi., trailing sodium vapor from the 50 mi. level and leaving a sunlight-sensitive sodium cloud near its peak altitude. Cloud was tracked photographically to provide data on the direction and velocity of winds in the upper atmosphere.

Second shot in the series failed when the vehicle disintegrated as the second stage burned, providing no wind data. Further sounding rocket launches have not been announced, but there is a serious lack of wind information in this area, and NASA will undoubtedly continue the program.

Solid propellant Nike-Asp rocket was used to produce the sodium cloud. This sounding rocket has a Nike-Ajax booster as a first stage and a Cooper Development Corp. Asp as a second stage. The rocket is 27 ft. long and weighs 1,550 lb. at takeoff.

The 75-lb. payload includes 10 lb. of sodium pellets and 15 lb. of thermite to vaporize the sodium. A timer mixes the thermite and sodium, and they start burning at an altitude of about 50 mi., exhausting a trail of sodium vapor that produces a sodium cloud as the rocket reaches peak altitude.

Sunlight excites the sodium and makes it glow, providing a good target for photographic tracking. The shots are made in dawn and evening twilight so that, while the cloud is in sunlight at its 150 mi. altitude, ground observations are not hampered by light scattering in the dark area nearer the earth.

Sodium cloud used in last week's experiment was produced at dawn and was visible for several hundred miles as it moved generally south and west across the eastern U. S. Best data was obtained in the first 10-15 min. after launch when wind effects on various sections of the cloud were clearest.

NASA project chief Maurice Dubin points out that this sodium cloud experiment can provide information on wind activity in an altitude zone where almost no wind data exists.

Data is obtained from the experiment by photographing the glowing sodium cloud continuously from various angles and assembling a three dimensional picture as it moves with the wind. Wind effects on different parts of the cloud can be measured at set times and positions to determine wind velocity and direction.

Mercury Capsule Readied for Sea Drops

By Irving Stone

El Centro, Calif.—First trial in a series of 30 drop tests of the Project Mercury full-scale unmanned space capsule models was scheduled for last week over the Salton Sea in a parachute landing system operation based at the Air Force-Navy chute testing site here. Series of drops is expected to stretch over several months.

Two Mercury capsules, fitted with photographic equipment, are being used in the test program, which is being conducted by Northrop Corp.'s Radioplane Division to establish basic compatibility of the capsule with its parachute landing system, designed by Radioplane's Paradynamics Group. Radioplane is the subcontractor to McDonnell Aircraft Corp., prime contractor for the capsule in the National Aeronautics and Space Administration manned space-capsule project.

Capsule model weighs more than 2,000 lb. The drop test program calls for the capsule to be carried aloft in an Air Force Lockheed C-130 cargo plane. Release altitudes for the capsule model will be in a range of heights between 5,000 and 30,000 ft. The lower limit altitude drops will be carried out to investigate the response of the chute landing system in relation to a possible malfunction with a future operational manned capsule, which would be deliberately separated from its booster missile in an emergency procedure and pushed to an altitude of perhaps 2,500 to 5,000 ft. by capsule rockets so that the parachute landing system could be deployed to permit a safe letdown.

In addition to investigating the general characteristics of the parachute landing system and its compatibility with Mercury capsule, the drop tests will check feasibility of shroud line length, chute load-carrying capabilities, and rate of descent with the capsule model. Design descent rate for the landing system's main chute is 30 fps.

Since Project Mercury probably will embody a reliability factor higher than has ever been built into an operational system, it is almost certain that the capsule's landing system will get a rigorous wring-out during the series of 30 drops over the Salton Sea.

Affording a fairly large test area, California's Salton Sea is an inland salt-water body, about 6 to 10 mi. wide by about 30 mi. long, located about 240 ft. below sea level.

In addition to its responsibility for designing and building the chute landing system, Radioplane will furnish retrieving aids, such as flotation gear and locator devices, under its subcontract to McDonnell.

The actual Mercury capsule will be flotable and the additional flotation gear will be incorporated primarily to provide surface stability. No flotation gear is being used in the Radioplane drop tests, but locating devices such as smoke pots probably will be employed.

Use of a C-130 aircraft will limit, of course, the altitude to which the full-scale capsule can be carried for the drop over the Salton Sea. However, in connection with Project Mercury's manned space capsule during operational re-entry, the plan is for the chute landing system to be initiated either by pilot or ground control stations by firing retro-rockets to decrease the capsule velocity and program the re-entry trajectory (AW Apr. 27, p. 114).

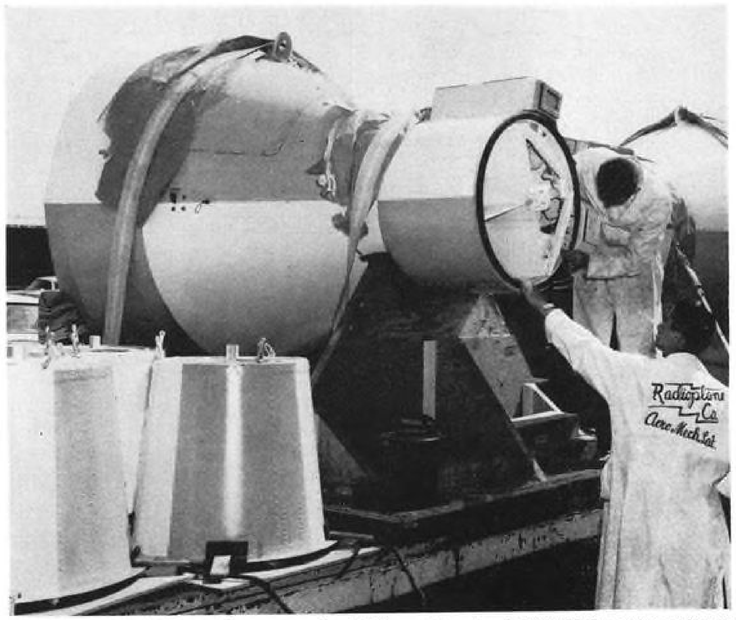
At 60,000 ft. altitude, a mortar will be triggered by altitude controls to expel the drogue chute, which will provide stabilization for the capsule. The drogue will remain attached until the capsule descends to about 10,000 ft. Main landing chute then will be deployed, and when the capsule reaches 5,000 ft. it will have an impact velocity of about 30 fps. as it descends to final letdown. At impact, the main chute will be released and recovery and locating aids, such as SOFAR bombs, dye-marker, radio beacon flashing light, and smoke signals will be ejected.

In addition to automatic sequencing of the chute system, the landing technique also will incorporate an independent pilot-operated reserve letdown system.

The drogue chute is a ribbon-type conical configuration. It has been tested at 70,000 ft. at Mach 1 in release from a Lockheed F-104 jet fighter.

Main or primary chute for the Mercury capsule landing system also is a Radioplane design, known as a ringsail chute. Originally it was developed in connection with drone recovery to provide low shock opening at very high speeds and provide high stability. Essentially, it is the same as that being used to recover, in the White Sands area, the Air Force's Radioplane XQ-4 drone, a Mach 1-to-1.2 Westinghouse XJ81-WE-3 jet-powered configuration, with a weight comparable to the Mercury capsule model.

Ringsail configuration is not a solid canopy but actually consists of panels with openings between them. Arrangement of openings, plus pitch of the panels, provides autorotation for stability in descent—to avoid oscillation and to allow straight-down descent rather than lower in a drifting pattern. This characteristic would be an important factor in projecting a letdown pattern to achieve landing of a manned capsule in a specified area. Also, elimination of oscillation upon impact will materially lessen the impact effect.



MERCURY CAPSULE mockups are unloaded from Douglas C-124 Globemaster prior to installation of complete landing systems by Radioplane Division of Northrop Corp. Landing systems were designed by division's Paradynamics Group for Salton Sea drop tests.

Sikorsky S-60 Carries Detachable Passenger Pod

A detachable passenger pod which effectively dampens cabin vibrations, was unveiled by Sikorsky officials last week as the company's S-60 crane helicopter entered the first phase of Army flight evaluations at Ft. Rucker, Ala. (AW Aug. 17, p. 39). The passenger pod, which was designed and built in three weeks, is purely experimental, the company said. The pod is attached to rubber bungees at four points beneath the S-60 airframe, eliminating metal-to-metal contact. Four steel cables run from the bungee contacts on the airframe to structural members of pod floor. The pod floor is the only structural member of the cabin area. By attaching suspension cables directly to it, the entire upper cabin area is left stress free, so that windows and openings of any size can be cut at any location. The four suspension cables attach to the S-60 airframe through bungee "clusters" of three bungees each, all stock parts from Piper landing gears. The steel cables are of fail-safe design. Sikorsky is also considering hydraulic and air elements for vibration isolation. The S-60, powered by two Pratt & Whitney R2800-50s, is the predecessor of a twin-turbine-powered crane, designated S-64 (AW Apr. 20, p. 29) which the company has begun developing with its own funds. Potential payload lifting capability of the turbine-powered craft will be about 12 tons.

Canada Selects F-104G Companies

Ottawa—Canadair will build the airframes and Avro's Orenda Engine Division will make the powerplants for Canada's F-104G in a production program calculated to provide maximum support for a badly depressed Canadian aircraft industry.

Canada will produce the Lockheed F-104G under agreement with Lockheed Aircraft Corp. and General Electric Co., the manufacturer of the fighter's J79 engine. The Mach 2 F-104G is intended to replace the ageing Sabre VI day fighters now used by the Royal Canadian Air Force.

Production of the F-104G will fill some of the gap left in the Canadian aircraft industry when the government canceled the CF-105 interceptor and Iroquois engine programs. When the CF-105 was canceled, the government made the politically unpopular decision to fill the air defense gap by building the USAF-Boeing Bomarc interceptor missile under license.

Since then, the defense role of the Bomarc has been a matter of controversy in the U.S., and Congress has suggested that some U.S. Bomarc bases be built in Canada. These and other factors have kept the Canadian air defense situation in a state of flux, and apparently Canada may still not produce the Bomarc for both technical and financial reasons.

Canadair, Ltd., a division of General Dynamics Corp., will manufacture 200 F-104G airframes, a contract which represents about 36% of the total program. Orenda Engines Division of Avro Aircraft, Ltd., will receive about 31% of the total program with its contract to build the engines. Arrangements have not been completed for fire control and other systems for the fighter, but most of them will be built in Canada.

Government received bids from Canadair, Avro and de Havilland Aircraft of Canada, Ltd. for the F-104G airframe contract. In making its decision on the airframe and engine production awards, the government said it tried to spread the program on a regional basis, "if this could be done with due regard to cost."

Splitting the work between Canadair and Avro is described as accomplishing this aim. Subcontracting pattern for airframe and engine production also is to be based on a policy of wide distribution among plants throughout Canada.

Bid which won the contract for Canadair calls for production of 200 airframes for a maximum of $91.5 million.

This ceiling price excludes variable costs under control of the government and is based on present specifications of the F-104G. If the actual production cost is less than the ceiling price, Canadair keeps a third of the difference and the rest goes to the government. The Orenda contract has similar incentive provisions.

Defense Ministry said it accepted the offers which provided the best prospect of producing the aircraft at the lowest cost. Also, building the airframe at Canadair is expected to result in significant savings because of lower overhead charges possible on other defense work there.

Control Error Aborts NASA Air Density Satellite

By Craig Lewis

Washington—National Aeronautics and Space Administration failed in its second attempt to measure air density in the upper atmosphere with an inflatable satellite when a control system error kept the satellite from orbiting.

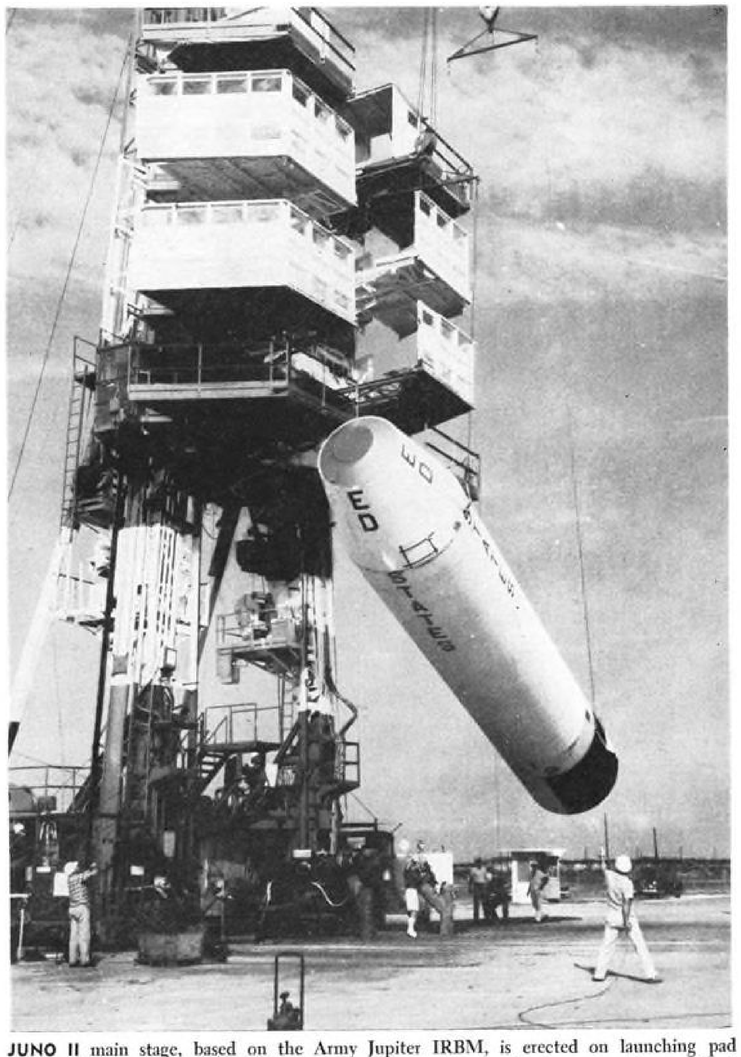
Satellite failed to go into orbit when the upper stage attitude control system apparently malfunctioned, pointing the upper stages and payload downward and to the left. Second and third stage rockets fired, driving the payload down into the atmosphere where presumably it ignited and was destroyed.

Inflatable satellite in the payload was similar to the Beacon unit launched with a Jupiter C vehicle last October. That Beacon failed to orbit when part of the upper stage cluster separated from the vehicle before booster burnout. In January, a similar sphere was launched by a Nike Cajun to a 75-mi. altitude in a successful demonstration of the ejection and inflation system.

Measurement of air density in the upper atmosphere is an experiment of basic scientific interest, and the Beacon satellite would provide valuable data in this field because of its great sensitivity to atmospheric drag. Although another Beacon shot isn't on the schedule at present, chances seem good that NASA will make another attempt to get an inflatable sphere into orbit.

Latest Beacon launch attempt followed closely the highly successful launching of the Explorer VI paddle-wheel satellite (AW Aug. 17, p. 30), and NASA reports that Explorer VI is broadcasting generally strong and clear signals, although it is still too early to draw firm conclusions from the data available. Solar cells on the satellite's four paddles are supplying the expected current to charge the batteries which power instruments and communications equipment.

The 12 ft. inflatable sphere NASA tried to put into orbit was designed as an air drag experiment by the Space Vehicle Group under William J. O'Sullivan, Jr. This type satellite is ideal for air drag measurements in the upper atmosphere since its relatively large size and light weight make it quite sensitive to air drag effects.



JUNO II main stage, based on the Army Jupiter IRBM, is erected on launching pad at Cape Canaveral, Fla. Main stage was topped with two high-speed solid propellant upper stages for the Beacon I satellite attempt. Jet Propulsion Laboratory provided these upper stages.

Varying Frontal Areas

Some gage of atmospheric density has been derived from the various satellites already launched, but most of them present varying frontal areas as they move around their orbits and are not really suitable for drag studies. Vanguard I, Vanguard II and Sputnik I are spheres and thus better suited to drag experiments, but NASA points out that the Beacon sphere would be 161 times more sensitive to drag than Vanguard I. The inflatable sphere has a frontal area per unit of mass of 11.3 sq. ft. per lb., while Vanguard I has a frontal area per unit of mass of .070 sq. ft. per lb.

Beacon Space Vehicle

Juno II launch vehicle for the Beacon attempt used a modified Army-Chrysler Jupiter IRBM as a first stage, with the upper stages clustered in a spin tub assembly on its nose. This Juno II was the first to have two upper stages in place of the usual three. Second stage was a ring of 11 scaled-down solid propellant Sergeant rockets. Third stage composed of three of these scaled-down Sergeants was located inside the second stage.

Upper stages were protected by an aerodynamic shroud which was jettisoned before second stage ignition. Payload was attached to the third stage, and, after third stage burnout, the signal which ordinarily ignited the fourth stage was intended to start the mechanism for ejecting the sphere and inflating it.

Guidance was the Delta Minimum Inertial Guidance Scheme standard in the Jupiter IRBM. It was after the Jupiter first stage with this guidance package in it separated that the control system malfunction in the upper stages diverted them along a re-entry flight path. Beacon was programed for an orbit inclined 48 deg. from the equator with a minimum perigee of 420 mi. and a maximum apogee amounting to 1,460 mi.

Payload Weight

Payload weighed 25.5 lb. and consisted of a stainless steel cylinder 7 in. in diameter and 31.5 in. long which contained the folded sphere and its ejection and inflation system. A telemetry assembly was attached to the lower end of the cylinder.

About 11 min. after launch, a timer was to have fired two squibs in a nitrogen pressure vessel, allowing the nitrogen to expand a bellows and force a piston to expel the sphere from the cylinder.

Nitrogen from the bellows was to pass through a connecting valve after ejection and inflate the sphere.

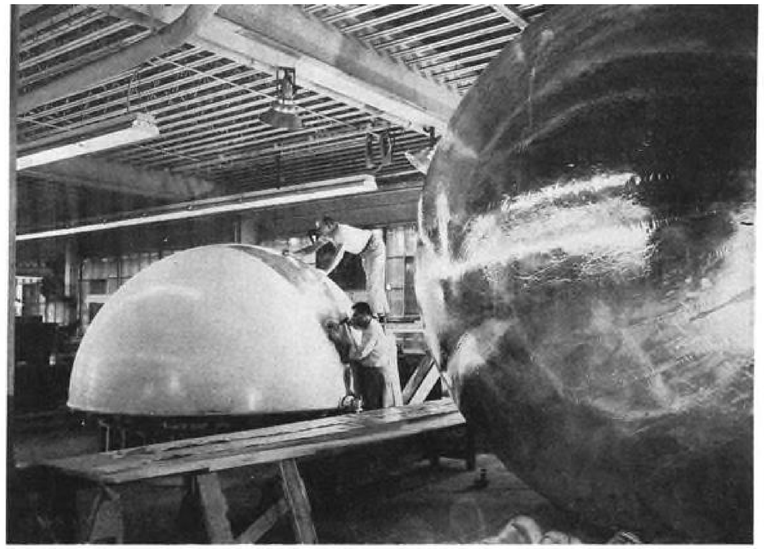
When the sphere was fully inflated, it would have been detached from the payload. After inflation, the nitrogen was to be bled off to keep the satellite from acting like a reaction jet in case of a micrometeorite puncture. It would retain its shape through rigidity of its aluminum foil skin.

The sphere designed for the drag experiment was made of Mylar plastic one mil thick covered by two layers of aluminum foil 0.5 mil thick. It weighed 10.2 lb. Sphere with its ejection and inflation system was developed by NASA's Space Vehicle Group. Development of all other payload components and payload assembly and checkout was the responsibility of the agency's Jet Propulsion Laboratory and Cooper Development Corp.

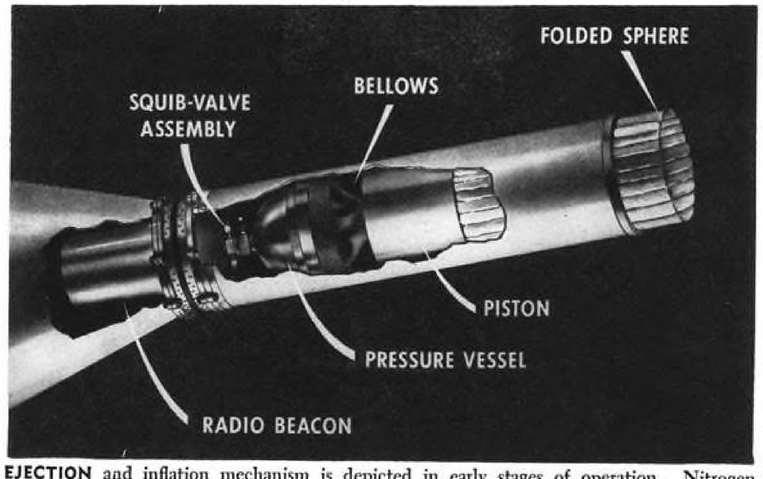
Tracking

Telemetry unit in the payload case operated with 60 mw. of power transmitting on 108.03 mc. for a few moments after launch. This signal would have been used for early tracking information on the sphere while it was still orbiting close to the payload case. Payload also had two flares which were to ignite at 190 sec. and 320 sec. for tracking, but there was no indication they fired.

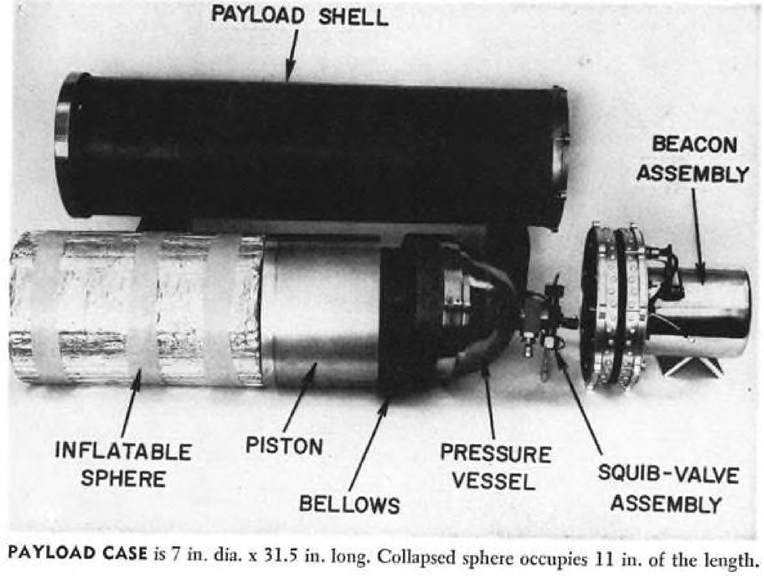
After the sphere and payload case drifted apart in orbit, tracking would have been by sight and camera. The aluminum skin would reflect about 80% of the sunlight striking it. A



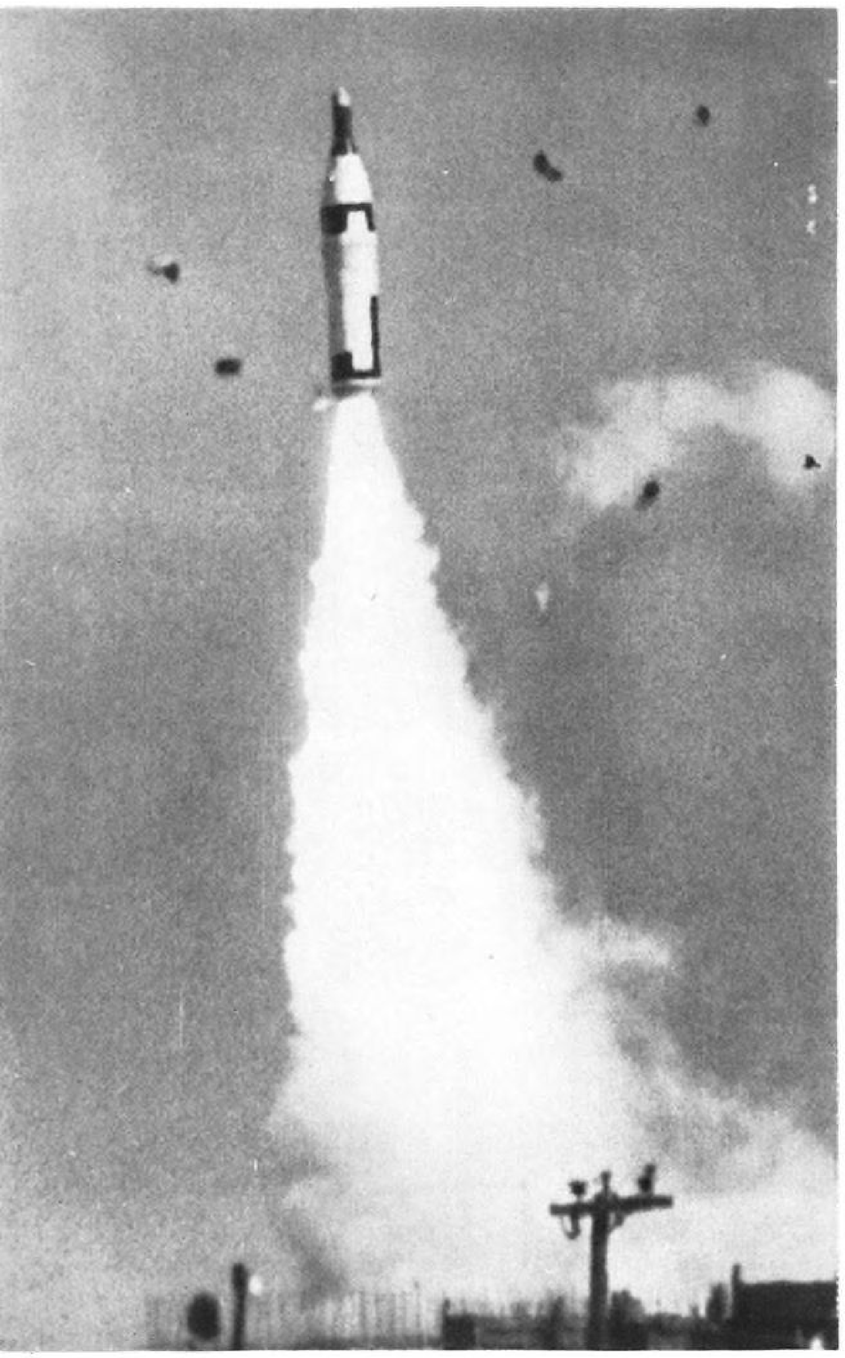
FULLY INFLATED sphere 12 ft. in diameter is in foreground; another sphere is being fabricated in background from extremely thin sheets of aluminum.



EJECTION and inflation mechanism is depicted in early stages of operation. Nitrogen from pressure vessel expands bellows which push sphere out of 25.5 lb. payload case.



PAYLOAD CASE is 7 in. dia. x 31.5 in. long. Collapsed sphere occupies 11 in. of the length.



Polaris Fired From Ship Motion Simulator

First "live" firing of a Polaris test vehicle from the USS Observation Island is scheduled to be made this week off the USAF Missile Test Center, Cape Canaveral, Fla., following the successful firing of a 600-700 mi. range AX test missile from Navy's Ship Motion Simulator at Canaveral (above). In the simulator launch, vehicle was blown to 100 ft. altitude by compressed air. First-stage engine then cut in, and test missile traveled full range. In the test, the first-stage engine ignited 1.8 sec. after the button was pressed to release compressed air into the chamber. Officials said the vehicle designated AX-13, achieved all its test objectives in the launch and downrange flight.

satellite such as this would vary generally between the brightness of third and fourth magnitude stars.

NASA reports strong, clear signals are coming in from its Explorer VI satellite, but it is still too early for a firm analysis of data on radiation belts, radio wave propagation, etc.

NASA said data received thus far from radiation instruments appears to confirm some facts and considerable theory about the structure of the radiation spectrum.

Explorer VI was hit by 28 micrometeorites during its first two days in orbit. Facsimile system is working, but it will be several weeks before enough data points have been received to assemble a picture.

Internal temperature is well within the design range of 25 to 115F, and solar cells on the satellite's paddles are charging the batteries as had been expected. Present orbit did not require the aid of the small boost rocket in the payload, and no decision has been made yet whether it will be fired later.

Raborn Urges Mobile Defense Installations

Ontario, Calif.—Fixed bases in this country represent a "Maginot Line type of military philosophy that is completely and unacceptably fallacious for the United States of America in the age of the ballistic missile," according to Rear Adm. William F. Raborn, Navy's Director of Special Projects.

Speaking to a group at dedication ceremonies for a Navy Data Design Laboratory here, he said it is quite possible for Soviet Russia to build intercontinental ballistic missiles that can zero in on any fixed installation in the United States.

As head of the Polaris project, Adm. Raborn emphasized that the Polaris weapon system is a "major war deterrent" more than it is a retaliatory weapon, and will do its job most effectively if it never has to be used.

"I think it is important," he said, "that we evaluate how we spend our defense dollar and that we don't buy a plausible explanation or plausible defense systems which may be wished to our attention by well-meaning salesmen. I, for one, am completely willing and eager to have the Polaris weapon system objectively evaluated by people who are interested in their country as the first order of attention and I think everyone else who has something to sell has to undergo the same close scrutiny.

"No amount of protection or warning devices that will tell us when the Soviets may have launched their ICBMs will bring about the kind of thing that we want and that is that they should never launch them."

Hebert Group Lists Legislative Objectives

By Katherine Johnsen

Washington—House Armed Services Investigating Subcommittee will wind up its hearings on charges of contractor influence in military procurement sometime this week, issue a report during the approaching congressional adjournment and consider legislation needed to implement its findings as the first order of business when the new session convenes in January.

The subcommittee headed by Rep. Edward Hebert (D.-La.) has sent out over 5,000 questionnaires to former high-ranking military officers and civilian government officials employed by defense industries, to the major defense contractors and to industry and service associations. The hearings, which began early in July with testimony by Deputy Secretary of Defense Thomas Gates (AW July 13, p. 35), have represented only a small cross-section of the extensive field covered by the questionnaires, which also will be evaluated for the subcommittee's report.

The objectives of the subcommittee members appear to be unanimous, but the method of achieving some of them is complicated and controversial. The objectives include:

• **First, encourage retiring** military personnel to continue in government service as civilians. At present, this is, in effect, blocked by laws against dual government compensation and by practice. In general, the law limits a retired officer to an income of $2,500 a year from government employment plus his retirement pay.

A check by the Army of 500 officers retiring over the past several months showed an average age of 46 and an average retirement pay of $350. Under Secretary of the Army Hugh Milton reported that there is "a great need" for the continued service in government of many of the outgoing officers, who are often compelled to take employment to meet financial obligations.

Top ranking retired officers, including Lt. Gen. C. S. Irvine, former deputy chief of staff for the Air Force, told the subcommittee that they would have preferred to continue within the Defense Department structure but that "there was no place further to go."

The subcommittee's problem is to decide whether the former military men should be knit into the civil service system or whether a separate corps should be established. Rep. Porter Hardy (D.-Va.) proposes that retiring admirals and generals now being bid for by defense contractors be retained on the Defense Department payroll and assigned to contractors. Hardy pointed out that the government is now paying the salary of many such top former officers as contract cost. If several contractors sought the same retiring officer, Hardy says, the service secretary would decide which contractor's work he could further most in the national defense interest. Hardy also believes that this plan would broaden the base of contractors who are well informed on future military requirements and in a position to direct their work to meet these.

• **Second, eliminate** "the appearance of evil" as well as any actual evil that might exist in the relation between active military officers and defense contractors and between former military officers and civilian government officials and their service.

Subcommittee members have hammered the point that the "appearance" must be ended to maintain public confidence and wipe out suspicions that now exist, and were reflected two months ago when a spontaneous motion to ban defense contracts to firms hiring top ranking officers within five years after their retirement narrowly missed passage, and then only after promise of a study by the subcommittee and a more considered solution.

Congressmen wish the military would take the initiative and impose a rigid code of ethics on themselves in accepting entertainment or employment from contractors. Rep. Carl Vinson (D.-Ga.), chairman of the Armed Services Committee, and Rep. Paul Kilday (D.-Tex.), chairman of its subcommittee on personnel, have urged this.

To accomplish this objective, the Hebert subcommittee is considering legislation that would require a "cooling off" period of probably two years before former officers could deal with their former service. Subcommittee members, however, are confused as to which officers such a law should apply. It has been repeatedly highlighted at hearings that a former engineering officer with inside technical knowledge, the former planner with advance information on strategic plans or an officer with national or world-wide prestige are sometimes more influential in making a "sale" for their company than the contract negotiator.

In its efforts to eliminate "the appearance of evil," the subcommittee also may propose a requirement that former officers who deal with the Defense Department must publicly register and call for an end to the practice of allowing contractors to charge entertainment off as a business expense against government contracts.

• **Third, discourage the lobbying** activities of Aerospace Industries Assn. and the promotional activities of Air Force Assn. The subcommittee already has expressed its views on this to the executives of defense firms appearing at the hearings who support the two organizations. Few sessions of the subcommittee have passed without members expressing their disapproval of AIA's use of dues charged off to government contracts in an effort to amend the renegotiation law (AW May 4, p. 31) and AFA's $1.2 million annual budget as compared with $580,000 for Army Assn., $180,000 for Navy League.

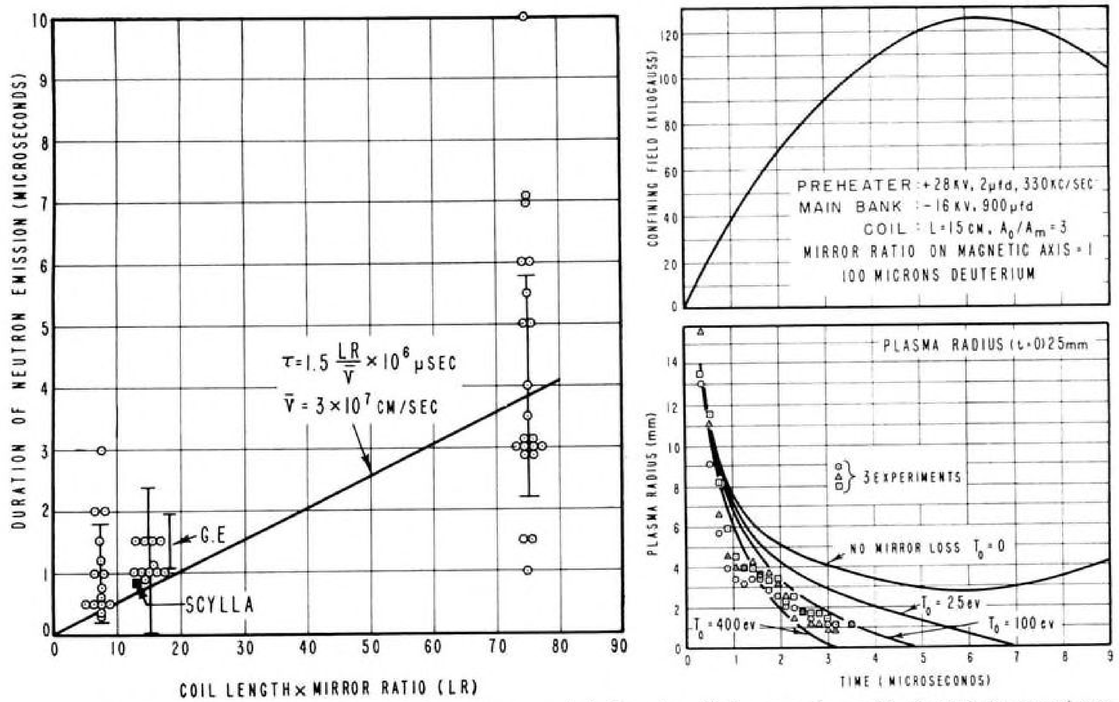
• **Fourth, minimize public battles** between contractors of competitive weapon systems which stir up local pressure and make it difficult for congressmen to vote funds for one or the other on the basis of merit. The subcommittee report is expected to censure both Air Force and Army for encouraging their contractors—Boeing Airplane Co. for USAF's Bomarc interceptor missile and Western Electric Co. and Douglas Aircraft Co. for Army's Nike Hercules air defense missile—to allegedly generate public concern over possible cutbacks in their programs at a time the Department of Defense was attempting to work out a "master plan" for air defense which has affected the future of Bomarc and Nike facilities.

GAO Challenges Convair

Washington—Testimony by General Accounting Office that Convair Division of General Dynamics Corp. has denied its investigators access to information concerning the Atlas ICBM and B-58 Mach 2 bomber programs set off a flurry of protests from members of House Armed Services Investigating Subcommittee last week. The final decision was a subcommittee wire requesting Frank Pace, General Dynamics chairman, to make the data available to GAO.

At first, subcommittee members asked GAO to direct Air Force to call off all further payments on Atlas and B-58 contracts, until it obtained the data it wanted. GAO recommended against this until a final approach had been made to the company.

In a July 24 letter, Pace assured the Comptroller General that company files would be opened, but GAO reported that as late as mid-August, Convair had refused. If the wire to Pace is not effective, Rep. Edward Hebert (D.-La.), chairman, threatened to use subpoena powers to obtain the information and turn it over to GAO.



NAVY CURVES show data from previously unstudied areas in magnetohydrodynamics. Data was made possible through the use of very strong magnetic fields and very dense plasmas. Information from devices somewhat similar to Kolb's are included on curve at left.

Space Technology

Navy May Hold Key to Controlled Fusion

By J. S. Butz, Jr.

Washington—Strong probability that a controlled thermonuclear reaction using deuterium has been achieved with small-scale laboratory equipment at the Naval Research Laboratory was outlined by the Navy last week.

Results of recent experiments, analyzed in the framework of known theory, show that the reaction which occurs in the sun and stars and in a hydrogen bomb probably has been controlled on earth for the first time.

Navy tempered its announcement by pointing out that positive experimental proof is still lacking to show that the extremely high test temperatures of 20,000,000 deg. K had resulted in true fusion of deuterium atoms. Positive proof can come only when the velocity of gases in random motion at millions of degrees can be measured directly. Use of mass spectrometers and other existing instruments for such measurements is so complicated and debatable that it is useless for any rigorous proof. Navy hopes to get more positive proof of its results when it starts using larger equipment now planned.

It was this measurement difficulty which earlier caused British scientists erroneously to claim achievement of controlled fusion and, aware of the British experience, Navy scientists headed by Dr. Alan C. Kolb have refrained for several months from making their results public. Working with the financial support of the Atomic Energy Commission and the Office of Naval Research, the Navy group has felt strongly for at least a year that it has been achieving fusion reactions.

Data Checks

Using several variations of experimental magnetic devices pioneered by Kolb which preheat deuterium plasma with shock waves and then compress it to very high densities, the group has eliminated all of its doubts concerning its data. This data now stands up to all known cross-checks.

These theoretical cross-checks are possible through experimental measurements primarily made with a streak spectrograph, X-ray photographs and a scintillation counter. The measurements allow calculations of radiation losses from the plasma, plasma densities and oscillations, plasma and magnetic pressures and the number of neutrons produced. Such measurements and calculations are well-proven methods of studying high temperature gases.

The prospect of using thermonuclear reactors to produce virtually unlimited power from the deuterium in sea water and to eliminate the radioactive waste problem of fission powerplants is still on the distant horizon, according to scientists connected with this work. AEC statements regarding controlled fusion, however, have become considerably more optimistic in the last two years.

Until last year, the AEC view was that the achievement of a thermonuclear reaction in the laboratory was still a considerable length of time away. Last year, top officials said that they believed it would be accomplished in a year or two in U. S. laboratories.

There also has been expert discussion both in the U. S. and the Soviet Union about the probable configuration of a thermonuclear device which fuses deuterium to efficiently produce power. Such a machine would be very large, probably a cylinder up to 300 ft. long and 20 ft. in diameter. Some estimates say that two or three of these machines consuming only sea water could provide New York City with power.

In taking a major step toward this goal, the Navy group under Kolb and Dr. W. R. Faust feel that their major accomplishments are:

• **Stable plasma has been** consistently produced in their experiments for 5 to 10 millionths of a second. (Some predictions are that this plasma confinement time will have to be increased to at least a thousandth of a second to produce power.) This plasma is not oscillating, changing dimension, under the influence of electric fields, or affected by any other known form of instability while it produces a shower of neutrons.

• **Confinement of the plasma** and production of neutrons continues in the Kolb device after the peak magnetic compression has passed. In the absence of any completely new phenomenon, the only explanation for this occurrence in a stable plasma is the achievement of a thermonuclear reaction.

The present Navy experiment is performed with a modification of the magnetic mirror device first used by R. F. Post of the University of California Radiation Laboratory. The Post work, however, has dealt with the problem of confining very low density plasmas approximately 1,000 times longer than the NRL experiments. Kolb's use of the magnetic mirror geometry has been to confine a very dense plasma after first preheating it very rapidly with a shock wave.

The Navy device is a glass cylinder nearly 12 in. long and about an inch in diameter, and it is surrounded by a heavy coil which has much stronger fields on each end than it does in the middle. The tube is filled with very pure deuterium gas since any sort of contamination in the gas or its container will cause erratic action once the ionization of the gas begins.

The sequence of operation of the device begins with the ionization of the deuterium by an RF signal so that it will respond to the action of a magnetic field.

Then an extremely large current is discharged as rapidly as possible through the coil surrounding the ionized gas. The strong magnetic field that this discharge creates drives the gas to the center of the tube so rapidly a shock wave is produced.

Further Compression

Further compression is produced by the strong fields on each end of the cylinder which have a "mirror" effect and reflect the plasma particles back into the middle of the cylinder as they try to escape from the ends.

Such preheating of ionized gas with electromagnetically created shock waves was first done in 1955 at NRL by Kolb. A number of different methods for producing the shock wave to rapidly preheat plasma to a million degrees or so and then compress it to produce higher temperatures have been tried. The magnetic mirror has proven the best compression arrangement and is used for the experiments which reach 20 million deg.

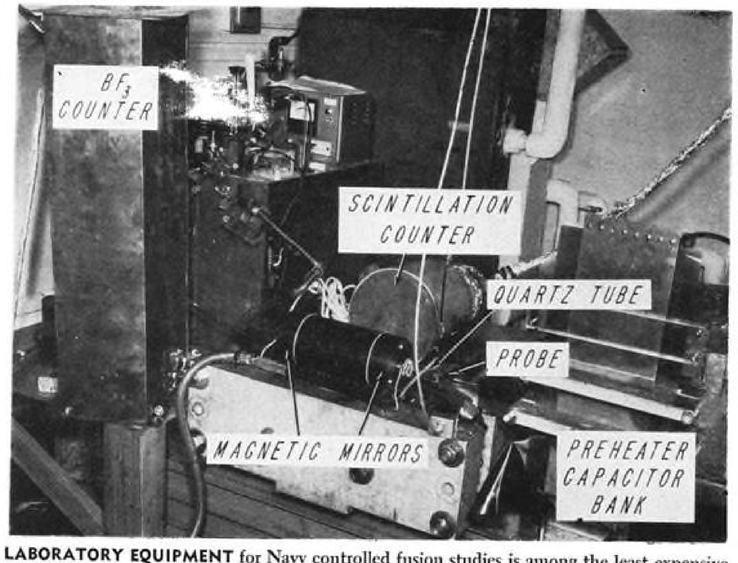
The Navy equipment now in use will produce a peak current of about four million amperes by discharging a 285,000 joule condenser bank to create the 20 million deg. plasma temperatures. The new equipment, now planned at NRL, would have a peak current of 60 million amp., a 20 million joule condenser bank and produce a peak plasma temperature of 50 million deg.

The NRL scientists feel that, if their present results were qualitatively duplicated at such temperatures, there would be no doubt about the existence of a thermonuclear reaction.

It also seems that the successful discharge of such large capacity condensers in 50 millionths of a second through a coil about 10 ft. long and seven inches in diameter would qualify the Navy physicists as electrical switching specialists of the highest order.

A number of scientists studying controlled fusion experimentally are known to be working with shock preheating. One group is at the Los Alamos Laboratory of the Atomic Energy Commission; two are in Britain, and France, Germany and Russia have at least one each.

The strong competition between these groups and among all scientists working on fusion devices has been steadily increasing. Kolb went to Uppsala, Sweden, last week to get his data and theories prominently on the record by presenting a paper to the Fourth International Conference on Ionization Phenomena in Gases.



LABORATORY EQUIPMENT for Navy controlled fusion studies is among the least expensive now in use. Magnetic fields squeeze plasma inside the black coil with magnetic mirrors on each end. Giant capacitor bank which discharges in a few microseconds to produce the required fields fills a large room below this apparatus.

West Germans Enter Sidewinder Program

Paris—West Germany will be the dominant partner and a West German company prime contractor in a six-nation NATO program to build the U. S. Sidewinder air-to-air missile.

Bodensee Werk, a subsidiary of the Perkin-Elmer Corp., is the prime contractor. A score of other companies in the six nations are included, such as Phillips which will handle the Dutch part of the program.

West Germany, which will have to equip its new Lockheed F-104G interceptors, will buy the largest number of missiles in the program. Other countries involved are Denmark, Greece, The Netherlands, Norway and Turkey.

On a smaller scale than the five-nation $500 million Hawk program (AW June 29, p. 24), the first joint production agreement formed since the U.S. promised technical and financial aid for such programs two years ago, the Sidewinder venture might eventually run to $80 million. Initial amount involved is $25 million.

German defense ministry said Bodensee Werk received a total order for approximately 8,000 Sidewinders at $3,000 to $4,000 each, making a total of $25-$30 million. Germans hope to have production under way in nine months to a year.

Discoverer Satellite Enters Orbit; Payload Reaches 537 mi. Apogee

Vandenberg AFB, Calif.—After failing to recover the capsule ejected from Discoverer V satellite on Aug. 14, USAF launched Discoverer VI last Wednesday in a second attempt to air-snatch the payload before it struck the water or retrieve it by boat soon after it dropped into the ocean.

Discoverer VI entered orbit near the nominal values sought for it, with an apogee of 537 stat. mi., perigee of 138 stat. mi. and a period of 95.3 min. It was launched at 12.25 p.m. Pacific Daylight Time, and was acquired by the Alaska station coming around on its first pass at 1:53 p.m. Pacific Daylight Time. Authorities at USAF Ballistic Missile Division said everything "looked normal." For Discoverer V the apogee was 450 stat. mi., perigee was 136 stat. mi., and period was 94.1 min.

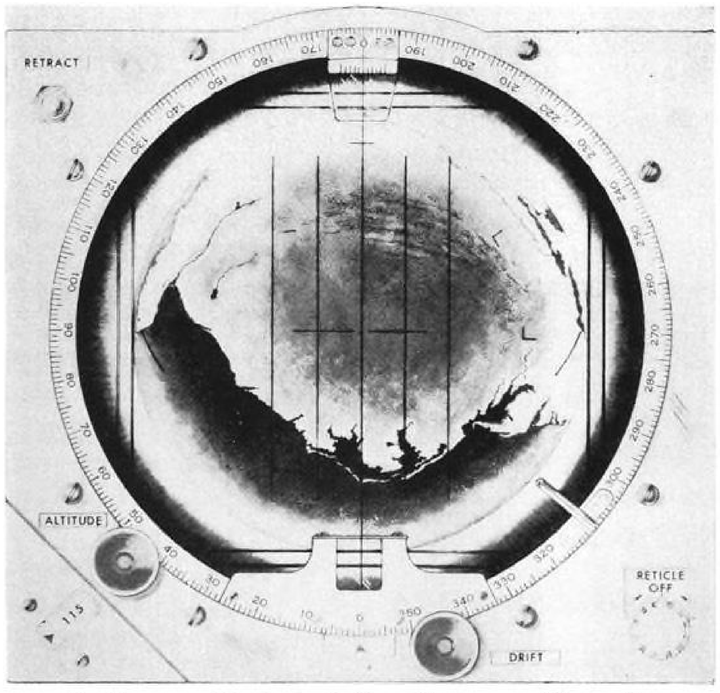
Payload which entered orbit weighed 1,700 lb. and was up 100 lb. from earlier Discoverer orbit vehicles. On Discoverer V, the total re-entry vehicle weight was 195 lb., including retro-rockets and the ablative structure which protects the recovery capsule during re-entry, both of which drop away at predetermined points in the re-entry trajectory after their work has been accomplished. Recovery capsule weighed 160 lb., leaving 35 lb. for protection and retrorocket.

For Discoverer VI, re-entry vehicle weighed 300 lb., while the weight of recovery capsule was not given, nor was weight of retrorocket and protective structure. If the weight of these components stayed the same, recovery capsule weight would be 265 lb. However, authorities said the classified payload (which is over and above the biomedical specimen capsule and its life support system), definitely did not include a living creature of any kind. Although the exact method of operating the separation of the re-entry vehicle from the satellite was not disclosed, it appeared to be a preprogramed event. In Discoverer II, the separation was to be by command, with an automatic timer backup, but the command malfunctioned and the capsule was ejected earlier than intended and lost.

The re-entry vehicle on Discoverer VI will eject on the satellite's 17th pass and the same provisions will apply for its recovery as did for Discoverer V, namely the UHF radio beacon, high intensity light, and parachute deployment at approximately 50,000 ft.

Beaver-tail Fairchild C-119s of the 6593rd Test Sqdn., based at Hickam AFB, Hawaii, will attempt to air-snatch the recovery capsule between 14,000 ft. and 1,000 ft. altitude (AW Aug. 17, p. 57). Additionally, Navy ships will be in the area.

According to the period of the satellite, the 17th pass would have occurred at about 2:13 p.m. Pacific Daylight Time last Thursday or 1:13 a.m. Hawaiian Standard Time. However, the capsule would have been ejected at such a point that it would fall into the recovery area after re-entry, indicating it would be in the recovery area within a range of ½ to 1½ hr. of this time either way.



Periscope Designed for Mercury Capsule

Drawing of 8-in. optical display of Mercury manned capsule periscope shows how 190-deg. view of earth would appear from a point 115 mi. above Raleigh, N. C. Florida is left; Cape Cod right. Altitude knob (lower left) moves four indices on viewing screen which measure the apparent diameter of the earth circle displayed on it. Other indices are used to determine attitude and position. At orbital altitude the periscope would view an area of more than 1,700 naut. mi. diameter. Power lens swings over the screen to superimpose a magnified 20-deg. view on the display. Perkin-Elmer Corp. designed the system and is building it under contract to McDonnell Aircraft Corp.

Turbofan 707-120B Wing to Be Modified

Renton, Wash.—Boeing Airplane Co. last week announced two new versions of its jet transports, essentially Pratt & Whitney turbofan engine versions of its standard 707-120 medium-range airplane and the 720 short-medium range transport (AW July 13, p. 48).

Along with the engine changes, the 707-120 will have a new wing leading edge inboard of the inboard engine nacelles, and will have three additional segments of leading edge flap.

Both airplanes will use the JT3D-1 powerplants rated at 17,000 lb. thrust, and carry "B" model designations; i.e., the 707-120 becomes 707-120B, 720 will be 720B.

Leading edge configuration and flap which will be incorporated into the 707-120B are already standard on the 720; thus the only major change on the 720B is the powerplant.

American Airlines has ordered 25 707-120s and 25 720s. In the deliveries, the airline will get the last 15 of its 720s in the B configuration, then will modify all its operational 707-120s into the B models.

United Air Lines has ordered 18 720s but has not yet announced whether it will change to the B model, nor has Aer Lingus, which has ordered three 720s. Neither has any other line except American announced plans to retrofit fan engines on 707-120s or do the complete modification to the B configuration. Boeing is working with Pratt & Whitney on development of thrust reverser and accessories.

The first 720 now is nearing completion at the Transport Division plant here, will be rolled out in October and make its first flight in November. Deliveries will start in 1960 on 720s, with B models also to be available next year or early in 1961.

One benefit from the wing and engine changes will be an increase in cruise Mach number at maximum continuous power of the engines from 0.88 to 0.90.

News Digest

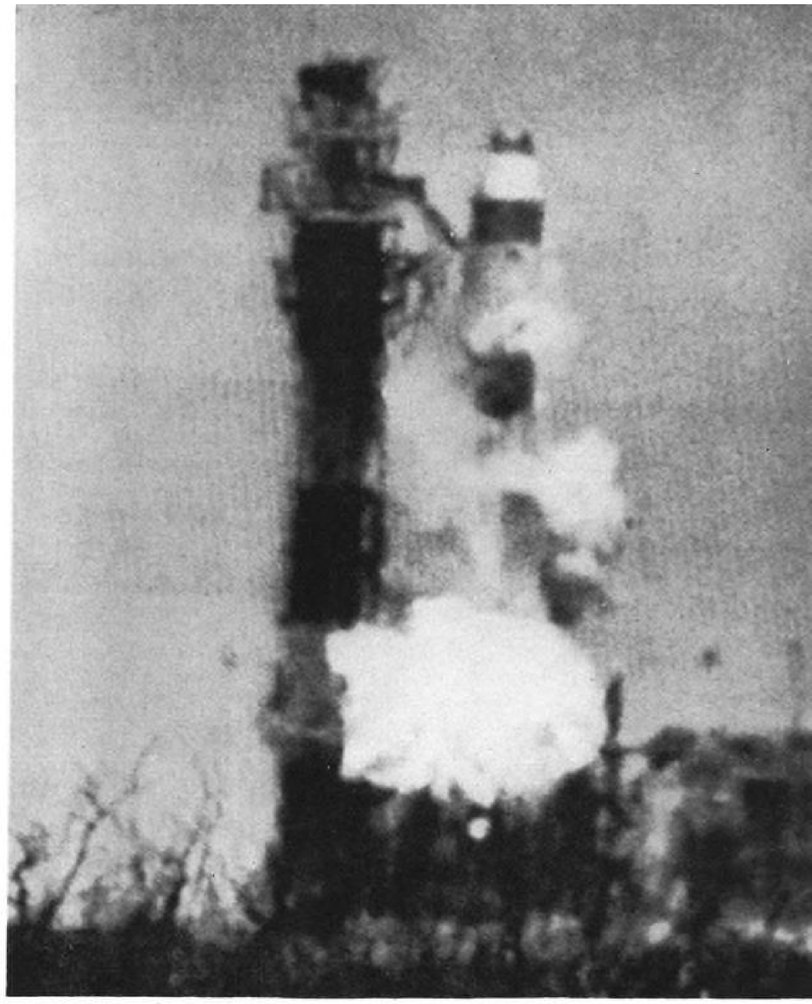
Pratt & Whitney J58 engine program was revived last week when Navy Bureau of Aeronautics gave the company an $11.2 million contract for further development work. Program was not funded in Fiscal 1959 and was dormant until last week. The 30,000-lb.-thrust engine is designed for Mach 3 flight, and Navy said it is intended for a very high speed aircraft "under consideration but not under development."

Capt. Thomas D. George, pilot of a Braniff Airways flight which crashed on takeoff at Miami International Airport in March, 1958 (AW Feb. 9, p. 103), killing nine persons and severely injuring 10 others, has voluntarily surrendered his airline transport pilot certificate and has agreed not to apply for another certificate in the future.

Claude Grahame-White, 79, first certificated British pilot, died last week in Nice, France. He was the first Briton to win a pilot certificate from the French Aero Club, and he later held pilot license No. 6 from the British Royal Aero Club. With the Royal Flying Corps in World War I, he flew on the first bombing raid in British history.

Bell Aircraft Corp. will provide hydrogen peroxide reaction controls for the Convair Centaur vehicle. Bell has a $380,000 initial contract from Convair's Astronautics Division for the control system.

General Electric Defense Electronics Division has received an $8 million Navy contract to build guidance control units for the Sidewinder infrared missile. Navy also awarded $1 million contracts for Sidewinder fuzes to Baldwin Piano Co. and the Ordnance Division of Minneapolis-Honeywell Regulator Co.



Titan Hold-Down Clamps Malfunction

First attempt to achieve in-flight ignition of the second-stage engine of Air Force-Martin's Titan intercontinental ballistic missile was aborted earlier this month by the premature and accidental release of the hold-down clamps. Designed to hold the missile on the pad for a six second period after first stage ignition to permit a final systems check, the four "A-frame" arms that lock on to longerons along the Titan's body fell back after only one second while the umbilical cord was still attached to the missile. Reason for the premature release was not definitely known. As the Titan began to rise off the pad, presence of the umbilical cord automatically touched off a malfunction signal which, in turn, triggered a safety mechanism that cut off the first stage engine. The missile, which had lifted approximately 10 ft. into the air, then crashed back onto the pad and burned.

Federal Aviation Agency has certificated increased takeoff and landing weights for the Fairchild F-27. Takeoff weight has been increased 800 lb. to 36,500 lb.; landing weight is increased 2,000 lb. to 36,000 lb.

Texas Instruments, Inc. will build AN/APS-80 advanced airborne surface search radar systems for anti-submarine warfare under a $9,373,728 Navy Bureau of Aeronautics contract.

Aerojet-General Corp. and Acoustica Associates, Inc., will jointly explore methods of utilizing, manufacturing sonic controls for advanced space vehicles.

BuWeapons Forms

Washington—Rear Adm. Paul D. Stroop will head Navy's new Bureau of Naval Weapons which becomes operational by Jan. 1 at the latest. New bureau, which will be formed by merger of Bureaus of Ordnance and Aeronautics, will become the Navy's largest, supervising 350 naval bases and facilities and 210,000 people. Deputy of Stroop, now head of BuOrd, will be Rear Adm. William A. Schoech, former deputy commander of BuAer. BuAer's present commander, Rear Adm. R. E. Dixon, will be given a sea command.

Commuter Ticket Trend Gains Impetus

Ticketing system begun by three major airlines may be followed by other carriers to meet competition.

By Glenn Garrison

New York—Recent introduction of "commuter" type ticket plans by three major airlines has started an industry trend that many other carriers are likely to join whether or not they are thoroughly sold on the idea.

Several major airlines will soon follow and if the plans work out successfully most of the industry can be expected to go along, if only to meet the competition.

Northwest Orient Airlines was the third airline to institute a simplified plan for its commercial customers. Capital Airlines and American Airlines had introduced generally similar plans earlier this month on certain of their routes (AW Aug. 17, p. 54). All three plans involve the sale of books of 10 tickets, with the customer making his reservation by telephone, filling in flight information on his ticket, and easing the ticket counter load at flight time.

The idea of airline commuter tickets has been around for some time, but as an Eastern Air Lines official put it, "somebody eventually had to make up his mind to jump into it." Eastern definitely expects to go into commuter-type ticketing within the next few months, despite certain misgivings about the plan.

But Eastern will tie such a move into a major ticketing improvement program now under way. This involves use of a new ticket printer, a new IBM auditor's coupon which will be attached to tickets to permit computer revenue accounting, and, the airline hopes, eventually an automatic ticket reader which will automate the entire accounting process.

First markets where Eastern probably will use the commuter plan are New York-Washington and New York-Boston. Most airlines see the plan as suited primarily to high density, relatively short haul markets, but Northwest's commuter tickets will be good on all domestic runs and to Alaska and Honolulu. Here is how some other airlines view the commuter ticketing idea:

• **Delta Air Lines** is studying the idea but hasn't yet decided to adopt it. The decision will depend partly on how well the plan works out for other carriers.

• **National Airlines** will watch the results of other carriers' experience for a while before going into the plan. It will appraise the demand and the problems that come up in operation. National has been considering commuter service for some time, but did not previously feel it was worthwhile in terms of demand for the service on National's routes. The airline has been in the commuter-type New York-Boston and New York-Washington markets for only about two years and only recently has reached a frequency level which it feels might justify this type of service. Also under consideration is a plan to link Norfolk to the commuter ticket pattern.

• **Northeast Airlines** may offer commuter tickets within the next month over its New York-Boston, New York-Washington and Washington-Boston routes. The airline recently began selling preprinted tickets over some of its routes as one move toward simplification. According to Nelson Fry, vice president-traffic and sales, the entire industry must cope with the ticketing problem as well as the reservations problem, which is closely tied in to ticketing. An objective, Fry said, is to keep as many people as possible away from the jammed ticket counters.

• **Trans World Airlines** expects to go into commuter ticketing soon, although no final decision has been made. Routes under consideration are New York-Pittsburgh, Pittsburgh-Chicago, Chicago-Kansas City, Kansas City-St. Louis, Los Angeles-San Francisco, and New York-St. Louis.

• **United Air Lines'** sales department is taking another hard look at the commuter idea, but no decision has been reached. It seems clear, however, that United would be forced to offer a commuter ticket plan if its major competitors did.

• **Western Air Lines** is watching the introduction of the commuter ticketing, but has no firm plans to go along. It will depend on how the competition makes out.

American's plan went into effect Aug. 15 over its Boston-New York-Washington route, and the original plan was to evaluate the results at the end of October and then consider expansion of the plan. With what a spokesman called "the rash of competitive plans," however, American is almost certain to expand the service after the evaluation. Other probable routes: New York-Chicago, Washington-Chicago, New York-Detroit.

American foresees little difficulty with possible abuses of the plan by its users. An official of another airline had suggested that the holder of a commuter's book might report for a flight on which he had not made a reservation and surrender a coupon (made out by himself) which nevertheless indicated space on that flight.

The ruse would be discovered, of course, but this official didn't like the idea of having to "slap a customer's wrist." Controlling this sort of abuse, in his view, would put the airline back where it started—i.e., require another check-in and eliminate the time-saving advantages of the plan.

American, however, says its commuter-book customers are regular American travelers who are well known to the airline and can be trusted not to abuse the service.

Regarding variations on the in-flight ticketing system introduced in June by Continental with its new Boeing 707-120 jet services, TWA is "very interested" in the idea. TWA, along with other carriers, has had representatives flying Continental schedules to see how the system, which involves an additional "passenger service agent" crew member, is working out (AW May 18, p. 52).

And Fry of Northeast said his airline is "very definitely" considering an in-flight ticketing plan. Northeast's system will not be similar but will incorporate "all the good points" of Continental's, Fry said.

American, on the other hand, has decided not to go into the system. The airline feels that its own system of handling passengers and ticketing, where possible, in its new departure lounges is a preferable solution.

Continental, for its part, has no plans along the commuter ticketing line. As far as its in-flight ticketing system goes, Continental points out that the plan might not work as well for larger carriers as it reportedly is for Continental. From a cost standpoint, Continental has found that the extra crew member is just a little less expensive than extra agents behind ticket counters to handle the volume of jet passengers would have been.

The increase in ticket counter traffic to Continental is proportionately much greater than to a carrier with more volume to start with, and hence the number of extra counter agents must be proportionately greater. Out of Chicago and Los Angeles, for example, Continental offered about 250 seats a day from each city before jet services began; by Sept. 5, this total will be about 800 seats at each city.

Continental said it had received a number of complaints from travel agents about the new system, on the ground that passengers would bypass the agents and buy their tickets on the plane. But the airline said only 5% of its jet customers are actually ticketed on the plane. The rest already hold tickets which are picked up by the in-flight agent or rewritten by him if they require changes.

The airline had expected at least a few customers to dispute excess baggage charges, which are collected in flight by the airborne agent. But there have been no complaints, according to Continental.

The carrier said it has sold more than $5,000 worth of tickets on its jets to representatives of other airlines making the flight to check out Continental's service.

Convair Accelerates 880 Jet Transport Tests

Three Convair 880 jet transports, used in Convair's flight test program, are lined up at San Diego plant. No. 1 plane (foreground) and No. 3 (background) have completed six months test program; both have flown at 615 mph. in level flight. The flight test 880 (in center) has completed its initial flight and will be used for service testing to simulate actual airline operations. Federal Aviation Agency certification flights will begin in September; first delivery will be made in November to Trans World Airlines with Delta Air Lines getting its first 880 in January. Powerplants are General Electric CJ-805-3 turbojet engines rated at 15,000 lb. thrust each.

Recorder Checked For Crash Clues

New York—Flight recorder recovered from the American Airlines Boeing 707-120 that crashed during a training flight Aug. 15 with the loss of five crew members was being examined last week for possible clues to the cause of the accident. The jet transport was approaching for a landing on Runway 23 at Grumman Field, Calverton, Long Island.

No emergency had been declared, and the flight had received landing clearance shortly before going into the ground from an altitude estimated at 500 ft. or higher on the basis of eyewitness accounts. Investigators were still sifting evidence last week and exact movements of the plane had not been determined.

From the location of the crash site, the aircraft might have been turning from base leg to final approach. The training program includes two-engine-out approaches.

The aircraft left New York International Airport at 1:40 p. m. and went out over the Atlantic Ocean for about two hours of medium and high altitude training maneuvers. It arrived at the Long Island field about 4:20 p. m., made a no-flaps approach without landing, and went around for the approach that was to prove fatal. Impact point was 3.2 mi. from the northeast end of the runway and .07 mi. east of its centerline. The impact area was 600-700 ft. in diameter.

An explosion and fire followed the crash. Killed in the accident were Harry C. Job, 45, the pilot instructor in charge; Fred W. Jeberjahn, 50, and William R. Swain, 49, student pilots; Arthur Anderson, 40, the instructing engineer; and Edgar Freeman, 36, student engineer.

Jeberjahn had 9 hr. 10 min. of actual pilot time on the 707-120, as well as 29 hr. 18 min. of training observer time and 25 hr. 5 min. of line observer time. Swain had 9 hr. 55 min. of actual pilot time, 14 hr. 52 min. of training observer time, and 25 hr. of line observer time.

Job had been an American Airlines check pilot since 1955. He had more than 200 hr. on the 707-120. The two captains being checked out were being qualified for their type rating, which usually comes after about 15 hr. of checking out.

Flying Tiger Completes CL-44 Financing

Washington—Flying Tiger Line last week said it had successfully completed the financing of a fleet of 10 Canadair CL-44D-4 turboprop air freighters purchased last spring from Canadair (AW May 18, p. 41).

Proceeds from a private sale of $5 million of 5½% convertible debentures due in 1974 were applied to down payments on the new aircraft. Previously, the carrier had called for redemption on July 1, 1959, an issue of 5½% debentures due in 1967.

Balance of the purchase price totaling $43 million—80% of which is guaranteed by the Canadian government—is covered by equipment trust certificates. The new issue will be Series B bonds convertible into common stock at $18 per share until 1969. The issue will call for a common stock reservation of 277,700 shares. As of July, 1,344,420 shares of common stock are outstanding.

General Dynamics itself bought $3 million of the debentures. Two mutual funds—Axe-Houghton Fund and Puritan Fund of Boston—bought $500,000 each and three other funds took the remaining $1 million.

Trunklines Heading for Record Profits

Washington—Domestic trunklines, backed by the most prosperous first half-year in their history, are now aiming for all-time highs in profits for the year.

Barring an unexpected reversal of the spectacular rise in passenger traffic recorded every month so far, chances are strong that the industry in 1959 will top the record $63 million in net profits set in 1955. Thus far, even the steel strike, which began in mid-July, has failed to stem the upward trend in traffic growth.

Net earnings of the 12 trunklines for domestic operations during the six-months ending in June reached $29.5 million. Net profits for the same period last year totaled only $7.9 million.

Operating revenues also rose sharply to a new high during the six-month period, a direct result of 1959's remarkable recovery of traffic growth following an 18-month period of business doldrums during which time traffic volume remained stagnant. However, expenses continued to climb and to threaten the rate of return the carriers feel is necessary to back the $3 billion jet equipment program now in progress.

Each of the 12 trunk airlines showed an increase in both revenues and expenses during the period. Only Capital Airlines and Northeast Airlines reported net losses for the period.

American Leads Industry

American Airlines led the industry in earnings with a net profit after income taxes and special earnings of $8.8 million. United Air Lines, despite inroads from jet operations by competitors, was the second highest profit maker, with a net of $7 million for the six month period including a gain of $476,000 on aircraft sales.

According to United President W. A. Patterson, an 11% increase in passenger revenues was attributed to a "general upward trend in the industry." He noted that coach traffic had increased 22% during the six-month period, while first-class passenger miles dropped 3% from the 1958 level due to a "planned reduction in our long-haul schedules subject to jet competition."

Trans World Airlines reported a system-wide net profit of $3.9 million before taxes, as compared with a loss of $11.9 million for the six-month period in 1958. Tighter management control over expenses and Boeing 707 operations were cited as the reasons behind the sharp reversal in the company's financial results.

Available seat miles for the industry hit an all-time high during the six months, although the month-to-month increase during the period was not as marked as it had been in years prior to 1958. Braniff Airways, which reported an 11% rise in revenues, adjusted schedules during the period to hold available seat miles .45% below the 1958 level. Net income for the period was $1.8 million, compared with $870,000 during the first six months of 1958.

Capital's operating revenues climbed 10% in the first half of 1959 over the same period last year. Although the airline reported a first half loss of $624,000, an operating profit of $550,000 and a net profit of $312,000 was reported in the second quarter of the year.

Western Air Lines showed first half earnings of $1.8 million, while Northwest reported a $1.8 million net profit from both domestic and international operations—a 260% increase over 1958 earnings.

Why the Increase

Generally, most carriers attributed the increase in revenues and profits to the expanding traffic markets developed by the attraction of the jets and to the wide-scale promotional and advertising campaigns that have accompanied the introduction of turbine power. Several airlines, which have not yet taken delivery on new equipment, feel they have benefited by the strong sales efforts of the carriers which have started turboprop and turbojet service.

In addition, the rapid monthly increases in coach revenue passenger miles during the first six months, compared to a steady fall in first-class revenue passenger miles, lead a number of observers to believe the airlines are now successfully expanding the huge vacation travel market.

Eastern Air Lines showed a comparatively small gain of 5% in total operating revenues. Failure to realize a larger increase was attributed "principally to the multiple competition imposed by the CAB on Eastern." The airline said that the revenue increases it did experience could be attributed to the two fare adjustments authorized by the Civil Aeronautics Board.

Eastern expects to enter turbojet competition early in 1960 with the first of its Douglas DC-8s. United and Delta plan to inaugurate their DC-8 service early this fall.

Delta Boost

Delta reported net earnings for its domestic operation of $1.6 million during the first six months of the year. On the basis of a fiscal year ending June 30, the carrier reported system-wide net profits of $4 million for the year. Operating revenues reached a new high at $103 million—a 17% increase over the $88 million for the previous fiscal year. Expenses were held to a 10% increase.

C. E. Woolman, Delta president, attributed the improvement in earnings to strikes experienced by competing airlines, the effect of passenger fare increases and the general recovery from the 1958 recession.

National Airlines, which reported a sharp increase in passenger revenue miles so far this year (AW July 13, p.

An-10 Starts Moscow-Simferopol Schedule

Aeroflot An-10 turboprop transport loads passengers for run from Moscow to Simferopol; nonstop flight takes 2 hr. Note pronounced washdown in wingtips extending from outboard engine nacelles (AW July 6, p. 34); another major modification is addition of two vertical fins for additional stability. Plane carries 85 passengers and is designed for operations from grass fields and dirt runways. It has truck-bed level loading door for cargo and has extremely short takeoff run and high initial rate of climb (AW July 27, p. 47).

36), earned a net profit of $1.6 million during the first six months of the year. Load factor remained well above that of its two direct competitors on the New York-Florida route, due principally to the service operated with Boeing 707s leased from Pan American.

National's operating revenues climbed from $30.7 million during the first six months of 1958 to $37.5 million in the same period this year.

For the industry, operating revenues during the six month period climbed to $859 million from $737 million in the same 1958 period. Operating expenses totaled $801 million this year compared to $715 million last year.

In the international field, Pan American reported net income after taxes of $652,000 for the first half of 1959 as compared with a loss of $1.6 million in the first six months of last year. Net income in the second quarter of the year was $3.1 million, compared with $1.7 million in the 1958 period.

Four Carriers Propose Military Airlift Boost

Washington—Four U. S. airlines last week asked the Civil Aeronautics Board for permission to confer with U.S. government agencies on development of a plan to expand the commercial airlift of military cargo and passengers.

Civil Aeronautics Board approval to discuss the plan with Defense Department and other federal agencies is needed to exempt the carriers from anti-trust laws which restrict them from acting in concert with one another. The four carriers involved are Northwest Airlines, Pan American World Airways, Seaboard & Western Airlines and Trans World Airlines.

Points the carriers want to discuss with the Defense Department are:

- **Expansion of peacetime** commercial airlift of military cargo and personnel as the most economical means of developing a large fleet of modern aircraft which would be instantly available in emergency as well as in peacetime.
- **Establishment of fixed rates** for military air transportation services.
- **Guarantee that continuity of** the air logistics pipeline will be maintained during emergencies.

The program is the latest effort on the part of the airlines to win a larger share of military traffic moving over international routes. The plan is similar to one proposed by Seaboard & Western (AW July 20, p. 30).

According to the carriers, the plan conforms to a Defense Department policy which calls for assurance of a service that "is always available and reliable, and rates which are reasonable and predictable, in crises as well as in periods of normal traffic."

Jet Training Flight Hazards

The recent crash of an American Airlines Boeing 707-120 jet transport while on a training flight must surely raise once again certain questions regarding the adequacy of our pilot training programs. At the time, the 707 was practicing emergency landing procedures in the phase of the training program that includes landing with two engines out. Pilots on many airlines, as well as some people within CAB and FAA seriously question whether this particular game is worth the candle.

There are CAB statistics available on training accidents. One can learn, for example, that over the past 10 years the airlines, on training flights alone, have damaged or demolished about 45 aircraft and killed 27 crew members. Some of these accidents might have happened on any flight since there were collisions, engineering design faults in the airplanes and various other things. But on the whole, these statistics tell us only that training is dangerous. And we already know this.

Reduce the Risk

Still we can hardly drop the matter. We must find out if it is possible to reduce the risk. Obviously the very nature of the beast is a handicap. Training implies lack of knowledge, which means mistakes which beget trouble. So the overnight, sure cure is hardly possible. It seems that we are faced with an industry problem which will take soul searching and head scratching and much objective discussion to improve. Although I speak in airline terms, there is no section of aviation that is immune to the training disease.

So here are some random thoughts. Do we know how much can be accomplished with simulators? The Air Force has made considerable use of such devices, but on the whole I do not believe that their findings have had much influence on the airline industry—a condition which means that we are wasting valuable information. Among airlines, both United and Pan American have made extensive use of training devices and elaborate schools. Is their knowledge being put to good use?

Qualified Teacher Need

The expenditure of money, time and effort does not, of course, guarantee high scholarship. Personally, I have the feeling that we continually overlook the need for good teachers. Indeed, I often think we palm off ground school chores on anybody who will take the job. Yet, qualified teachers should rank high on the list of "musts" in a training program.

Numerous training accidents, such as the recent American crash, seem to occur during low-level, partial power exercises. Are these necessary? Must we tool around the local aerodrome in 707s and Douglas DC-8s with two engines out? Does this really produce a safer pilot? On the whole, pilots seem to have little difficulty in coping with power failure during actual operations. But in the peculiar climate of training, or on the check ride, the hazard becomes magnified, and trouble often results.

Certainly, I would not make a plea for less training. Quite the opposite. It would appear that pilots should have the opportunity to acquire even more flight time on high performance aircraft. And not just command pilots either because the days of one man operation are gone.

If I were the president of an airline, I believe I would be extremely choosey about who was in charge of my training plans where $5 million aircraft were concerned. I would not settle for less than my best operational man, who would hire the best teachers and make use of all existing information. And I would not pinch his budget. Above all, however, I would keep asking, "Is there a better way?"

SHORTLINES

► **British Overseas Airways Corp.** will begin New York-Tel Aviv, Israel, service via London and a continental European point in November. Bristol Britannia aircraft will be used, with de luxe and economy seating from New York to London and first and tourist class from London to Tel Aviv.

► **Continental Airlines** flew an estimated 70,484,000 revenue passenger miles last month, a 77% increase over the 39,775,000 figure logged in July, 1958. Air mail, freight and express rose 30% from 322,000 ton-miles in July, 1958, to 417,000 ton-miles this year.

► **Emery Air Freight Corp.** had $3,205,033 in revenues during the second quarter of 1959, a 44% increase over the same period last year. Adjusted net income after taxes amounted to $109,753. First half revenues for the air freight forwarder were $6,264,517 this year, compared with $4,443,110 during the first half of 1958. Net income for the 1959 period was $238,928, or 33 cents per share.

► **Frederick B. Ayer & Associates, Inc.,** has purchased the interiors of five of the 10 Douglas DC-7B aircraft being converted from passenger to freight configurations by American Airlines. The interiors are in both first and tourist class configurations and will be marketed along with the Douglas DC-6A and DC-6B aircraft Ayer is currently selling and leasing. Customizing will be done by AirResearch Aviation Service Co., division of the Garrett Corp.

► **Board of Airport Commissioners,** Los Angeles, has approved two contracts for improvement and development at Los Angeles International Airport. The first contract for $817,043 goes to Matrich Brothers, Colton, Calif. for reconstruction of instrument Runway 25L and includes overlaying 6,000 ft. of existing pavement with concrete. Second contract for $36,963 provides for extension of south taxiway K.

► **Pacific Northern Airlines** carried 17,245 passengers a total of 14,884,000 revenue passenger miles during July, an over-all increase of 6% over July, 1958. The airline's air cargo rose 7% to 336,935 ton-miles.

► **Port of New York Authority** has authorized an expenditure of $1,250,000 for construction of a 3,350 ft. extension to the east end of Runway 13R-31L which will make it 14,600 ft. long.

AIRLINE OBSERVER

► Domestic trunkline traffic continued its spectacular climb in July with the 12 carriers reporting a strong 64.38% load factor. Although July's revenue passenger miles totaling 2.58 billion dropped slightly from June's 2.61 billion, the July figure represented a 15% increase over the 2.25 billion revenue passenger miles flown during July, 1958. Available seat miles in July reached four billion to set a new record for the industry. Thus far this year, load factors have held above the 60% mark in every month except February when the figure dropped to 57.72%. (For earnings breakdown see p. 41.)

► **Heavy impact of turbojet operations on the investing public is indicated by the market activity of Pan American common stock following the return of a Boeing 707-120 transport to Idlewild last Monday shortly after taking off for Buenos Aires. Immediately after the incident was reported, Pan American shares gained in activity and closed the third most active on the New York Stock Exchange. Boeing closed fifth in volume standings for the day. Both stocks showed losses of one point.**

► Capital Airlines will make a decision on its re-equipment program within the near future. The carrier now is close to completing its refinancing plans to underwrite the program which will include Lockheed Electras and Convair 880s. Active discussions between Capital and Hughes Tool Co. are still under way covering the possible purchase of a part of the fleet of 30 Convair 880s Hughes has on order for TWA.

► **Port of New York Authority takes a dim view of broadcasters' proposed efforts to steer crowds away from airports during emergencies by including admonitions in bulletins describing the incidents. Austin Tobin, Port Authority executive director, has said such instructions to radio audiences were "like telling the baby not to stuff peanuts up his nose." National Assn. of Broadcasters recently met with Federal Aviation Agency and volunteered to press for such warnings as part of emergency bulletins (AW Aug. 3, p. 35).**

► Aeroflot, the Soviet state-owned airline, in another step toward converting its fleet to all-turbine power (AW Aug. 3, p. 40), has replaced twin-engine Il-14s with 80-passenger Il-18s on the route between Moscow and Frunze, central Asian capital of the Kirgiz Soviet Socialist Republic. The thrice-weekly Il-18 flights cover the 2,050 mi. run nonstop in about five hours.

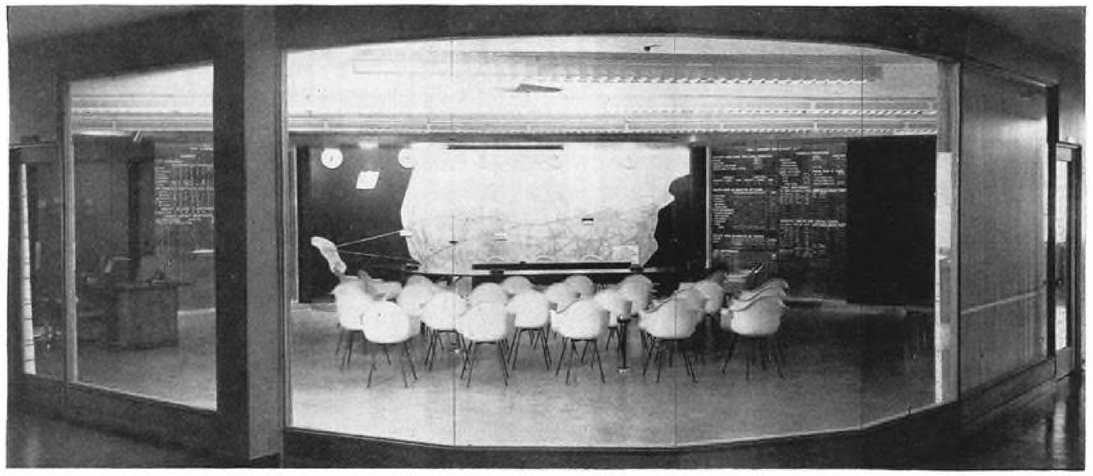
► **Pilots flying for airlines involved in the recently-established Air Union (Air France, Alitalia, Sabena and Lufthansa) have formed a European Federation of Airline Pilots "to protect pilots' professional interests within the Air Union set-up." Lufthansa pilots have not as yet officially joined the group, which is to be called Europilot. They have agreed, however, to cooperate with it. KLM pilots will attend Europilot sessions as observers.**

► Napier has replaced all bearings on all Eland turboprop engines that have been subjected to truck transportation. Due to brinelling of bearings, Napier engineers have determined that road shock on truck shipments between New York and Washington was the direct cause of engine failures on Allegheny's Canadair 540 (AW July 27, p. 27). Plane has been in scheduled service with Allegeheny for the past four weeks without any indication of further bearing trouble. All engines are now being airlifted directly from England to Washington.

► **Pan American's Boeing 707-320 turbojet service from Los Angeles and San Francisco to Tokyo, scheduled to begin Sept. 5, is sold out until mid-October.**

► Rolls-Royce has increased the thrust of its Conway turbofan engines from 16,500 lb. to a minimum guaranteed thrust of 17,500 lb. 18 months ahead of schedule. The engine has been specified for the Douglas DC-8 aircraft purchased by Trans-Canada Air Lines and Boeing 707-420s ordered by Air India, British Overseas Airways Corp., Lufthansa and Varig.

► **New emphasis on promotions to attract tourist and vacation markets is beginning to pay off. Sharp upswing in the sale of package vacations during the first six months of the year is being reported by most major carriers.**



FOCAL POINT of United's operating base is briefing room; irregularities can be spotted along entire system.

United Center Gears for DC-8 Integration

Denver—United Air Lines will lean heavily upon its briefing room facility here as a key factor in the integration of its fleet of Douglas DC-8 turbojet transports into scheduled service next month.

The briefing room, located at United's operating base, serves as a standing overseer of all operating and maintenance activities of the airline. It is a managerial command post where last-minute operating facts and figures are gleaned from every segment of the system and then compiled into an up-to-date statistical record of the company's over-all performance.

Running Account

In this way, a running account of the airline's current operating status is constantly available from the briefing room's wall charts and maps to permit management to correct immediately—and anticipate—performance deficiencies. United President W. A. Patterson has on his desk early every morning a current summary of the briefing room's records showing traffic statistics, operating performance, gross revenues and profit for the preceding midnight-to-midnight 24-hr. period.

Focal point of the briefing room is an 8 × 10 ft. wall map outlining the company's 14,000-mi. route structure. Coded lights on the map flash continuously to indicate weather conditions and other operating factors at various terminals.

The map is flanked by panels of lucite approximately 8 × 8 ft. in size. Complete summaries of operating performance for the previous 24-hr. period are posted on the panels—a detailed record showing engine, aircraft, station and flight performances, mileage flown and canceled, delays, maintenance and overhaul statistics and traffic records. The room is enclosed with glass walls so that any person assigned to the base may check up-to-the-minute records throughout the day without actually entering the room.

Briefing sessions begin promptly at 8:00 a. m. Monday through Friday and are attended by managerial representatives from all departments, including personnel, economic controls, finance and property. Actual records on the lucite panels are posted every 24 hr. seven days a week.

Sessions are conducted by four specialists who review operations for the past 24 hr. and outline plans for the next 24-hr. period. Opening discussion is presented by a meteorologist who describes weather forecasts for the next 24 hr. and pinpoints weather conditions which have influenced operations throughout the system and which may continue to affect flight movements in the period ahead.

Flight Progress

As a consequence, passenger service, ground services, passenger relations, ramp service and payload control are not excluded from the detailed weather information normally confined to flight operations and allied departments. United places a high value on the effect such information has in keeping passengers informed on the anticipated progress of their flights.

A maintenance and overhaul specialist follows the meteorologist. Summary of equipment covering aircraft scheduled for service and those out of service for routine and non-routine purposes is presented. Status of aircraft and engine overhaul work at United's maintenance base in San Francisco also is included in this review.

'Deficiency Patterns'

United officials here are convinced that the engineering phase of the briefing will be of major importance in establishing "deficiency patterns" in the shakedown stages of the DC-8. At present, the procedure enables engineers to put their fingers on the exact cause of a decline in operating efficiency by studying problem patterns as they develop.

For example, briefing records disclosed that in May the Curtiss-Wright R3350 engines for the DC-7 experienced 11.6 removals per 10,000 engine hr. flown—highest since December—while the Pratt & Whitney R2800 engines on the Convair and DC-6 transports maintained a relatively normal record of 2.6 removals per 10,000 engine hours flown. The upward trend was immediately checked following a further analysis and study of the R3350 engine performance record.

In another case, a rash of engine generator malfunctions which was causing a slight dip in on-time flight performance was brought to light by the records. Statistics revealed a problem pattern that spotlighted deficient washers as the source of the generator breakdowns. A new type of washer was introduced to eliminate this particular problem.

Traffic briefings are third in line during the morning sessions, which last about 35 min. The traffic specialist concentrates on customer service problems and proposes solutions adaptable to economic, traffic and operational considerations. Since customer service problems generally arise from operational problems, a close coordination between the various major departments—once rare in the airline industry—evolves as the issues at stake are ironed out.

Traffic summaries include current load factors, number of passengers carried, number of flight schedules completed—close to 99% at the present time—originating and en route flight performance factors.

Equipment Availability

A flight operation specialist takes over following the traffic briefing to outline availability of equipment for regular service plus charter or extra section requirements. Operating plans for the next 24 hr. are presented in detail.

The session closes with a summary of the main items discussed, which are flashed on a screen by an overhead projector.

Briefing room records not only serve the airline as a minute-by-minute tabulation of daily and monthly activities but also act as a ready source of information in economic research and analysis, traffic studies and source material for testimony before Civil Aeronautics Board hearings. Each daily record is permanently filed on microfilm.

Data also are used by the sales department in directing sales campaigns and advertising programs to strengthen weak traffic areas. Merchandising programs are developed according to traffic flows disclosed by the records. New schedules are revised whenever the briefing room records indicate a softness in any area or route segment.

Briefing room information is available to all managers and supervisory personnel and plays the role of monitor in guiding future moves toward maintaining top efficiency and effectiveness of the airline's performance.

Communications Flow

Despite the fact that more than 100,000 figures are extracted from roughly 3,500 teletype messages received daily from United stations, the airline has made very few changes in communications requirements in developing the program. Field documents extensively employed, and most teletype messages used are copies of messages essential to flight dispatch, weather, load planning, reservations, station coordination and customer service.

In effect, basic information stems from the passengers and how they are treated. A perfect trip—no delays, no incidents—is filed statistically and routinely without embellishment and draws little attention from those scanning the briefing room charts.

It is the irregular flight that commands the major attention of management and calls for more than a simple rundown of figures. Statements detailing the cause of the irregularity and the corrective action, either taken or proposed, must accompany the report.

Briefing Room

The briefing room is a clearing house of information for the airline. Data fed to it through the various operating, traffic and sales departments is returned to those departments as a compiled history of each day's operation. This history, United officials feel, will provide them with the constant check on jet operations that will permit a smooth introduction of DC-8 flights into the present scheduled pattern.

DOUGLAS DC-8 jet transport, in United Air Lines markings, makes takeoff for another in a series of flight tests. United has 40 DC-8s on order at a cost of $225 million. Aircraft's four P&W J57 turbojet engines provide total thrust of more than 40,000 lb.

FAA Lists Federal 1960 Airport Funds

Washington—Federal Aviation Agency has set a Sept. 1 deadline for the filing of requests for airport construction aid funds totaling $126 million for Fiscal 1960 and 1961.

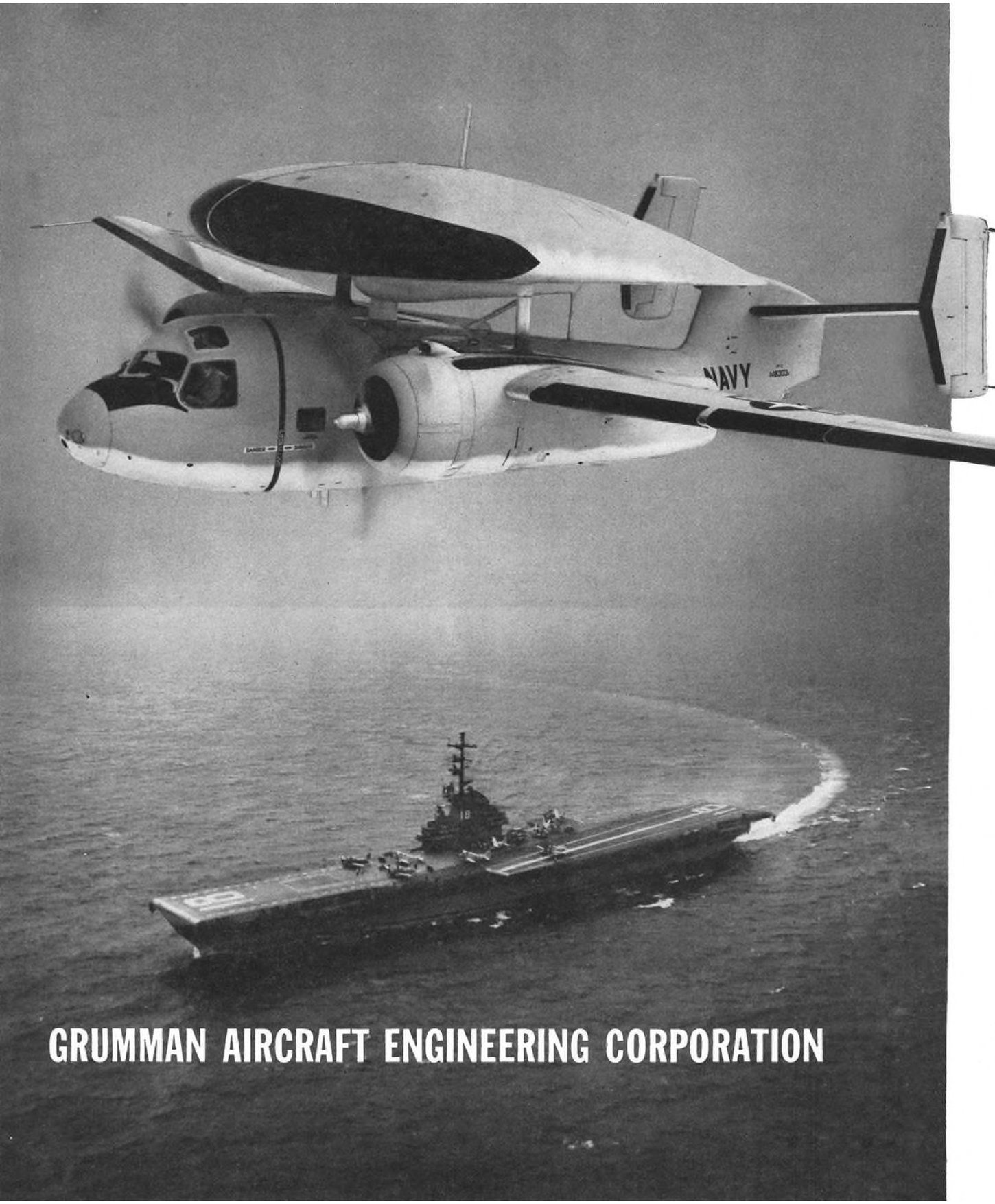
FAA also has cautioned state and territorial applicants that requests will be "carefully screened" in line with the agency's policy of stressing federal aid projects needed for increased air safety.

Such items as acquisition costs of land for auto parking areas will not be eligible for federal funds, according to FAA Administrator Elwood Quesada, and airport construction projects will be limited to buildings considered essential to safety. These include airport traffic control towers and facilities needed for weather reporting, communications, fire fighting and crash equipment, plus a limited amount of public use space in terminal buildings.

FAA says its allocation of aid funds available has been divided equally for the two fiscal years with $63 million eligible for projects each year.

Here's how Fiscal 1960 federal aid funds are apportioned by individual states:

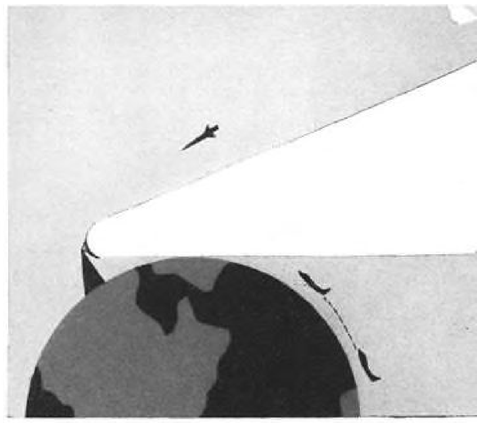
Alabama	$836,180
Arizona	$939,544
Arkansas	$670,938
California	$2,734,099
Colorado	$955,269
Connecticut	$340,256
Delaware	$64,980
District of Columbia	$120,271
Florida	$851,856
Georgia	$942,419
Idaho	$694,985
Illinois	$1,721,651
Indiana	$852,738
Iowa	$800,327
Kansas	$882,263
Kentucky	$733,174
Louisiana	$760,599
Maine	$385,768
Maryland	$439,214
Massachusetts	$767,282
Michigan	$1,654,594
Minnesota	$1,072,185
Mississippi	$676,053
Missouri	$1,096,682
Montana	$1,157,301
Nebraska	$759,013
Nevada	$827,050
New Hampshire	$147,216
New Jersey	$781,667
New Mexico	$985,691
New York	$2,606,233
North Carolina	$989,458
North Dakota	$605,945
Ohio	$1,511,101
Oklahoma	$841,462
Oregon	$932,127
Pennsylvania	$1,902,130
Rhode Island	$127,157
South Carolina	$542,723
South Dakota	$657,256
Tennessee	$798,404
Texas	$3,093,777
Utah	$719,824
Vermont	$126,216
Virginia	$803,025



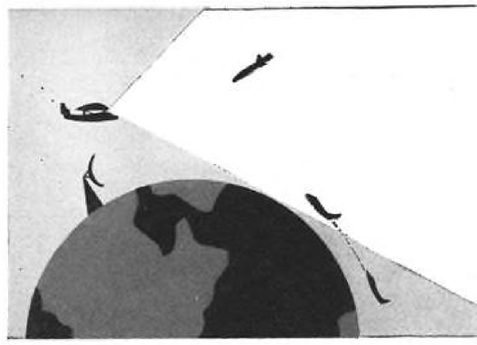
PEACE TAKES A LOT OF WATCHING!

That's why the U.S. Navy will send eyes aloft to scan the seas and skies beyond our shores. The eyes, with this special kind of vision, are early warning aircraft. Many will be WF-2 "Tracers", produced for the Navy by Grumman.

WF-2's "see" via a saucer-shaped radome that houses super-sensitive, long-range electronic detection equipment. Operating from aircraft carriers far out at sea, "Tracers" patrol the extremities of our defense perimeter. And, detect the approach of aircraft or missiles that might invade the privacy of a nation's peace.



Low-flying "enemy" aircraft or missiles are undetected by ground radar because, as the diagram shows, the range of ground-level radar extends no further than the horizon.



Detection range is increased appreciably when the radar detection equipment is airborne directly over the ground installation.

The scope and effectiveness of radar detection are extended dramatically with WF-2's operating off fast, mobile and far-ranging aircraft carriers at sea.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

Bethpage • Long Island • New York

Grumman

- **Washington** $868,070
- **West Virginia** $475,132
- **Wisconsin** $993,906
- **Wyoming** $754,789
- **Discretionary Funds** $15,000,000

Total $60,000,000

Territory apportionments are:

- **Alaska** $1,350,000
- **Hawaii** $750,000
- **Puerto Rico** $600,000
- **Virgin Islands** $300,000

Total $3,000,000

PanAm to Convert 10 DC-7Cs for Cargo

New York—Pan American World Airways will convert 10 of its 25 Douglas DC-7C aircraft to cargo configuration under a $2.8 million contract with Lockheed Aircraft Service, Inc. The program will begin next month at Lockheed's Ontario, Calif., base and the first converter plane is expected to go back to PanAm in December. The rest will follow at the rate of about four a month.

The cargo DC-7Cs will cruise at 300 mph. and can carry 16 tons of transatlantic cargo, compared with 250 mph. and 11 tons for the four DC-6As currently operated by the airline. PanAm says it has no plans for disposing of the DC-6As.

Pan American plans to put its first cargo DC-7Cs onto the Atlantic, with the Pacific and then Latin American Divisions receiving the later aircraft. But this sequence depends on Military Air Transport Service contracts and other traffic developments. The unconverted DC-7Cs probably will be used on the Atlantic for a time, although some may be converted later.

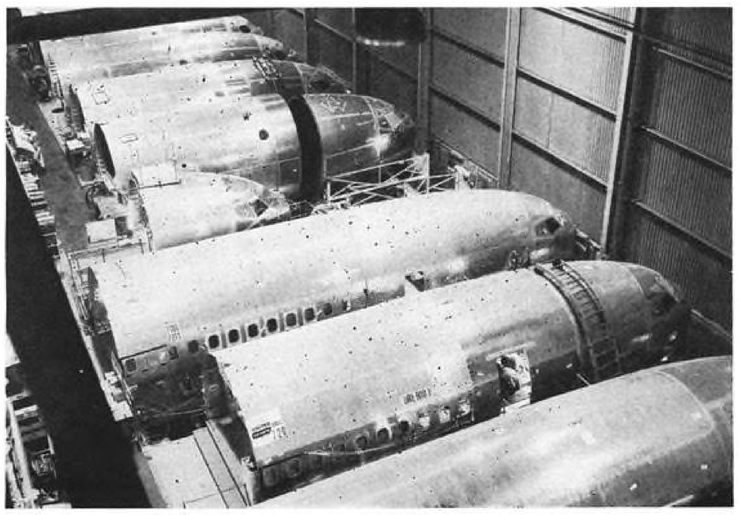
Idlewild Impresses Tu-114 Crewmen

Crew members of the Russian four-turboprop Tu-114 which visited New York (AW July 6, p. 38) were impressed by the facilities at Idlewild International Airport.

On returning to Moscow, Plane Commander A. P. Yakimov described Idlewild as "a huge airdrome equipped with the last word in technology." He remarked on how many planes "take off and land simultaneously at any time of the day or night under very limited weather minimums" and also commented favorably on Idlewild's "seven active runways, all at least 2,500 meters long, with an eighth under construction."

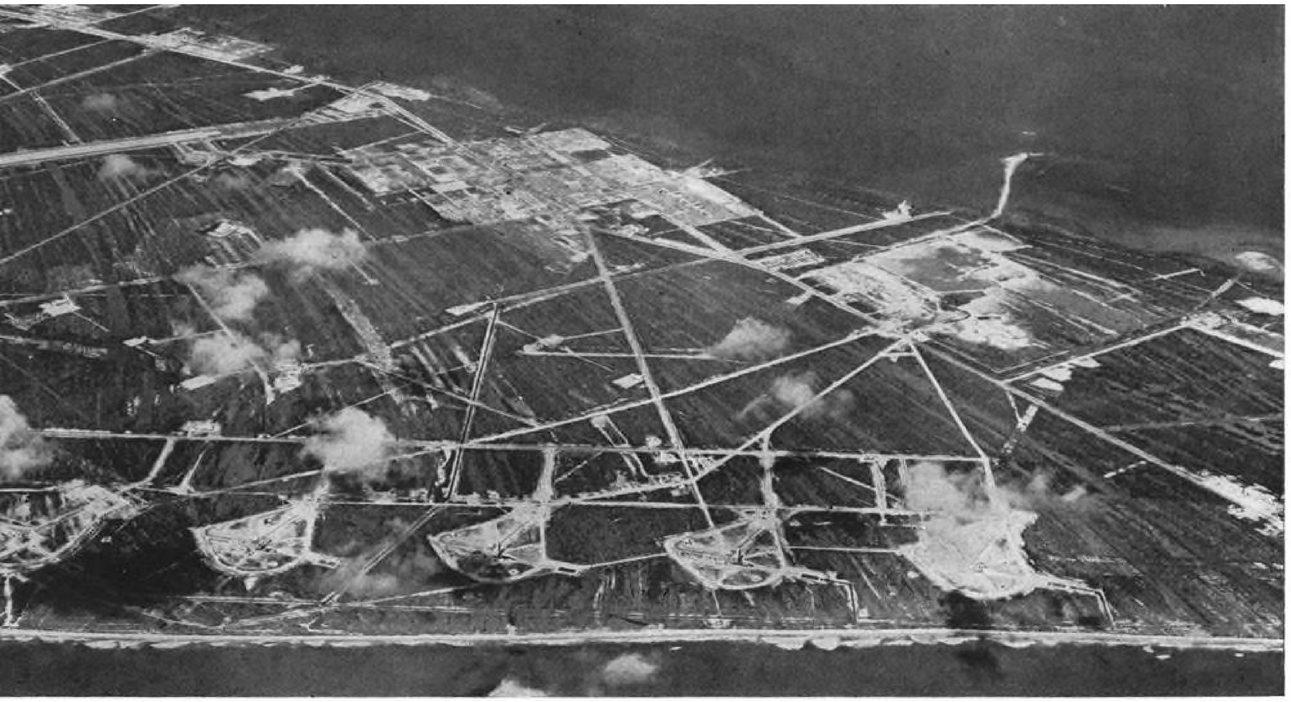
Yakimov noted particularly that the "enormous tug" dispatched at Idlewild to bring the Tu-114 to its unloading position had all the power necessary to tow the airliner. (Unit referred to by Yakimov was a Pan American World Airways tractor with a 25,000 lb. drawbar pull, made by Silent Hoist Corp.)

He recalled that when the Tu-114 visited Paris shortly before, each of three tugs sent to tow the Russian transport had insufficient power to do the job and that two tugs working together finally brought the Tu-114 to the ramp.



707-320, 720 Forward Fuselage Sections Compared

Forward fuselage section of the first United Air Lines Boeing 720 turbojet transport is in foreground, between the forward fuselage sections of two 707-320 Intercontinental models. Total length of the short to medium range 720 is 136 ft. 2 in., as compared with 152 ft. 11 in. for the intercontinental range version. The first 720 will be rolled out of Boeing's Renton, Wash., plant in early fall and will be delivered to United in April, 1960.



AERIAL PHOTO taken from over the Atlantic Ocean shows four USAF-Martin Titan intercontinental ballistic missile launching pads (foreground), one USAF-Convair Atlas pad (far left), industrial area (center background) on Banana River side of Cape Canaveral Missile Test annex at Air Force Missile Test Center, Fla. Two pads for 1.5-million lb. thrust Saturn space vehicle are now being built at extreme right foreground, beyond Titan pads.

Atlantic Missile Range—Part I

Space Spurs Missile Center's Growth

By Evert Clark

Cape Canaveral, Fla.—Nine years after a rocket engine first split the quiet of this palmetto-covered sandspit, the Air Force Missile Test Center is preparing for space systems that will put permanent stations into orbit around the earth and send men to establish bases on the moon.

Launching pads to handle thrusts of more than a million pounds already are under construction, dwarfing the efforts that began here when a German V-2 carrying an Army WAC Corporal first roared seaward on July 24, 1950.

At least 10 more launching complexes handling a range of thrusts from one-to-10 million lb. can be located in the 15,000 acre Cape Canaveral launching area as it now stands.

Military and civilian space systems that fell into the category of science fiction two years ago now dominate future planning for the center and profoundly affect its current operations as well.

For 19 months, satellites have been launched into orbit around the earth; space probes have been fired toward the moon and around the sun, and the schedule is growing increasingly heavy.

Three years ago this month, the Cape boasted only one of the ballistic missiles that have made this new era of flight possible—the Army's Redstone—and four Air Force aerodynamic missiles, the Matador, Snark, Bomarc and Navaho. Matador and Snark were jet powered and rocket boosted; Bomarc used rockets for boosters and ramjets for sustained flight; Navaho, powered by turbojets in the test versions and later by ramjets, was boosted by the same rocket engines that now power the Thor and Jupiter intermediate range and Atlas intercontinental range missiles, as well as five types of missile-boosted space vehicles.

New Complexes

Now six ballistic missiles are being flown—Army's Redstone and Jupiter, USAF's Thor, Atlas and Titan, and Navy's Polaris—and complexes are being built for the Army Pershing and USAF Minuteman. The first four of the six missiles currently flying have been used for space systems and Titan, Polaris and Minuteman are expected to be used in the future.

In 1956, 11 contractors employed 1,600 engineers and technicians here. The range operators, Pan American Airways and Radio Corp. of America, employed only 4,000. Now some 30 missile contractors employ 4,742 and the range operators employ 7,970. Total population of the center, including its military complement, was 18,417 last May 31.

The greatest upsurge came during 1956 in preparation for the first launchings of intermediate and intercontinental range missiles. In that year, the center's population increased by 40%. It since has increased another 53% over the IRBM-ICBM buildup period and is expected to grow by another 20% or more in the next few years before it levels off at an estimated 21,000 to 22,000.

Brevard County, the 18-mi. wide, 72-mi. long Atlantic coastal strip in which the center is located, has had even more spectacular growth, and it has seen missiles surpass citrus fruit and livestock to become the principal industry, producing approximately half of the county's personal income.

In 1940, Brevard had a population of 16,142. By 1950, when the center's average population stood at only 876, Brevard's population was 23,653. Its population now is estimated at 114,800, and studies done by and for the Air Force indicate it will reach 162,500 by the end of 1963.

The center's impact on the surrounding area can be measured in many ways, but one of the best is in personal income. Brevard in 1950 had a total personal income of $24,086,000. By 1957, the figure had reached an estimated $160,000,000. Even with the great influx of population, per capita income rose from $1,418 in 1950 to $1,915 in 1956, an increase of 98% as compared with a 30% boost for the state in the same period.

One basic engineering fact has accounted for the center's amazing growth—complex missile and space systems must be extensively tested and proved before they can be used and the center is the largest and most heavily instrumented rocket proving ground in the Western world.

It consists of the missile assembly and launching areas on the triangular-shaped cape; Patrick Air Force Base, 18 mi. south, which serves as the center's administrative and technical support area; and a 5,000-mi.-plus network of island tracking stations and ocean range vessels making up the Atlantic Missile Range. These facilities and a few small tracking stations scattered along the Florida coast represent an investment valued at $478,348,000 as of last Mar. 31.

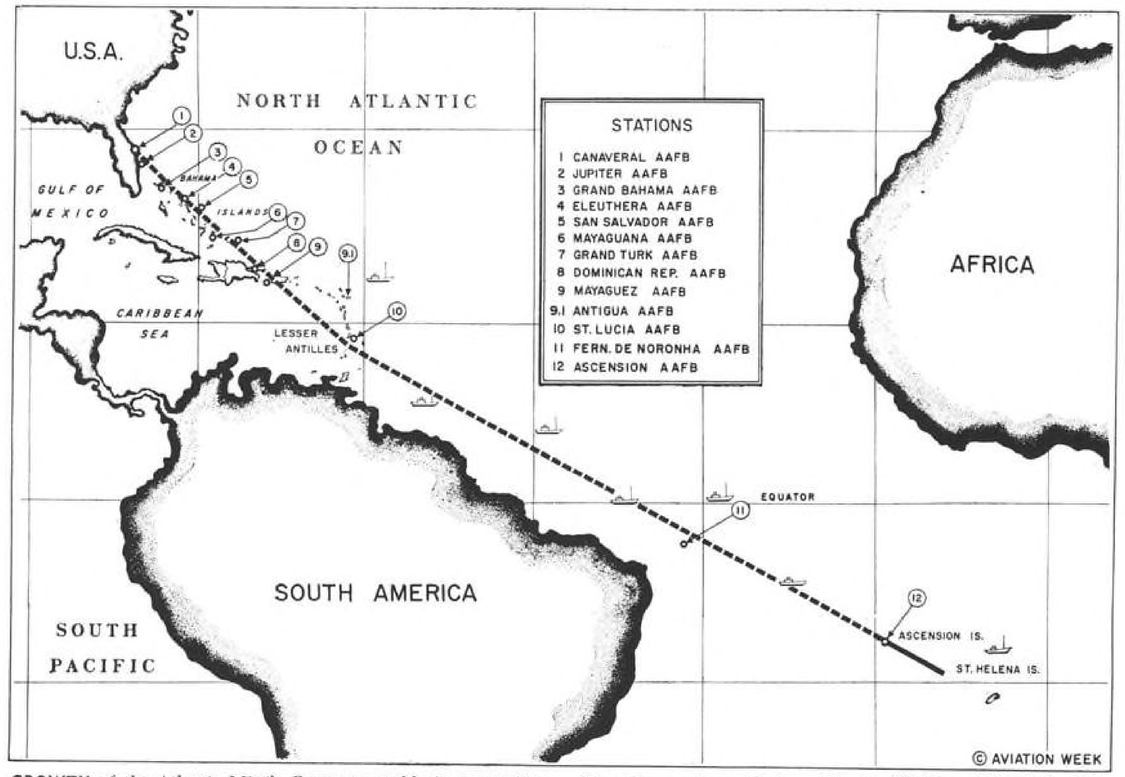
Island Range

The chain of island range stations stretching southeastward almost to Africa are a fortunate accident of geography from the standpoint of flight monitoring and control. Even more fortunate from the spaceflight point of view is the fact that they stretch in an easterly direction. Space vehicles requiring many thousands of feet per second of velocity to reach their goals gain a natural advantage from the speed of the earth's rotation, just as they gain a trajectory advantage from the center's proximity to the equator.

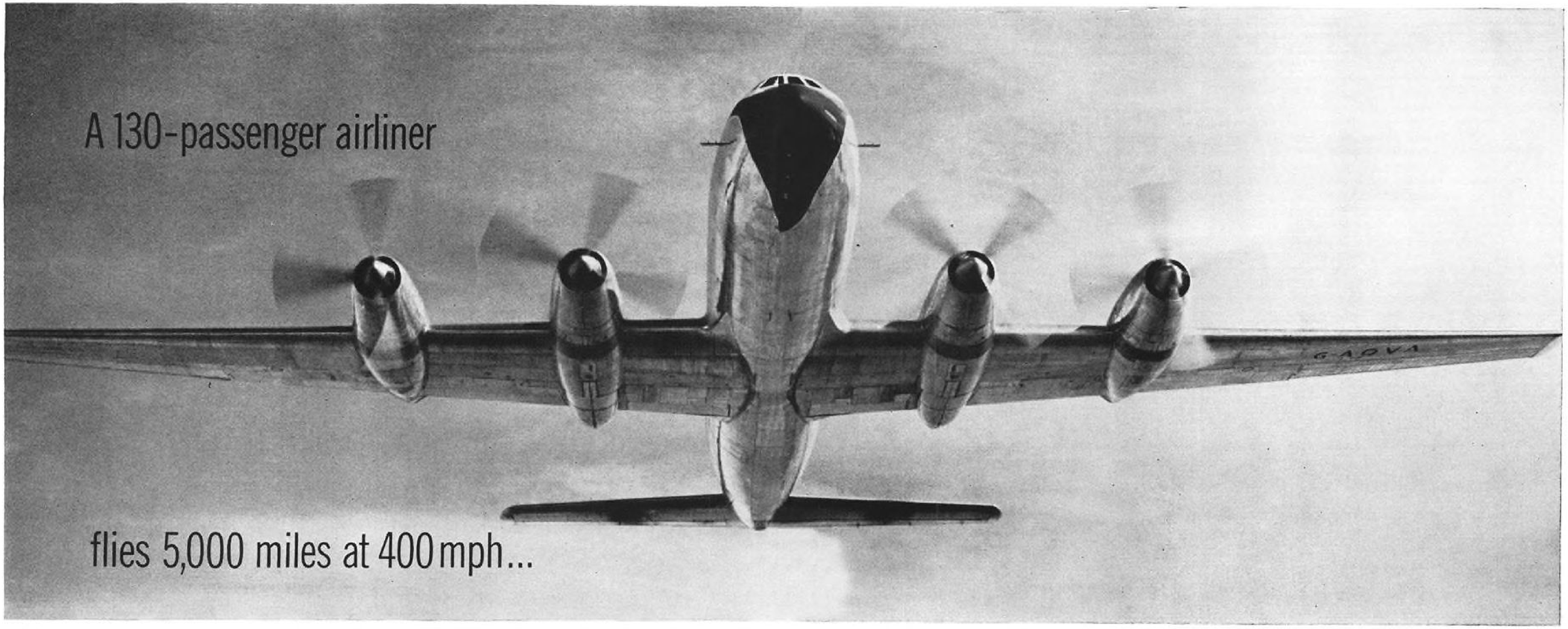
Although the center is not suitably located for launching vehicles into polar orbits or firing precisely from the equator, almost every system that will be used is expected to go through its proving days at Cape Canaveral.

The closest thing to being a potential limiting factor on increased use of the range right now is development of new instrumentation. This is based on the ever-recurring research and development problem that the tools used to test a very advanced weapon must be more accurate than the weapon itself.

Maj. Gen. Donald N. Yates, who



GROWTH of the Atlantic Missile Range to enable it to monitor missile flights as long as 6,300 mi. is illustrated by the history of its island tracking stations. Grand Bahama was first used in mid-1951 to track and land Matador. Eluthera, San Salvador, Mayaguana, Grand Turk and the Dominican Republic stations were first used late in 1955 for Snark flights. Mayaguez was first used in mid-1956 for X-17 re-entry test vehicles. Antigua began service late in 1957 for a Jupiter firing. St. Lucia was first used in late 1956 for a Snark flight. Ascension, more than 4,800 mi. from Cape Canaveral, was first used late in 1957 for a Thor-Able flight. Ocean range vessels used for telemetry, tracking and recovery now number a dozen and effectively extend the range beyond Ascension. Ships have been used for telemetry, tracking and recovery, now number a dozen and effectively extend the range beyond Ascension. Ships have been used since early in the range's history and have been added to as needed. Intermediate range missile impact area is near Antigua; intercontinental range impact area is in the vicinity of Ascension.

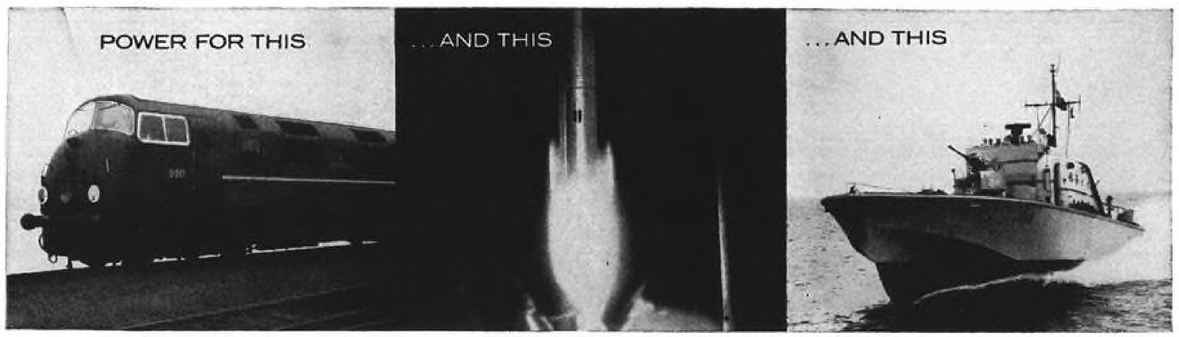


...AND BRISTOL SIDDELEY SUPPLY THE POWER

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Proteus.

A turboprop in the 4,000 hp class, the Proteus powers the Britannia airliner, in service with RAF Transport Command and ten airlines all over the world. The Proteus is perhaps the most dependable engine in the air today. It reached an overhaul period of 2,000 hours in under two years—a rate of increase never before achieved by any other engine, piston or gas turbine. Proteus derivatives have been designed for use as turbo-generator powerplants and as marine turbines.

BRISTOL SIDDELEY ENGINES LIMITED



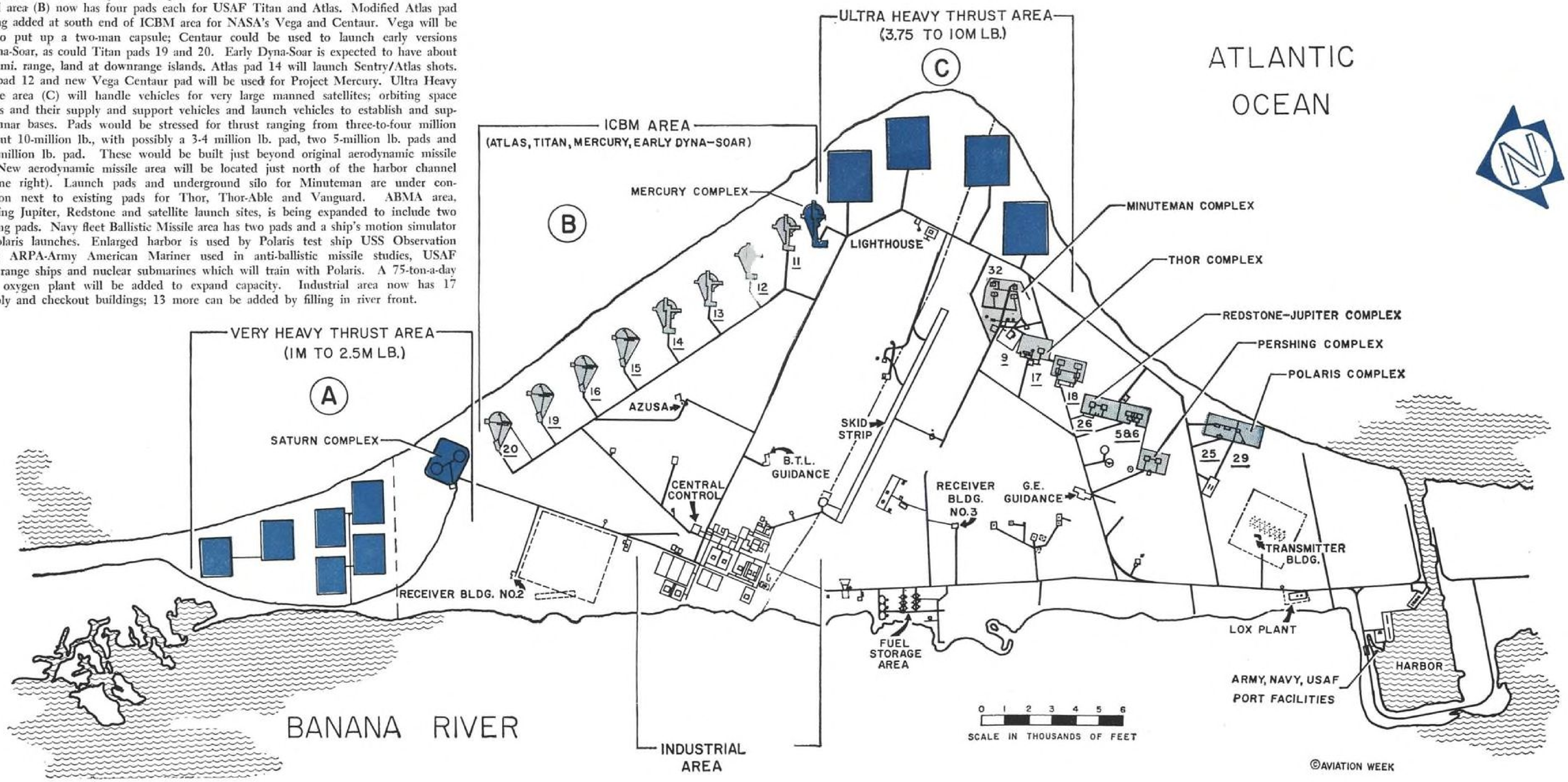
TWO BRISTOL SIDDELEY MAYBACH diesels power this British Railways diesel hydraulic locomotive—develop a total of 2,200 hp. A large number of Maybach diesel engines have been ordered by British Railways alone.

THE BRISTOL SIDDELEY GAMMA rocket engine powers the Saunders-Roe Black Knight—Britain's highly successful space research vehicle. The Gamma, for a dry weight of 700 lb., sends Black Knight 500 miles into space.

THE BRISTOL SIDDELEY MARINE PROTEUS powers the world's fastest naval vessels, the "Brave" class Royal Navy patrol boats. Three Proteus deliver a total of 11,500 hp—give these boats a speed of over 50 knots.

Cape Canaveral Growth Potential

Aviation Week artist's conception shows how Air Force Missile Test Center launching area is expected to grow to handle advanced space systems and booster engine thrusts ranging up to 10-million lb. Dark blue squares show future launch pads; light blue indicates pads existing or under construction. North section (A) will be Very Heavy Vehicle area, with six or seven pads to handle booster thrusts from one to 2.5-million lb. for orbital versions of Dyna-Soar, large military satellites, other space vehicle test systems. Construction is under way on two pads for ARPA-ABMA Saturn vehicle in this area. ICBM area (B) now has four pads each for USAF Titan and Atlas. Modified Atlas pad is being added at south end of ICBM area for NASA's Vega and Centaur. Vega will be able to put up a two-man capsule; Centaur could be used to launch early versions of Dyna-Soar, as could Titan pads 19 and 20. Early Dyna-Soar is expected to have about 5,000 mi. range, land at downrange islands. Atlas pad 14 will launch Sentry/Atlas shots. Atlas pad 12 and new Vega Centaur pad will be used for Project Mercury. Ultra Heavy Vehicle area (C) will handle vehicles for very large manned satellites; orbiting space stations and their supply and support vehicles and launch vehicles to establish and support lunar bases. Pads would be stressed for thrust ranging from three-to-four million to about 10-million lb., with possibly a 3-4 million lb. pad, two 5-million lb. pads and a 10 million lb. pad. These would be built just beyond original aerodynamic missile area. New aerodynamic missile area will be located just north of the harbor channel (extreme right). Launch pads and underground silo for Minuteman are under construction next to existing pads for Thor, Thor-Able and Vanguard. ABMA area, including Jupiter, Redstone and satellite launch sites, is being expanded to include two Pershing pads. Navy fleet Ballistic Missile area has two pads and a ship's motion simulator for Polaris launches. Enlarged harbor is used by Polaris test ship USS Observation Island; ARPA-Army American Mariner used in anti-ballistic missile studies, USAF ocean range ships and nuclear submarines which will train with Polaris. A 75-ton-a-day liquid oxygen plant will be added to expand capacity. Industrial area now has 17 assembly and checkout buildings; 13 more can be added by filling in river front.



has commanded the center since 1954 and through its period of great expansion, warned recently that "supporting facilities such as are provided by our range and its instrumentation are too often taken for granted," with the result that "for the past five years we have been driven into a frantic race with missile performance in our job to provide instrumentation of commensurate performance. . . . I see a problem forming which becomes acute upon close comparison of our future measurement requirements versus the state of the art in data acquisition," Yates said. "For example, in electronic tracking, we are being asked to improve our accuracy not by a factor of two or three but by one order of magnitude to accommodate a second generation missile soon to be tested.

"Explorations in space will bring about their own family of requirements which, a few years hence, will probably relegate today's space tracking equipment to the class of primitive first attempts."

The backlog from war-time developments was exhausted in meeting the requirements of the ICBM program, Yates said, and "we were oftentimes forced to use an assortment of instrumentation systems obtained from various sources to meet a single requirement.

"In some cases, compromises in missile test requirements were made due to the exorbitant costs incurred by the use of these assorted, expensive systems.

"We are now at the bottom of the barrel, so to speak, in instrumentation development. We would like to initiate a major development on a new tracking system during this fiscal year (1959); however, funding limitations have dictated that this must be deferred.

"We must get this equipment developed and installed on the range if we are to meet presently known requirements. It is not difficult to foresee astronautic systems of the future with more demanding requirements than can be met even with this new equipment."

Yates said the job cannot be done

without "a complete about face" from the "level of funding for instrumentation development during the past several years.

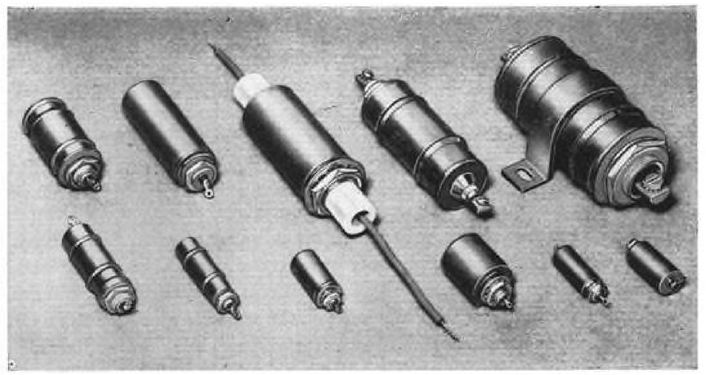
"The funds expended on the Atlantic Missile Range for development of all instrumentation are a very small fraction of approximately the cost of the production missiles themselves," Yates said.

"It is not unusual for the range to be asked to evaluate a new guidance system that may have cost $100 million or more with an instrumentation system that has cost a few per cent of that."

In addition to the need for funds and the need for maximum accuracy and 100% reliability, time also is an enemy. "Generally," Yates said, "we have found that it takes as long, and sometimes longer, to develop an instrumentation prototype as it does to develop new vehicle prototypes. When the missile contractor has his prototype complete, he is ready to test it. On the other hand, the range usually will require some production units of the developed

Maj. Gen. Donald Yates

Maj. Gen. Donald N. Yates has commanded the Air Force Missile Test Center since July, 1954, through its period of significant growth into the West's largest and most complex missile testing range and space launching facility. Gen. Yates was born in Bangor, Me., in 1909, was graduated from the U. S. Military Academy in 1931 and from California Institute of Technology in 1939. He learned to fly at Kelly Field, spent five months in Russia in 1942 as a member of a military mission and directed Strategic Air Forces Weather Service in Europe in World War II. He served as chief of the Air Weather Service from 1945 to 1950 and as assistant deputy chief of staff for development and later as director of research and development at USAF headquarters before taking over AFMTC. He is a former president of the American Meteorological Society and a member of the Institute of Aeronautical Sciences and the American Rocket Society.



New Series of Sprague Cylindrical-Style Radio Interference Filters: top row, l. to r.—4JX14, 5JX94, 1JX115, 20JX15, 50JX20 bottom row—5JX27, 1JX54, 1JX113, 1JX117, 2JX49, 1JX118.

New Series of Small, Light Radio Interference Filters

The new cylindrical-style radio interference filters recently announced by Sprague Electric Company are the smallest and lightest filters of their type available for military and industrial electronic and electrical equipment. Their basic design was pioneered by Sprague in order to achieve maximum miniaturization.

This new series of standard filters, believed to be the largest in the industry, ranges in current rating from 5 milliamperes to 50 amperes to cover the great majority of application needs.

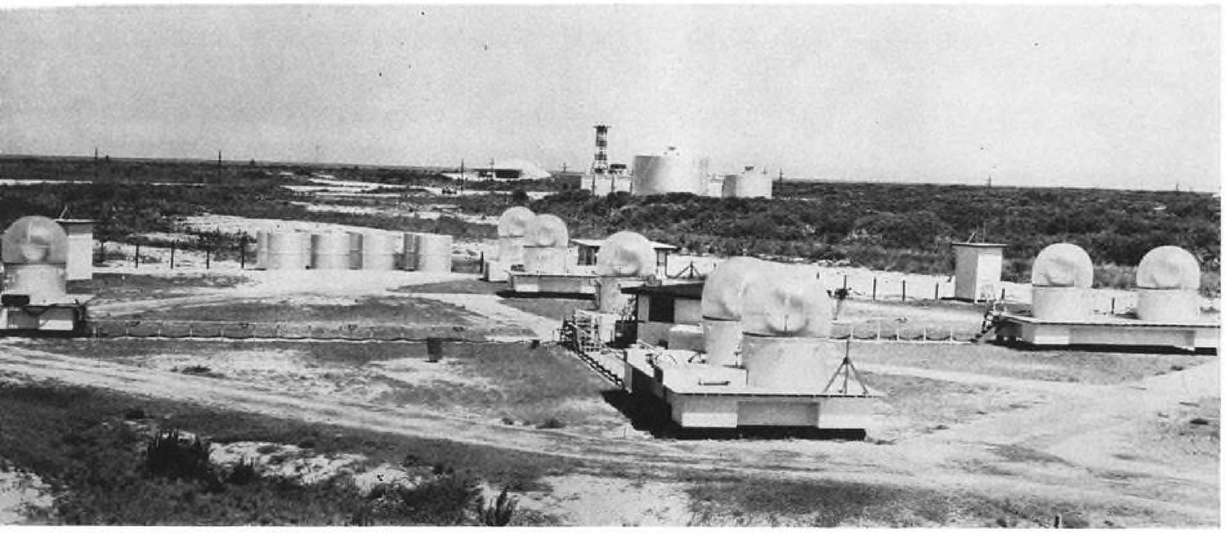
The natural shape of the rolled capacitor section and of the toroidal inductors dictates the cylindrical form. All filters have threaded-neck mountings for use on panels or bulkheads. This assures both the proper isolation between input and output terminals as well as a firm peripheral mounting with minimum impedance to ground.

Listed in Sprague Engineering Bulletin 8100 (available upon request to the Technical Literature Department) are 68 of the more popular low-pass filter designs intended for use as three-terminal networks connected in series with the circuits to be filtered. The excellent interference attenuation characteristics reflect the use of Thrupass® capacitor sections.

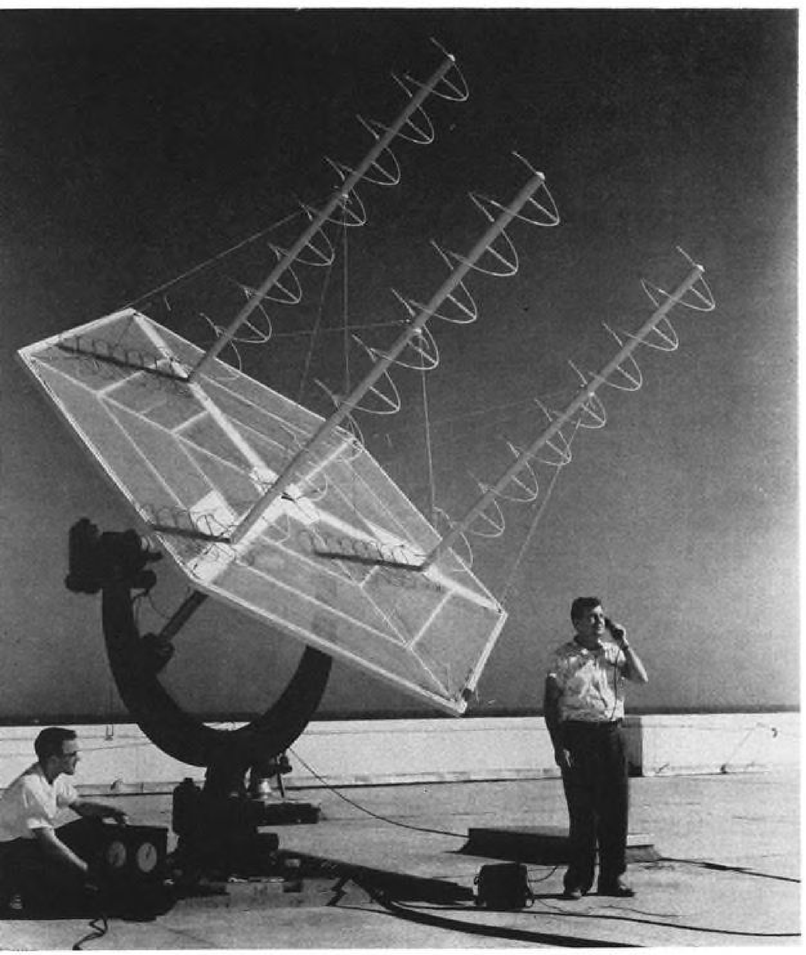
Since maximum effectiveness of filtering involves elimination of mutual coupling between input or noise source and output terminals, filters should be mounted where the leads being filtered pass through a shielded chassis or bulkhead. The threaded neck mounting is designed to give a firm metallic contact with the mounting surface over a closed path encircling the filtered line and to eliminate unwanted contact resistance so that the theoretical effectiveness of these units is realized in practice.

Typical insertion loss is determined by measurements made in conformance with Military Standard MIL-STD-220. Minimum curves for specific filters are available upon request.

For assistance in solving unusual interference, rating, or space problems, contact Interference Control Field Service Manager, Sprague Electric Co., at 12870 Panama Street, Los Angeles 66, California; 224 Leo Street, Dayton 4, Ohio; or 327 Marshall Street, North Adams, Massachusetts.



MISSILE velocity and position data obtained by Convair Azusa system allows prediction of impact point. Note Atlas tower at rear.



TRI-HELICAL telemetry antenna, mounted atop an Air Force Missile Test Center's large Technical Laboratory, is one of many data gather devices operated by Radio Corp. of America.

instrumentation system to meet the test requirements of the new vehicle in addition to the prototype.

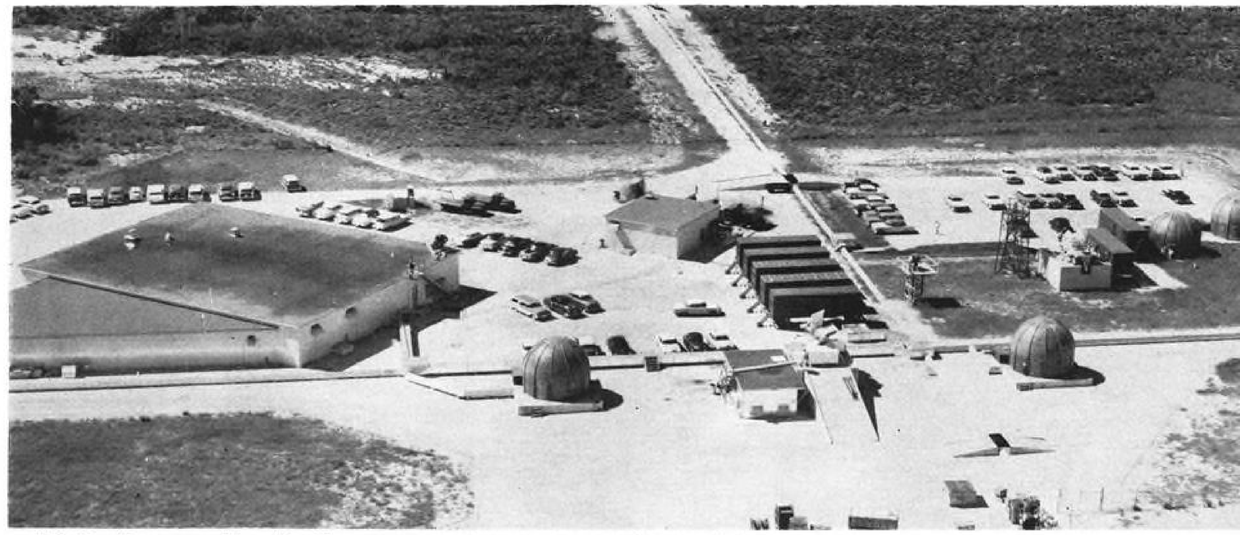
"Thus the 'bottleneck' . . . is instrumentation. For example, several major instrumentation systems used to support the ballistic missile operations . . . required an average of about four years for development. If you add to this the amount of time required for the budget cycle, plus the time required to check out and 'de-bug' the system after it is installed, the average time from inception of the need to an operational use of a complex instrumentation system can be as great as five to six years."

Yates suggested the following as some partial answers to the lead-time problem:

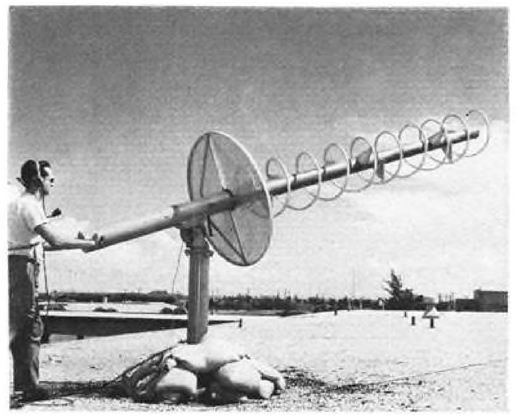
• **Continual cognizance** by the instrumentation developer of what missile people are developing. This is difficult because "systems contractors do not have a clear outline of test needs until the actual test stage is near. Consequently, they are reluctant to release the advance information we need to proceed with our development plans."

• **Permit development of** new instrumentation to proceed "not on the basis of known missile requirements solely to advance the state of the art but against the trend of technical requirements as forecast by top missile and astronautic people." The center's parent Air Research and Development Command has applied research programs with these goals, but instrumentation projects must compete "with more glamorous end-item developments for their funds."

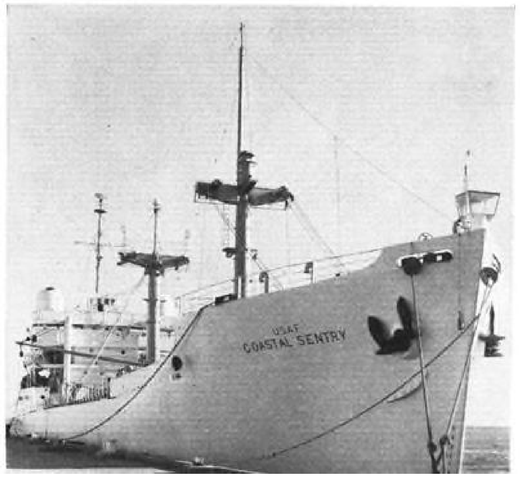
Yates said a "well-founded, flexible instrumentation development plan, adequately funded and aggressively pursued," would allow narrowing or even

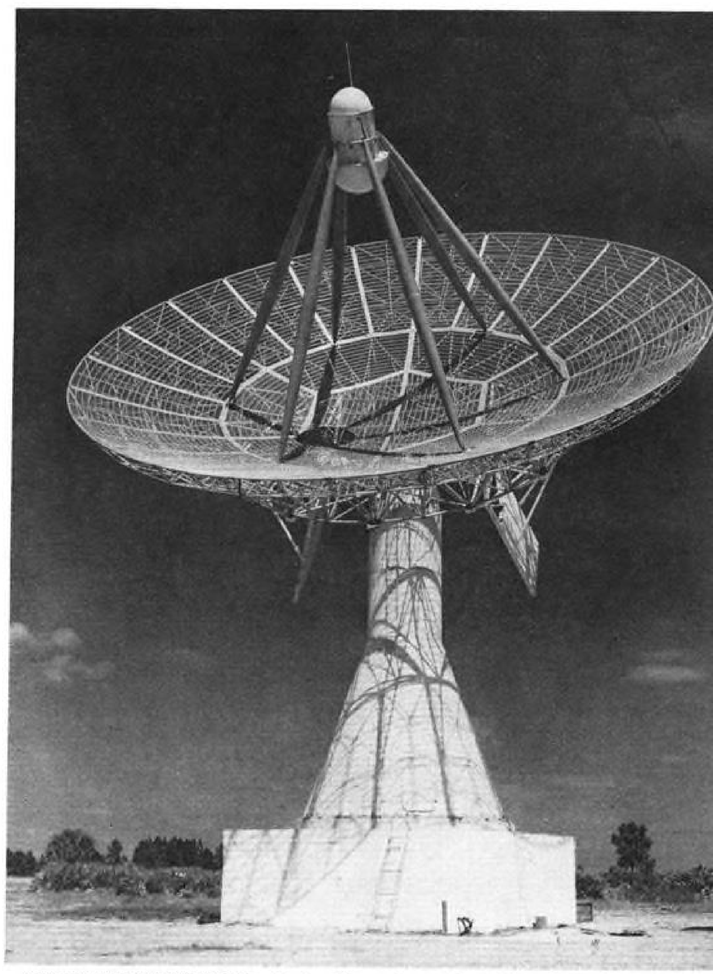


ATLAS radio command-inertial guidance system developed by General Electric will be used in future attempts to place Atlas in orbit.



EXPERIMENTAL helical telemetry antenna (above) is mounted atop a building at Patrick AFB, headquarters for the test center. Below is one of a dozen ocean range vessels used for tracking and telemetry along the 5,000 mi. range. Note instrumentation domes. Ship is docked at Trinidad.





AUTOMATIC TLM-18 high-gain tracking antennas located at Cape Canaveral, several downrange islands are used for missile and satellite tracking.

Population Growth—Brevard County

(Location of Air Force Missile Test Center)

Year	Population
1940	16,142
1950	23,653
1955	46,000
June 1957	72,000
" 1958	95,500
1959	114,800
1960	131,000
1961	144,000
1962	154,000
1963	162,500

Note: Due to lack of complete census, figures from 1955 through 1959 are estimates, although available figures indicate estimates are quite accurate. Figures beyond 1959 are, of course, projections.

closing the gap between need and existing hardware. He added, however, that this gap is "now widening day by day.

"Certainly some breakthroughs are necessary in the state of the art if we are to satisfy the data acquisition needs for future vehicles."

Among the most recent instrumentation additions is the improved Azusa Mark II missile impact predictor (AW July 27, p. 81) with a 1,000-mi. range that can be extended to lunar distances with the addition of narrow band and correlation circuits. This will be operating early in 1960.

Other advancements that the center and its range operators hope to obtain in the next two to three years include:

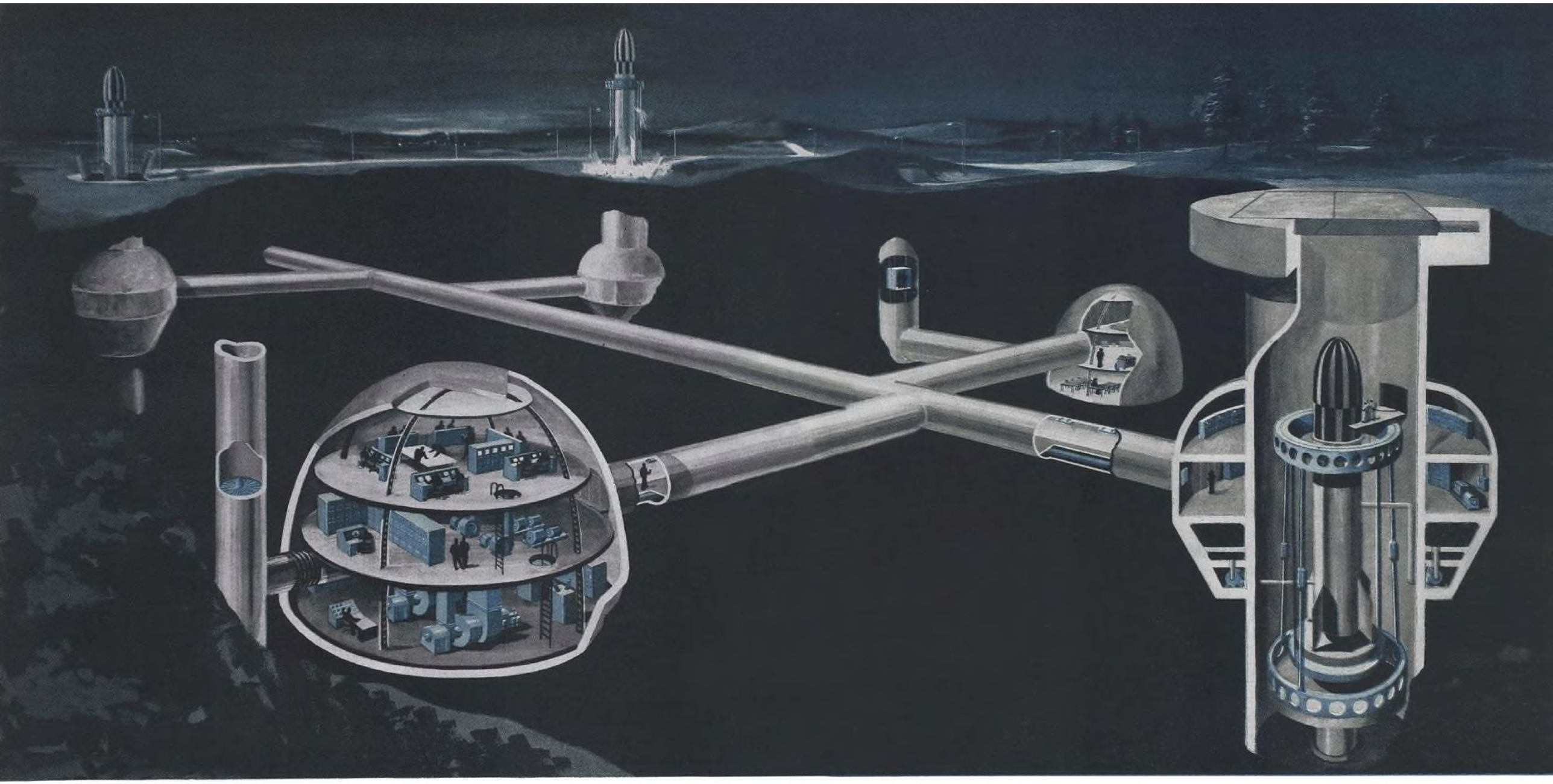
• **Shift to higher telemetry** frequencies. Next year the 216-245 mc. band will become 225-260, with the lower band remaining available on a non-protective

Personnel Growth

Air Force Missile Test Center

Year	Personnel
December, 1953	7,219
" 1954	7,115
" 1955	8,639
" 1956	12,056
" 1957	14,456
" 1958	17,463
May 31, 1959	18,417*
Estimated future growth	
Fiscal 1960	20,010
" 1961, 1962, 1963, 1964	21-22,000

* Includes 15,323 civilians, of whom 12,712 are contractor personnel; 3,094 military. Of the military, 1,849 are assigned to the center, 1,158 to tenant units such as Army and Navy, and 87 to contractors



Westinghouse equipment

Complete electrical distribution systems for USAF's first two Titan hardened missile complexes at Lowry AFB, Colorado, will be 100% Westinghouse.

Whether above ground or below, soft or hardened, defense installations require a great variety of equipment which must operate without fail as individual units *and* as elements of interrelated systems. As a supplier to the government and to general, electrical and mechanical contractors, Westinghouse provides system-coordinated applications of standard or shock-proof apparatus which assure the most reliable and economical installations.

Take advantage of this Westinghouse experience, product range and application coordination. Contact your Westinghouse sales engineer, or write: Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J-92040

selected for Lowry Nos. 1 and 2

Westinghouse distribution system equipment includes:
Circuit Breakers • Switchgear • Power Centers • Motor Control Centers • Panelboards • Reduced Voltage Starters • Transformers • Alarm Panels • Relays • Safety Switches • Pushbuttons

Major Participants in Lowry Nos. 1 and 2 include:

Daniel, Mann, Johnson & Mendenhall & Associates	Architect-Engineer
USA Corps of Engineers, Omaha District Office	Contracting Office
Morrison-Knudsen & Associates	General Contractor
Fishbach & Moore	Electrical Contractor
Ling-Howard Electric, Inc.	Electrical Contractor

Artist's conception of a possible hardened missile site, showing in blue some of the equipment which Westinghouse can supply.
Copies of this illustration suitable for framing are available when requested on your letterhead.

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Sign at entrance to Patrick AFB, USAF Missile Test Center headquarters, was recently changed to reflect its expanding space role.

basis. Some time prior to 1970, all telemetry operations in the 216-260 mc. band will shift to ultra high frequency bands to relieve congestion in lower frequencies. Although some UHF components are not yet fully developed, use of UHF frequencies are expected to result in less flame attenuation of signals and less noise from the stars. This also should favor development and use of new types of modulation such as pulse code modulation and utilization of higher subcarriers in the present FM/FM system.

• **New telemetry receiving** system in the 2,200-2,300 mc. band for Grand Bahama Island and Antigua Island tracking stations, and pulse code modulation telemetry ground stations for Grand Bahama, Antigua, San Salvador and Ascension. The PCM system will offer the advantages of increased accuracy, high-channel capability and retransmission and compatibility.

• **Infrared tracking systems** for passive tracking of missiles when re-entry shock waves blank out radar beacons. Two systems would be installed on Ascension and one on Antigua. They would be slaved to radar tracking units and be capable of self-tracking when radar was ineffective. Pickoffs on the infrared trackers would provide the angular data for repositioning the radar antenna.

• **Target acquisition and** display systems, handling real time data for the extended range, would be installed on Grand Bahama, San Salvador, Antigua and Ascension. This system is considered essential not only for present requirements but also would meet requirements for missile and space systems over the next 10-15-year period without requiring major modification.

• **Mobile electromagnetic** radiation monitoring stations to support special programs and spaceflight programs. Eighteen units would be used, three at Grand Bahama, three at Ascension and one each at San Salvador and Antigua.

Grand Bahama Station

Grand Bahama, the first island station in the chain, is some 150 mi. from the Cape. It was first used on June 20, 1951, to monitor a Matador flight, and a Matador first landed there nine days later. Since it is one of three or four primary stations, a list of its services and equipment illustrate the function of the downrange bases:

• **Data acquisition for midcourse** and terminal trajectory telemetry, using eight telemetry links.

• **Midcourse and terminal radar** coverage for technical and range safety purposes using two tracking radars.

• **Electronic** and position data acquisition in support of ballistic missile tests, using DOVAP and EXTRADOP systems.

• **Air surveillance radar** for range clearance, using AN/FPS-8.

• **Radio destruct** control (two fixed AN/FRW-2 transmitters) and high power destruct control (10 kw. dual, RF, power amplifiers) for range safety and control.

• **XN-2 (AN/FPS-16)** radar coverage.

• **Optical tracking coverage** of ballistic missiles (three BC-4 ballistic camera facilities).

• **Frequency analysis and control** for range safety and control.

• **Ionospheric sounding** for measurements of the ionosphere.

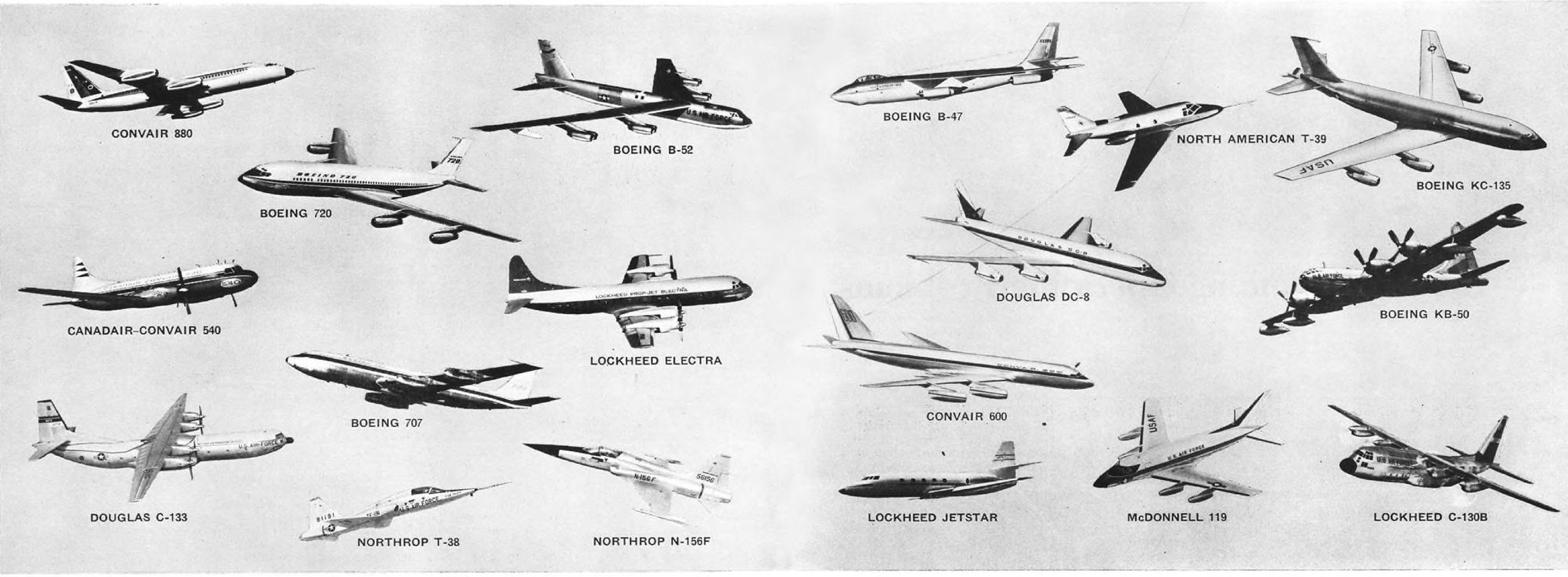
• **Surface and upper air** weather data.

• **Single point control** for range safety and control.

In the future, Grand Bahama also will provide additional improved interference control, Microlock tracking of missiles and theodolite tracking of satellites.

(This is the first of two articles detailing the technological advances and needs of the Air Force Missile Test Center, its past growth and future potential.)

All these jet aircraft use General Electric fuel flowmeter systems



REASON: operational savings through more efficient cruise control and lower fuel reserve requirements.

For the full story on mass fuel flowmeter systems, write for bulletin GEA-6828, General Electric Company, Aircraft Instrument Product Section, 40 Federal Street, West Lynn, Massachusetts.

596-502

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

AVIATION WEEK editor-pilot Robert I. Stanfield flew to Europe and return as a crew member of a MATS Douglas C-133A.

C-133A Overcoming Operating Problems

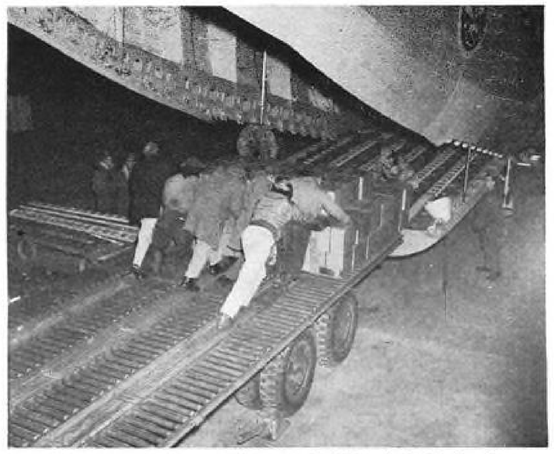
By Robert I. Stanfield

Dover AFB, Del.—Military Air Transport Service's Douglas C-133A Cargomaster logistics carrier is fast approaching a scheduled operating basis despite "growing pains" tied to en route support and spares, modifications, and problems with engine and propeller components. The C-133 has hauled as much as an 85,000-lb. payload to Europe, and has carried a record 117,900 lb. of cargo to an altitude of 10,000 ft.

For a first-hand check on C-133 operations and en route performance, this AVIATION WEEK editor traveled to Eastern Transport Air Force's Dover AFB, from which he flew to Europe and back as a crew member of the Cargomaster, which was first evaluated in this magazine last year (AW May 12, 1958, p. 70).

The airplane, which normally flies at a maximum gross weight of 275,000 lb., can carry up to 117,728 lb. of fuel and has a maximum payload of 117,800 lb. Its average overseas mission is to carry a 60,000-lb. payload. The C-133A is powered by four Pratt & Whitney T34-P-7W or T34-P-7WA turbines of 6,500 eshp. each. Three-bladed propellers, of 18-ft. diameter, are full-feathering Curtiss-Wright electric.

The C-133 can carry any missile at maximum fuel—with full tanks it can haul some 39,000 lb. of cargo. Beginning with production aircraft No. 33, clamshell doors will add three feet of usable space, for handling of Titan without disassembly. (Titan, 84 ft. minus nose cone, is presently shipped in two parts, the aft section being loaded first.) Atlas, which is now a tight squeeze and usually carried via one C-133 and one C-124, also will fit into the new models as a less ticklish operation than at present.



PALLETS are pushed manually into C-133A (left) by backing a conveyor-equipped flatbed trailer to the horizontal ramp. Lightweight roller conveyors are being installed in C-133A floor in background at right. Nylon straps form a cage which restrains palletized cargo.

Capable of handling 96% of the "implements of war," the turboprop Cargomaster—and it alone—can carry intact a 20-ton crane, Ross straddle carrier, 120 mm. gun on the M-1 mount. Sikorsky H-34 helicopter and T-41 El gun 76 mm. tank.

The C-133 route structure is practically unrestricted with the exception of the Arctic (until next year), due to this area's supply-test status (maintenance support). Aircraft from Dover have flown to the Middle East, Africa and Europe. On the Pacific side, from Travis AFB, Calif., Cargomasters normally fly to Honolulu, Wake Island, Japan and Okinawa. Both bases initiate flights throughout the United States, particularly from missile manufacturing sites to test ranges.

MATS has yet to achieve its optimum utilization rate for the C-133. Thirteen of the aircraft are assigned to the 39th Air Transport Squadron of EASTAF's Dover AFB, and 10 to the 84th Air Transport Squadron of Western Transport Air Force's (WESTAF) Travis AFB.

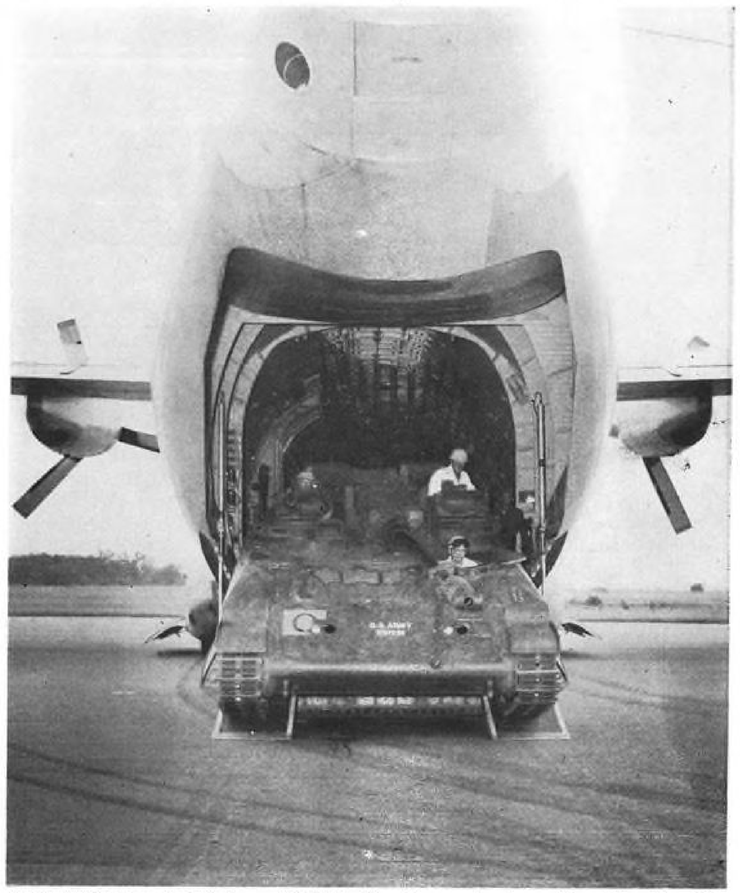
Dover expects to have 16 aircraft assigned by January, 1960. Travis also expects to reach this figure at this date, with one-a-month deliveries through December. Dover received its first Cargomaster on Aug. 28, 1957. Travis received its first airplane Oct. 15, 1958, and made its first flight in the Pacific area the following January.

Dover's C-133 Operation

Highlights of Dover AFB's C-133 operation, under the 1607th Air Transport Wing now commanded by Brig. Gen. Robert J. Goewey, include the following:

- **Overseas airlift.** On Aug. 10, 1958, a Cargomaster out of Dover airlifted the heaviest load overseas to date: 82,500 lb. of cargo, via Harmon, Newfoundland, to Lajes, Azores, to Chateauroux, France. A Dover-based C-133 made the first flight over the Pacific in October, 1958.
- **Altitude-payload record.** On Dec. 16, 1958, a C-133 carried 117,900 lb. to 10,000 ft., breaking a world record set by the Soviet Tu-104 in 1957. Airplane, off the ground after a roll of 4,900 ft., initially grossed 274,500 lb. Weight on landing was 261,300 lb. Actual payload of 117,900 lb. was greater than aircraft operating weight of 116,900 lb.
- **Domestic airlift.** With one refueling stop at Carswell AFB, Tex., a C-133

ATLAS ICBM upper section is loaded into a C-133. The Convair missile airframe can be loaded as one unit into a C-133, but is usually carried in one C-133 and one C-124.



ARMY TANK is unloaded from a C-133A. The Cargomaster is capable of handling 96% of all war materiel items. The turboprop transport has hauled as much as an 85,000-lb. payload to Europe, and has carried a record 117,900 lb. of cargo to an altitude of 10,000 ft.

on Oct. 28, 1958, carried 105,513 lb. of cargo from Long Beach, Calif., to Dover AFB. Total flying time was 9 hr. 10 min.

• **Support task.** During the last three months of 1958 C-133s from Dover AFB airlifted components and supporting elements of a Thor missile to Europe (C-124s carried missile itself). Cargomasters carried more cumbersome liquid oxygen tanks and missile shelters. Tanks are about 625 in. long, weigh about 35,000 lb. each and can be loaded on a C-133 in two hours leaving about 575 in. length for other cargo.

• **Loading.** General cargo can be loaded into the C-133 in 3.5 hr. and a palletized load in 2 hr. Flat-bed loading is currently utilized, in which cargo is placed on a three-fourths inch plywood pallet (of 10,000-lb. capacity) and loaded on flat-bed roller (low-bed 40 ft. trailer which holds nine pallets and is tied down with nets). At Dover 219,500 lb. has been loaded on C-133 at one time. Two-stage Martin Titan has been loaded, via winch, in a total of 39 min. (14 min. for second stage, 25 min. for first stage). By comparison, the first Titan took 16 hr. to load. Six men, using complete roller conveyor and net tiedown systems weighing approximately 2,356 lb., can load and secure about 70,000 lb. of cargo in 43 min.

• **Crew capability.** MATS crews are exceptionally well trained, and the 39th ATS, flying the C-133s at Dover, averaged on Apr. 30 about 5,856 total flying hours for 56 qualified and qualifying pilots, including line and administrative, flight examiners, aircraft commanders, and first and second pilots attached for training. Average time for 32 aircraft commanders assigned and attached was a high 7,173 hr. C-133 second pilots are all hand-picked C-124 first pilots. Normal crew has averaged 10 members: three pilots, three systems engineers, two navigators, two loadmasters. In addition to simulator and systems-procedures schooling, pilots must run four flight checks per year, two local and two line.

Two hours per month are required in aircraft or simulator and, for a three-months period, eight instrument letdowns (two in simulator) and eight night landings.

T34 Turboprop

The T34 turboprop also has its problem areas, ranging from "growing pains" and developmental troubles to "nuisance items." As one operations officer mentioned to AVIATION WEEK, "Too much is expected of this airplane, which can haul twice as much as the C-124." Main trouble spots:

• **Climb-cruise power.** At maximum gross, MATS would prefer to start initial cruise at not less than 20,000 ft., but is forced to start at an average of 15,000 ft. and fly 2,000-ft. step-climb. Reason: insufficient power, above 10,000 ft., at maximum gross weight. Final cruise altitude on nonstop flight averages 22,000-25,000 ft. Hot-day operation often finds the C-133 limited to initial climb altitude of 14,000 ft. Heavy fuel consumption at low altitudes restricts long-range nonstop operations. Along these lines, Federal Aviation Agency traffic control comes in for some criticism for prolonged low-level holding procedures, which are fuel consuming. The aircraft in which AVIATION WEEK flew from Dover was held after takeoff at 4,000 ft. for 12 min. With taxi time, takeoff, holding, and climb to 15,000 ft.—total of 45 min.—fuel consumed was 11,500 lb. Consumption at 15,000 ft., 1 hr. 20 min. after takeoff, including gas turbine units, was 8,910 lb./hr. Whether initial cruise altitude will increase with installation of Pratt & Whitney T34-P-9W (PT2G-6) engines of 7,500 eshp. in the "B" model is problematical, since aircraft gross weight is expected to increase from 275,000 lb. to 286,000 lb. Feeling in some quarters is that the airplane needs an engine in the 8,500-10,000 eshp. bracket.

• **Engine overhaul.** T34 turbines now

C-133A Specifications

Maximum takeoff weight	282,000 lb.
Design weight	275,000 lb.
Design zero fuel (2.0 limit load factor)	215,000 lb.
Maximum landiag weight (4.0 fps.)	282,000 lb.
Normal landing weight (7.5 fps.)	245,000 lb.
Operating weight	120,000 lb.
Maximum payload*	117,800 lb.
Wing span	179 ft. 8 in.
Length	157 ft. 6 in.
Height	48 ft. 3 in.
Stabilizer span	60 ft.
Cargo compartment:	
Length	97 ft. 4 in.
Height	12 ft.
Width	12 ft.
Volume	13,028 cu. ft.
Cargo ramp length	15 ft. 9 in.
Rear ramp door	12 ft. 6 in. by 12 ft.
Side cargo door	8 ft. 10 in. by 8 ft. 4 in.
Engines: Four Pratt & Whitney T34-P-7W/WA turbines of 6,500 eshp. each.	
Propellers: Curtiss-Wright electric, three-bladed, 18-ft. diameter, full feathering.	

*(Note—Operating weight must be lowered 2,800 lb. in order to carry 117,800 lb.)

have 600 hr. overhaul intervals, which are expected to increase to 1,500 hr., the time for which the prototype was previously validated. (Initial engine problem area at Dover concerned 22 engines overhauled at San Antonio Air Materiel Area, of which 11 failed at an average of 35 hr. Thrust bearing failures, cracked accessory cases and excessive oil consumption were involved.)

• **Icing restrictions.** The C-133 has been restricted from areas forecasting moderate icing which are expected to exist for periods in excess of one hour cruise conditions. Reason: engine fluctuations when propulsion system is subjected to icing. Occasional freezing of the fuel control system was attributed to freezing water entrapped within burner pressure-sensing bellows.

• **Spares and support.** En route support and spares problem gradually is being alleviated, but it is still in the "nuisance" stage and a delay cause. Parts are being cannibalized. Spare propellers and components constitute a sore spot, particularly because of difficulties with governors, drifting from switch settings, oil leaks and shorting of cannon plugs. Propeller inspection level is 1,200 hr.; in early test program was validated at 1,100 hr.

• **Auxiliary gas turbine units.** Units provide hydraulic and electrical power, provide pressurization and air conditioning. Time between overhaul is 300 hr. for the 85-3, expected to increase to 1,000 hr. The unit initially was subject to frequent and premature failure.

Current procurement program for the C-133 covers 50 aircraft, with the present contract running through 1959. Included are 15 C-133Bs, the first of which will go into test this December. Dover AFB is programed to receive all of these B models.

Dover now has 12 C-133s "assigned" (others having been returned to Douglas at Long Beach for major modification).

Aircraft utilization runs about 15% for training, 35% for scheduled operations (cargo only) and 50% for special missions (missiles, missile components and support equipment, the former termed "Go-Way Operation").

Cargo Operations

Cargo operations usually are scheduled two or three months in advance. Special missions embrace a diversity of routes.

Channeled cargo is handled by MATS at a ton-mile rate, all funded. Special missions are charged at an hourly rate.

By comparison, the smaller Douglas C-124 Globemaster, of which Dover has 74, has a utilization breakdown of 60% scheduled cargo, 15% training and 25% special missions. Both the C-133 and C-124 fly 65% of their total missions over water. On special missions, the C-133 flies 75% over water, 25% domestic.

The Cargomaster is programed to fly about 5 hr. per day, approximately

C-133A Performance

(at 275,000 lb. unless otherwise specified)

Service ceiling	19,400 ft.
Emergency ceiling (MRP on three engines)	11,100 ft.
Optimum altitude	15,000 ft.
Minimum control speed	105 kt.
Minimum with two engines out, one side	136 kt.
Maximum speed (20,000 ft., 220,000 lb.)	288 kt. TAS
Normal operating speed	260 kt. TAS
Never exceed speed (below 15,000 ft.)	274 kt. IAS
Critical field length	5,400 ft.
Takeoff field length	4,500 ft.
Landing ground roll	2,510 ft.
Rate of climb (initial, zero flaps)	1,100 fpm.
Three-engine rate of climb (initial, zero flaps)	440 fpm.
Fuel capacity	117,728 lb.
Range, maximum gross, full tanks, 47,000 lb. cargo (no reserves)	3,975 naut. mi.

Marine HRS Modified for Spraying

Sikorsky HRS helicopter has been modified at Cherry Point, N. C., Marine Corps Air Station for insect spray uses. Aircraft carries two 55-gal. tanks of insecticide ducted to spray booms on each side. Modified HRS was test flown at Cherry Point and will undergo service evaluation tests at Patuxent River, Md. Modification was made under a program of the Bureau of Aeronautics and Bureau of Medicine and Survey.

twice the flying now done. The C-124, by comparison, utilizes about 5 hr. per day, and is programed for 5 hr.

Monthly C-133 utilization is highlighted in the following EASTAF operations data for Dover AFB during March of this year:

• **Total time.** Flying hours numbered 699, of which 346 were for training, 321 for transport, 32 for test hops, etc.

• **Engine changes.** Total was 15, of which 12 were for failure and three for high time. Engine life at time of change: average, 258 hr.; failure at, 186 hr.; high time at, 546 hr.

• **Maintenance.** Manhours totaled 61,372; in direct labor was 36,200 hr. Direct manhours/flying hour were 51.8. Maintenance inspections were as follows: Preflight, 49 inspections @ 4 hr./inspect., 43 manhours/inspect. Postflight, 12 inspections @ 29 hr./inspect., 153 manhours/inspect. Periodic, five inspections @ 215 hr./inspect., 1,575 manhours/inspect.

• **Payload.** Average during the month was 56,200 lb. (28.1 tons).

• **Loading.** Manhours per aircraft averaged 24.6. Average time to load one aircraft was 3.9 hr. Manhours expended per ton loaded average 1.0, compared with 1.4 for a C-124. By comparison, the average C-124 payload in March was 30,500 lb., 20.9 manhours were expended per aircraft loaded and average loading time was 2.6 hr. In the time that one C-133 was loaded, 1.42 C-124s could have been loaded, but 13,000 fewer pounds would have been loaded on the C-124s. Direct operating cost for the C-133 averaged about 7¢ per ton mile. This figure is for actual payload flight, and does not involve training and testing flight hours.

• **Cost per hour.** Dover's cost per flying hour by type aircraft, based on actual operations for the first three quarters of Fiscal 1959, were $288.82 for the C-124C and $487.18 for the C-133A. For March, the cost was $299.66 for the C-124C and $489.18 for the C-133A.

The Globemaster's jump over the first three quarters was due primarily to increases in depot maintenance of aircraft and engines. The same holds true for the Cargomaster, though the main factors were materiel expense and depot maintenance of engines.

Overseas Routing

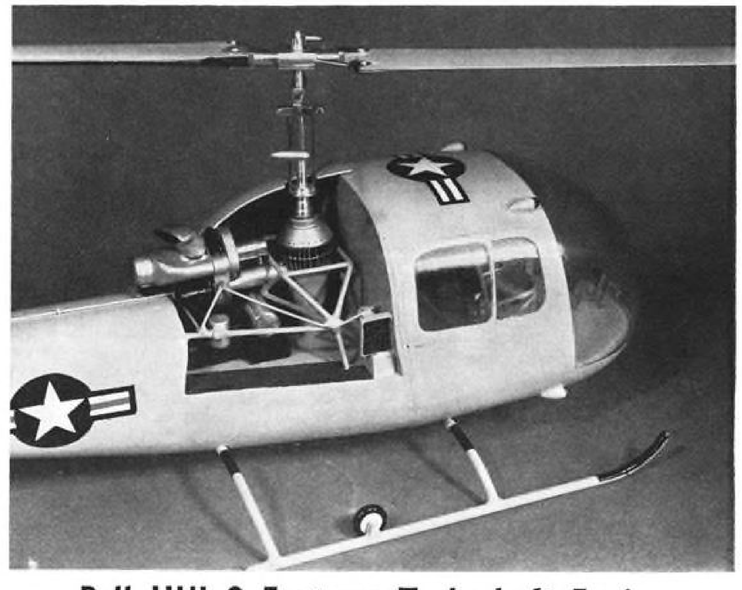
C-133s out of Dover are normally routed to Europe via Lajes, Azores, 2,275 naut. mi. from the Delaware base, or via Harmon, Newfoundland, 964 naut. mi. from Dover. Aircraft operate to two main areas; Chateauroux, France, and Mildenhall, England.

The distance from Lajes to Chateauroux is 1,382 naut. mi.; from Lajes to Mildenhall is 1,445 naut. mi. From Harmon, the distances are 2,472 naut. mi. and 2,289 naut. mi., respectively. Distance direct, Dover to Chateauroux, is 3,420 naut. mi.; to Mildenhall direct is 3,410 naut. mi.

Pacific routing out of Travis AFB, with figures in nautical miles, covers Travis to Hickam, 2,142; Hickam to Wake, 2,070; Wake to Tachikawa (via Marcus Island), 1,775; Tachikawa to Midway, 2,300; Midway to Travis, 2,875; Midway to Hickham, 1,100.

Base Capability

Cargo moved through Dover, inbound and outbound, runs between 10-14 million lb. a month. The base has the capability of handling and processing 20 million lb. without moving into



Bell HUL-2 Features Turboshaft Engine

Bell HUL-2 turbine-powered helicopter model is cut away to show positioning of the Allison YT63-A-3 turboshaft engine which produces 250 shp. Navy has ordered two aircraft for evaluation (AW July 6, p. 33); helicopter is an advanced version of Bell's HUL-1 and company says it will have increased hovering ceiling (in excess of 15,000 ft.), higher payload and faster speed. Climb rate will be up to 1,300 fpm.; maximum speed will be more than 110 mph., and aircraft will carry 1,000 lb. payload in addition to the pilot for a range of more than 200 mi. Engine drives a metal rotor.

wartime capacity. Current storage facilities can backlog 1.5 million lb. of cargo without crowding. About 250,000-260,000 lb. cargo is overseas-outbound per day; about one-half this amount is inbound daily.

Cargo Handling

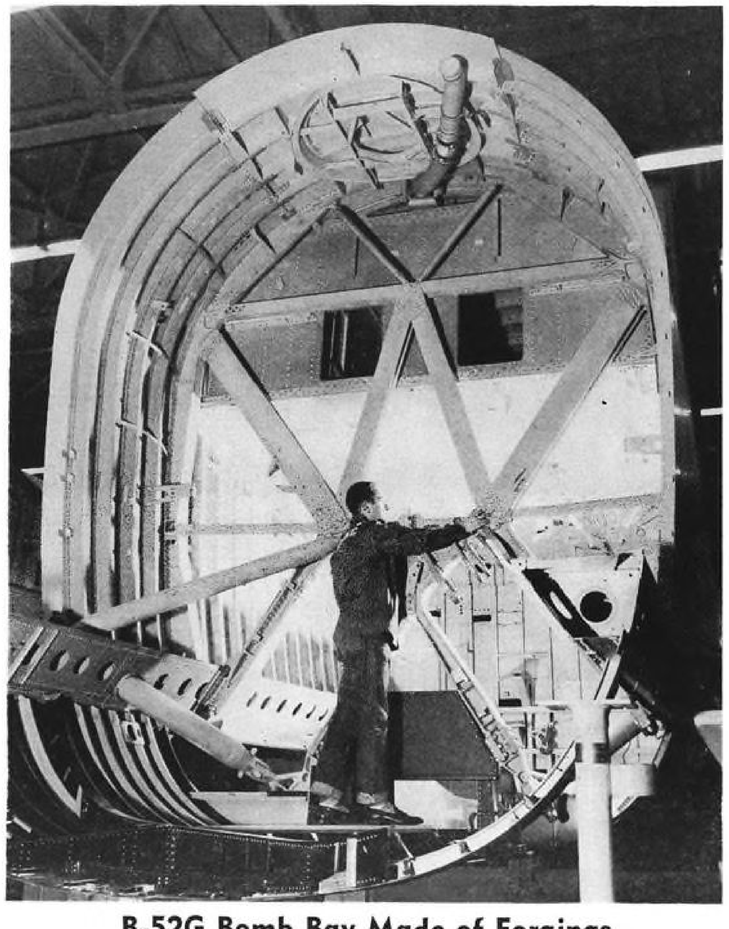
C-133 cargo is loaded on pallets in the terminal, which is 200 ft. wide, 488 ft. long, and has a 15-ft. wide covered loading dock. Eight ramps provide access to 95,634 sq. ft. of gross area, which is reduced to usable net of 95,349 sq. ft. by four fire doors and 48 posts. Cargo is moved from a pier equipped with roller conveyors to the aircraft. Pallets also are placed on flatbed trailers equipped with roller conveyors and driven to the aircraft.

The prototype Douglas system, developed at Dover for the C-133 and undergoing a six-month test, embraces 7 ft. x 10 ft. rigid pallets to which cargo is restrained by means of nylon straps forming a cage. Pallets are moved to the aircraft on lightweight roller conveyors restrained to the aircraft floor. Side guide rails, running the entire length of the cabin floor, guide the pallet and provide a means of rapid restraint.

Guide rails are restrained to the floor with integral tiedown rings and incorporate pins which engage the pallets and provide restraint in all directions. Loaded pallets not exceeding 90 in. total height may be loaded by the straight and level method. By backing a conveyor-equipped flatbed trailer to the horizontal ramp, pallets can be pushed manually into the aircraft.

The C-133 ramp is restricted to 10,000 lb. lifted and 10,000 lb. stowed.

The Titan missile is presently loaded in two stages. Redstone, by comparison, comes in three enclosed trailers. For the former, an electrically-



B-52G Bomb Bay Made of Forgings

Boeing Airplane Co. technician inspects forward landing gear bulkhead in bomb bay section of B-52G jet bomber; Bay dimensions are 12 x 14 ft. and unit is made almost entirely of forgings. Top assembly (W-shape) is manufactured by H & B Machine Co.

operated portable winch is utilized. The winch can be plugged into aircraft outlets or tied in to an external power unit of 200 v. The winch holds 205 ft. of ⅞-in.-dia. steel cable, capable of moving an object requiring a 15,000-lb. pull at the rate of 6 fpm.

Cable from the winch, hooked in the front section of the aircraft, is run out to Titan, which sits on its transtainer (trailer), and is broken into two stages. Stage two, weighing more than 10,000 lb., is shorter than stage one, and is pulled into the Cargomaster first. Stage one, also weighing over 10,000 lb., takes up most of the aircraft and usually entails lowering the front end of the transtainer and raising the back end during the loading operation.

Clearance area on stage one is critical, as a servo motor hanging from the cabin top allows only 2 in. clearance from the top of the missile, which can be decommissioned with but one scratch. Personnel are stationed at critical areas as the missile is pulled aboard. Should the missile come within one inch of any part of the aircraft, a sharp blow on a police whistle is given as a signal to halt the winch.

Two Martin Co. personnel will service the Titan during the entire flight, via four nitrogen bottles of 1,500 psi. each, keeping it under pressure to prevent contamination inside the tank, which could cause its collapse.

Efficiency and thoroughness of well-coordinated MATS crews was evident to AVIATION WEEK pilot-editor who flew eastbound to Mildenhall, via Lajes, with EASTAF C-133 and return from Chateauroux to Dover, also via Lajes, with WESTAF Cargomaster.

Flight to England

The flight to England constituted a "Go-Way Mission," and also an upgrading to aircraft commander for Capt. Richard Brooks, who was being checked by 1607th Air Transport Group chief pilot Maj. Henry Bierbaum. Other crew members included first pilot Lt. James Foster, flight examiner navigator Capt. Donal Zellmer, navigator Lt. Warren Packard, engineer technicians, all master sergeants, Warren Rose, Donald Birdsall and Clemens McGara. Loadmaster was S/Sgt. Francis Cave.

Takeoff from Dover, into a crosswind of 12 kt., outside air temperature 28C, was made at gross weight of 274,956 lb. The aircraft was airborne after a roll of 6,200 ft. Initial rate of climb was 200 fpm. until the airplane cleaned up and speed built up to 180 kt. The rate then increased to 1,200 fpm.

Flight to Azores was made via step-climb, held down initially by traffic control which held the C-133 in holding pattern at 4,000 ft. for 12 min. Result, about 3 hr. after takeoff, at 17,000

Model Shows New Kamov Helicopter Configuration

Soviets are constructing a new Kamov helicopter as a follow-on to the Ka-15 and Ka-18 developments. This model was displayed on an aft landing platform of a model of the nuclear-powered icebreaker Lenin at the Soviet Exhibition of Science, Technology and Culture in New York (AW July 13, p. 117).

ft., was average fuel consumption of 10,000 lb./hr.

The aircraft, No. 56-2008, landed at Lajes 8 hr. 40 min. after takeoff, with 15,000 lb. fuel left on board. There were no delays en route to Mildenhall and no trouble areas. C-133 flight characteristics and controllability are good. The aircraft has no boost system, only flying tabs. Cruise was held to 260 kt. true airspeed. The flight was entirely by hand; Eclipse-Pioneer PB-20 autopilot is still in test status.

Return Flight

Return was made via C-133 "Spirit of Santa Monica Schools," No. 54-140, which had been on display at the Paris air show (AW June 29, p. 20), and which was extremely impressive during its low-level fly-by, grossing 170,000 lb.

This WESTAF airplane, out of Travis AFB, at the request of air show officials made two of its passes with engines cut; first the two starboard, then the two port. Impressive, also, was the high-speed pass and climbout initiated following takeoff and last low-level run across the field, with two propellers feathered on one side.

The WESTAF crew, hand-picked for the Paris show, was commanded by Maj. Robert Tourte, assistant operations officer for Travis' 84th ATS. The crew included flight examiner (a/c) Capt. Robert McMurry, first pilots Maj. James Myers and Lt. Warren Saline, second pilot Lt. Sidney Cutter, navigator Lt. Charles Greenley, engineer technicians M/Sgt. Kenneth Whitaker, T/Sgt. Darrell Johnson, T/Sgt. Joseph Chini, and loadmasters S/Sgt. Henry Turnsk and A/1C Carl Depp.

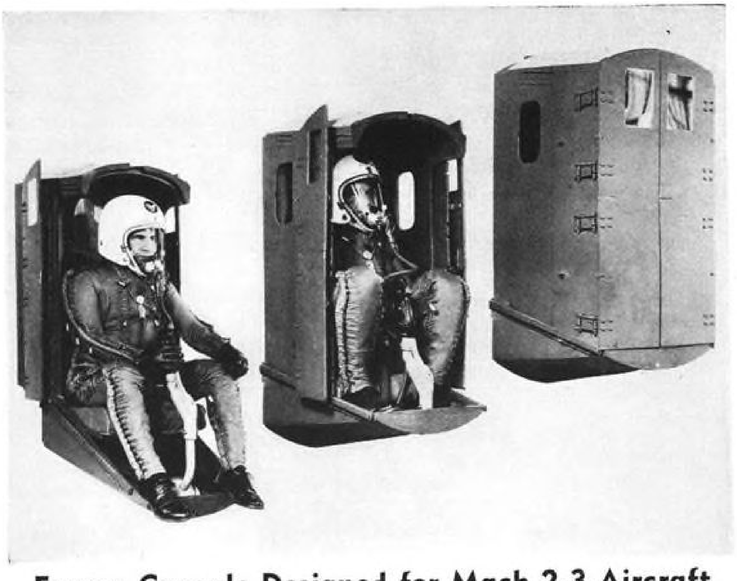
From Chateauroux, grossing 248,322 lb., outside air temperature 30C, field elevation 532 ft., airplane was airborne after a run of but 4,200 ft. Initial climb, clean, was at 1,500 fpm. At 17,000 ft. the C-133 was ascending at 500 fpm., and leveled off at 18,000 ft. Cabin altitude was 1,500 ft., with 6.55 cabin differential pressure.

From Lajes, grossing 274,000 lb., outside air temperature at field elevation of 180 ft. being 23C, climb to initial cruise altitude of 14,000 ft. was made in 20 min.

Big as the C-133 cockpit is, the design might have embraced the engineer sitting parallel with pilot and copilot, rather than facing his panel aft of the copilot's seat. Reason: the engineer has no clock, outside air temperature gage or airspeed indicator for his calculations; neither has he engine instruments or access to engine controls. He must check other panels to maintain his flight log.

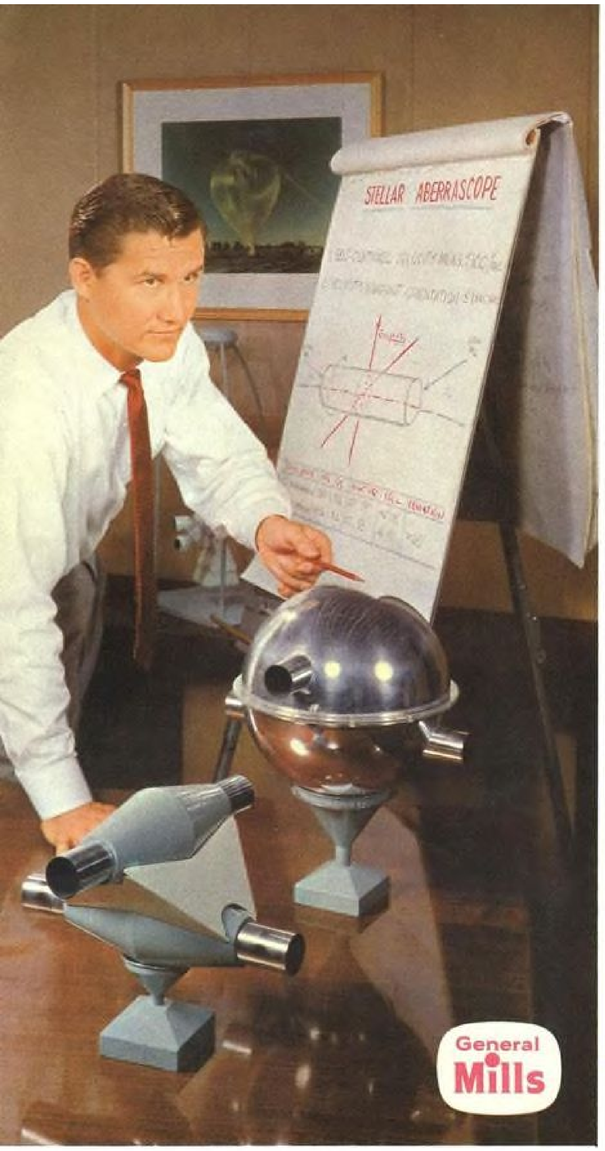
The bottom row of engine instruments, on the main pilots' panel, the oil temperature and oil pressure gages, are partially obscured by the hump of the center pedestal, and can't be read properly by either pilot or engineer at their respective stations. Readings necessitate one of the three bending low over the pedestal.

The new C-133 flight deck is roomy; the adjoining "lounge" is comfortable and relatively quiet, with two airline-type seats and a four-place couch that breaks out into a bunk, Pullman-style. Coffee buffet and heater provide hot "TV-dinner" type meals, a far cry from the "box lunch" days.

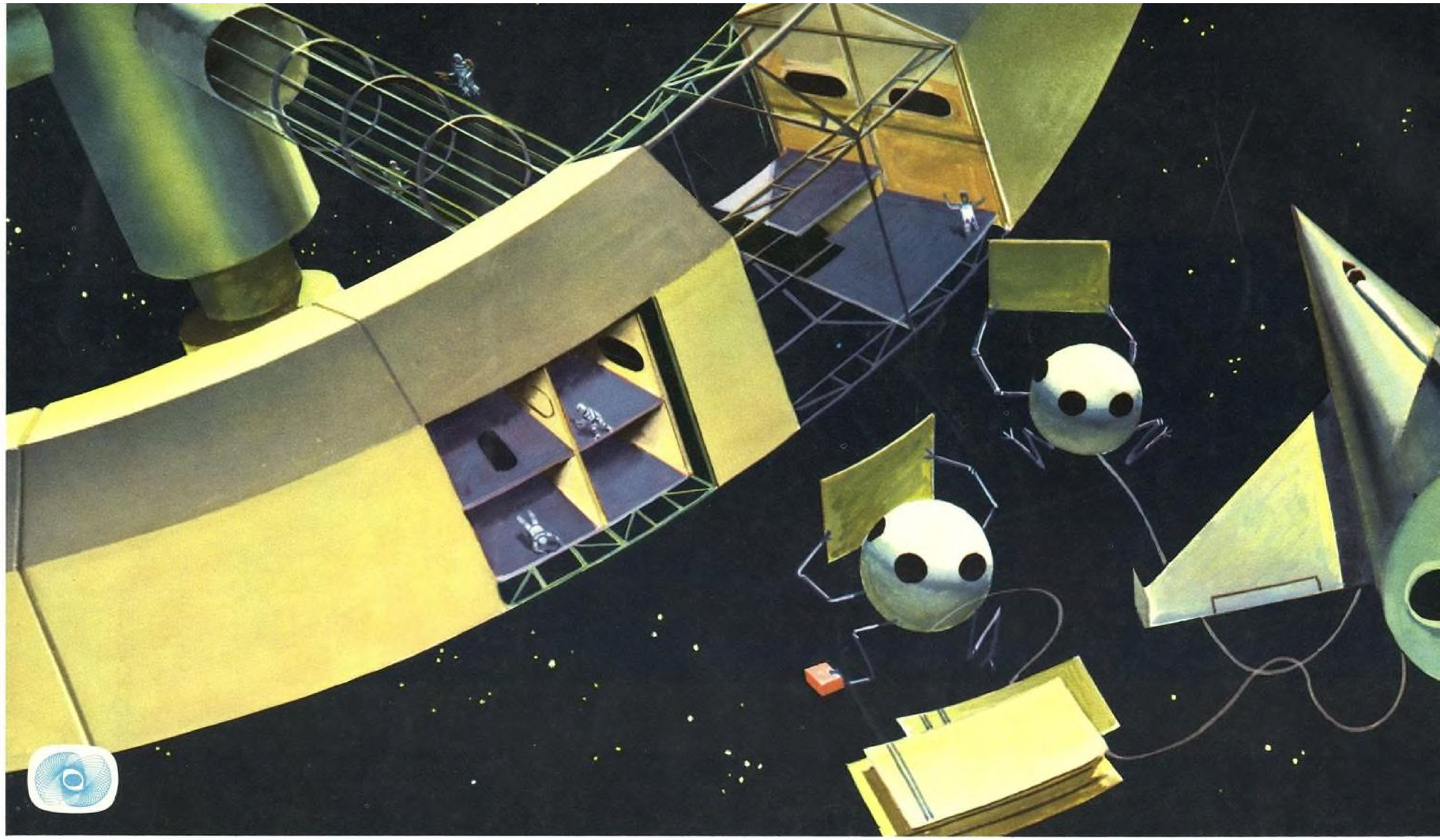


Escape Capsule Designed for Mach 2-3 Aircraft

Aircraft escape capsule was designed by Republic Aviation Corp. for escape from Mach 2-3 aircraft, and from manned satellites. Two rockets separate the capsule from the vehicle and a parachute facilitates recovery. The capsule may also be adapted to low-altitude and low-speed escape as on takeoffs, Republic says. Sequence of operation, shown from left to right, takes less than two seconds.



This is our R. L. Lillestrand, Project Engineer. Here he examines a model of his Stellar Aberrascope, a multiple star tracking device which is expected to provide the measurement of space vehicle velocities to accuracies of the order of 100 feet per second. The Aberrascope is designed so that precise alignment of the star trackers is not necessary. His investigations could have a bearing on self-contained guidance systems used in future space vehicles.



assembling a space station . . . illustration from a book written for General Mills by Willy Ley.

General Mills is working today to help guide vehicles in outer space tomorrow

Development of a space vehicle guidance system which may one day be a factor in sending manned U.S. space stations into orbit around the earth is just one problem being attacked at the Mechanical Division of General Mills. In research, engineering and manufacturing, we are finding solutions to many problems that have application in the space age.

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In our engineering department, current projects include: airborne early warning systems, micro wave radar test equipment, antennas and pedestals, infrared and optics, inertial guidance and navigation, digital computers.

Our entire manufacturing department is geared to produce systems, sub-systems and assemblies to the most stringent military requirements. Our people have a wealth of experience in complex military projects.

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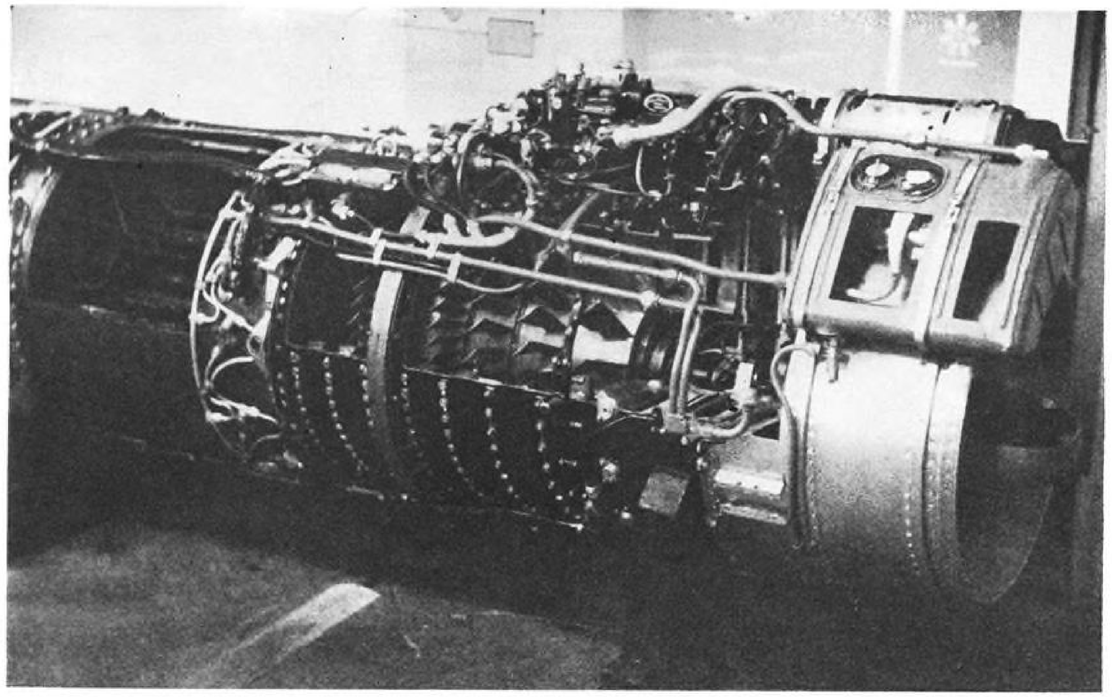
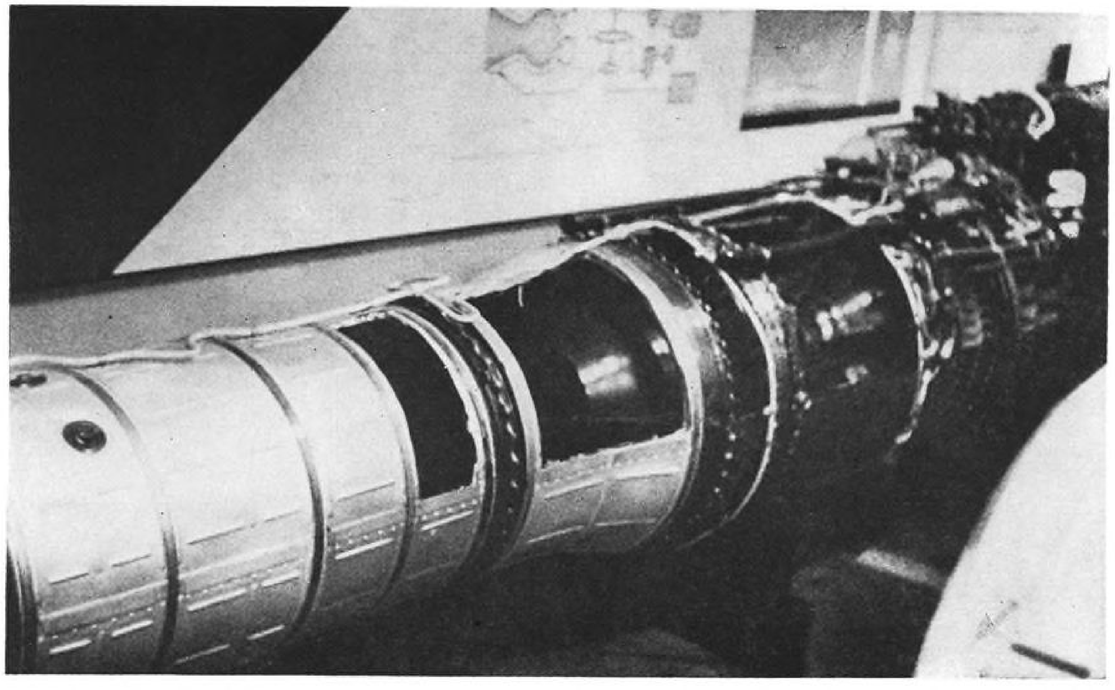
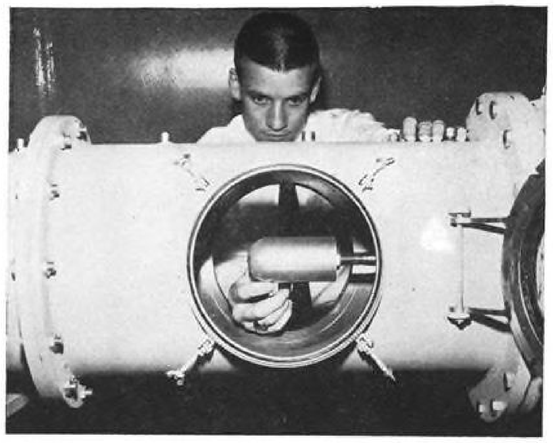
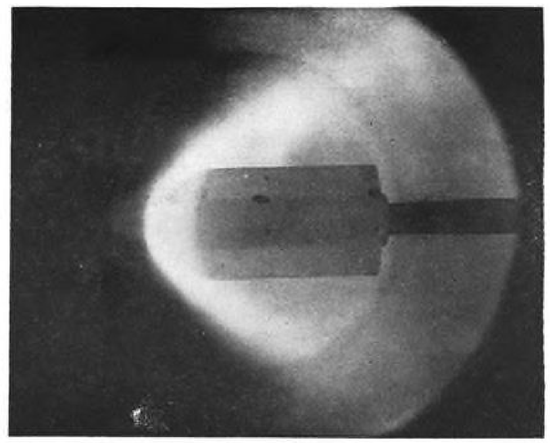


Kuznetsov Turbojet Engine Powers Yak-25

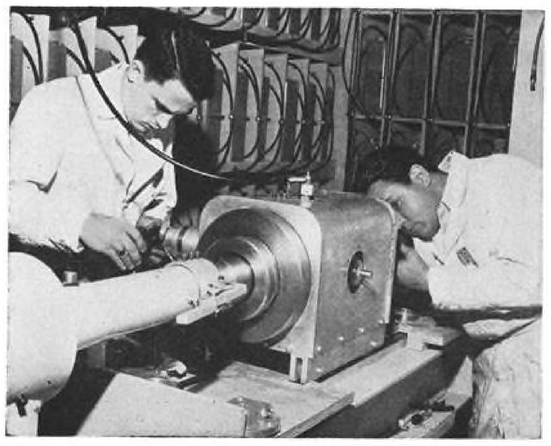
Cutaway model of the Kuznetsov axial flow turbojet that powers the Yak-25 (Flashlight) all-weather fighter is displayed in the Air Museum in Moscow. This turbojet is rated at 8,000 lb. static thrust without afterburner and about 12,000 lb. thrust with afterburner. Note simplified design that smacks strongly of the German Jumo axial flow developments. Engine has a six stage compressor (shown above), cannular combustion chamber and a two-stage turbine. Short, simple afterburner is shown below. Yak-25 is powered by two of these eagines mounted under the wings.

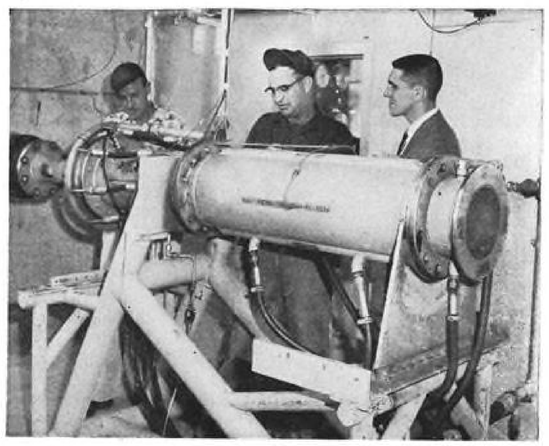






TUNNEL project engineer J. A. Kyser adjusts a model about to be tested at 13,000 mph. in test section of the Chance Vought Aircraft hypersonic unit. At right is a photo of the blunt shape during a test at Mach 13. Luminous air rushing past the model produced its own picture when camera shutter was left open. Circular rings behind model are reflections on window on opposite side of the 12-in. tunnel.





SQUARE arc chamber (left) is heart of the Mach 20-capability wind tunnel. Capacitors behind technicians store up more than 1 million kw. of electricity for release into chamber of compressed air inside the chamber. Tests last only 40/1,000th sec. At right, a 10-in. ramjet engine provides a 3,400 deg. flame to test ceramic and metal nose cones; hoses below engine supply water for cooling.

Wind Tunnel Capable of Mach 20 Testing

Dallas—Chance Vought Aircraft has extended its wind tunnel test capabilities into the Mach 20 area by adding a new hypersonic tunnel to its subsonic, transonic and supersonic tunnel complex.

Hypersonic tunnel now in operation supplements an older subsonic tunnel and the new trisonic tunnel opened late last year (AW Dec. 29, p. 57) which can handle velocities up to Mach 5. Company also has a ramjet facility for testing space vehicle nose cones.

Compressed Air

In the hypersonic tunnel, 20 cu. in. of air are compressed in an arc chamber at pressures ranging from 500 to 2,000 psi., then one million kilowatts of electricity are released in the chamber, and temperature goes to 15,000F and pressure to 30,000 psi. A quarter-inch nylon disk is ruptured, and the pressure wave and compressed air rush through an eight-foot-long nozzle into the evacuated 12-in. test section and on down an 18 ft. tube.

High Mach number flow around the model in the test section lasts only 0.040 sec., but it can be recorded with a press-type camera using a short time exposure. Polaroid and cut-film cameras mounted on oscilloscopes give pictures of traces on cathode ray tube displays for further test data.

In its test facility for nose cones, Chance Vought uses a 10-in. ramjet engine to produce 3,500F heat and simulate re-entry effects. Metal or ceramic nose cones are mounted on a water-cooled sting and can be moved as close as three inches from the ramjet engine exhaust tube.

Ramjet burns oxygen and JP-4, and a water jacket is used to cool the engine during tests which can run as long as two hours.

Control Room

Test objects can be moved toward and away from the ramjet exhaust to vary temperature, and angles of attack, and yaw can be varied. Operators monitor the test from a control room projected by shatterproof windows and through a closed circuit television system.

Aerial Mappers Use Gravity Meters

New York—Successful gravity contour-mapping of California's Imperial Valley by means of airborne gravity meters promises increased mapping accuracy for plotting missile trajectories and more effective means of mapping unchartered areas of the earth. Aerial mapping system, precise to 10 milligals (gravity measurement unit) or better, is adequate for geodesic purposes.

Mapping Project

The mapping project, accomplished with a Boeing B-17, was undertaken by Fairchild Aerial Surveys, Inc., in conjunction with LaCoste and Romberg, a gravity meter company, and Gravity Meter Exploration Co., a data reduction concern.

The B-17 flights amplified the findings of a limited gravity meter test made in November, 1958, from an Air Force Boeing KC-135 under sponsorship of the Air Force Cambridge Research Center, Bedford, Mass.

Air Force interest in more precise geodesic information stems not only from interest in missile trajectories, but also in pinpointing locations of long range navigation facilities. Small errors in the location of Loran stations are magnified in fixing the location of an aircraft or ship at long ranges. Corrections in island positions have been made by observations of satellites; however, this method is impractical for mapping large areas.

Aerial Gravity

Aerial gravity contour mapping is made possible by advances, not only in mobile gravity meters, but in navigation equipment, radar altimeters, autopilots and recording equipment which

Dural Propeller Tested on Electra

Newly designed Hamilton Standard propeller, now undergoing flight tests on a Lockheed Electra turboprop transport, features round tipped blades and solid dural construction. Strain gages are attached to the blades to determine stress loads in all configurations. The propellers, geared to Allison 501-D13 turbine engines, will be installed on 12 KLM Royal Dutch Airlines Electras and on U.S. Navy's YP3V-1 anti-submarine warfare models.

Vertol selected to build new 2-3 ton transport helicopter

Vertol has been selected by the U.S. Army to develop a new 2-3 ton capacity helicopter, destined to write a new page in the mobility book of today's fast striking forces. This multi-turbine powered vehicle (Army designation the YHC-1B Chinook) is a growth version of the company-developed Vertol 107 family prototype.

The all-weather, day-night YHC-1B will be capable of performing such varied missions as redeployment, reinforcement, attack and pursuit. In a logistical role, the aircraft could transport missiles, nuclear warheads and general cargo, and evacuate casualties. Its unobstructed 30-foot long payload compartment, with a straight-in rear loading ramp that can be left partially or completely open or removed entirely to transport extra-length cargo, speeds the entry and discharge of men and materiel . . . and facilitates in-flight parachute or free-drop delivery for special missions.

The YHC-1B will not only be able to air-lift tactical units capable of completing assigned combat missions, but provide vitally needed mobility within the combat zone. This mobility is requisite in the concept of limited conflicts and, in addition, provides an important offensive and defensive weapon against nuclear attack. In a nuclear situation, the YHC-1B could provide the means for the prompt concentration of troops for attack and their equally rapid dispersion to negate effective retaliation.

All the proved advantages of tandem-rotor helicopters as pioneered by Vertol, will be inherent in this newest Army air vehicle. Large center of gravity range that permits indiscriminate seating and regrouping in flight • Low rotor downwash velocity • Excellent towing characteristics • Rotors high on airframe to permit landing in wooded terrain • Excellent hovering characteristics under varied conditions • Pilot seats low in airframe for ease in judging clearances • Easy maintenance.

Vertol's years of research in the VTOL-STOL field, personified in the YHC-1B, assure our Pentomic army the mobility, speed, flexibility and freedom from terrain that are among the nation's most potent weapons in preventing aggression.

Engineers: *Join Vertol's advanced engineering team*

VERTOL *Aircraft Corporation*

MORTON, PENNSYLVANIA

SUBSIDIARIES: ALLIED RESEARCH ASSOCIATES, INC., BOSTON, MASSACHUSETTS, VERTOL AIRCRAFT CO. (Canada) LTD., ARNPRIOR, ONT.

permits data reduction of the gravity and flight records.

'Measuring gravity variation while airborne is made difficult by the instantaneous effects of the motion of the aircraft. These forces are thousands of times greater and indistinguishable from local gravity variations. These instantaneous forces are balanced out by averaging the readings on the basis of one-minute primary averages, which are averaged over 3 min. intervals.

Another problem in airborne gravity measurement is caused by Eotvos Effects—changes in the earth's normal centrifugal force caused by motion. These effects, greatest when the aircraft is flying an east or west course, can be as high as 1,200 milligals when flying eastward at 200 mph.

At 200 mph. east, a change of one mile per hour in groundspeed will cause a gravitational change of 6 milligal. At 200 mph. north, a course change of one degree would make an east or west component of 3.5 mph., which would introduce a gravity effect of 20 milligals.

The aircraft's altitude must also be recorded precisely, as a variance of 10 ft. will result in change in gravity meter readings of one milligal.

The Imperial Valley was chosen for the project because of its topography and the availability of accurate maps of the region. The Fairchild B-17 carried some 500 lb. of equipment, including a LaCoste and Romberg mobile gravity meter and recording equipment, to accomplish the mapping project.

The aircraft was flown at an altitude of 12,000 ft., an altitude more turbulent than the 20,000 ft. flown by the KC-135. Nine flights were made to map the region, with the final one considered too turbulent for reliable results.

Course, speed and elevation were established by means of photographic and APR radar altimeter records, in conjunction with maps of the area. In addition to the radar altimeter, the aircraft carried a hypsometer, a precision instrument for measuring pressure altitude by determining the temperature of boiling toluene. The use of doppler navigation systems will simplify the task of maintaining precise navigational tolerances.

Electra to Tour South America

Lockheed Aircraft Corp. will send a turboprop Electra on a 16,600 mi., 23-day sales trip through South America, departing Burbank, Calif., on Sept. 3.

Demonstrations will be given at Caracas, Rio de Janeiro, Brasilia, Sao Paulo, Porto Alegre, Lima, Bogota, Mexico

City, with a total of 34 demonstration flights scheduled.

Airlines invited to participate include Loide, Real, Panair do Brasil, Cruzeiro, Varig and Vasp (all of Brazil); Faucett (Peru); Braniff and Panagra (U. S.); Austral (Argentina); LAN (Chile); Avianca and RAS (Columbia); LAV and Avensa (Venezuela); British West Indian Airways (Trinidad), and Aeronaves (Mexico).

Lockheed Senior Vice President Cyril Chappellet, B. W. Holloway, T. F. Bergman and R. G. McDonald will lead the group, while flight crew will be headed by Herman R. Salmon, with Frank Butora as copilot. Also aboard will be propulsion system representatives from Allison and Aeroproducts Divisions of General Motors, and AiResearch Corp.

British Aviation Exports Set Record

London—British aviation industry had a record half-year for exports. In the first six months of 1959 shipments overseas were valued at $245.64 million, representing an annual rate of more than $490 million, Society of British Aircraft Constructors reports.

Last year the industry exported a total of $431 million worth of goods. During the half year, exports of aircraft and parts totaled $149.5 million, compared with $104.7 million in the corresponding period of 1958.

Overseas sales of engines were valued at nearly $86 million, $18.2 million more than the first half of last year.

Von Braun, Blackburn Differ on Pilot Role

Santa Monica, Calif.—Pilot's role in the space age lies in the re-entry phase of orbital and space flight, rather than in the powered exit phase, Dr. Wernher von Braun, director of development for Army Ballistic Missile Agency told the Society of Experimental Test Pilots here. Sharp exception was taken by SETP President Al Blackburn, who cited recent successful centrifuge runs where pilots have "threaded the needle" during exit and re-entry transverse-g profile runs.

Von Braun said that multistage rockets have no inherent stability due to a lack of aerodynamic surfaces and cannot stand even momentary displacement from course. Therefore, he said, "there is very little time for intelligent reaction during the powered phase of flight. We like to think of man as an amazingly versatile computer, but in missile terms he is outrageously slow and cumbersome."

Re-entry, however, is a different mat-

ter and here man will prove his usefulness, he continued. Capsule-type vehicles, such as planned for Project Mercury, have the disadvantage that their landing point is extremely difficult to predict, necessitating a "considerable portion of the U. S. Navy" to be standing by for recovery, von Braun contended. Piloted hypersonic glide vehicles such as Dyna-Soar are the answer to making a "spot landing" at a predetermined point on earth but the main difficulty here is that the re-entry vehicle must have aerodynamic surfaces which will permit a final controlled descent, such as the North American X-15 will make, according to the speaker.

Von Braun emphasized that if a winged vehicle were placed atop a multistage rocket, its aerodynamic surfaces would be extremely destabilizing during the powered portion of flight. An answer to this problem, he said, would be to have the aerodynamic surfaces deployed only after powered flight is completed. Inflatable structures may be the answer, he added, saying that ABMA was already at work in this area on what he termed the "hypersonic blimp."

He was not, he said, "a two-headed monster who is trying to throw airplanes into the ash can." The missile age is now at a point where its technology is not sufficient to permit man's inclusion and that, as knowledge is advanced, safety factors will become high enough to make manned flight possible, he said. Although he admitted that there has been little use for pilots in missile experiments, he stressed to the test pilots: "This is not to tell you, however, that your profession is dying. Its greatest challenge lies ahead."

Designers Modify Soviet Yak-12M

Moscow—Improvements in performance and comfort have been accomplished by a clean-up of the design of the Yak-12M single-engine utility airplane.

The new Yak-12A, powered by an AI-14R radial engine, has completed its test program, according to official Soviet engineering sources.

The Yak-12A differs externally from the previous model by having tapered outer wing panels, compared with the rectangular planform on the Yak-12M, this change reducing wing area by 13.4 sq. ft. and increasing wing loading from 12.6 lb./sq. ft. to 14.2 lb./sq. ft. Wing bracing was modified; a single strut replaces the former V-strut. Stabilizer is now cantilever and is attached to the fuselage at three points and is supported on both sides at two points, rather than three points and a strut. Wing leading edge slats are now automatic—previously they were of the fixed type.

Top speed is now 130-133 mph., compared to 111.7 mph. for the Yak-12M.

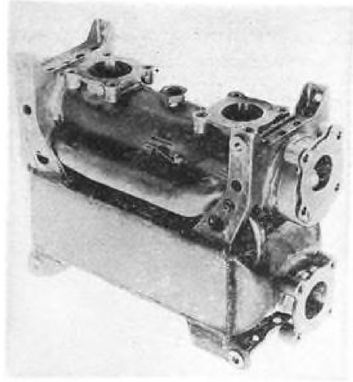
Fuel capacity on the Yak-12A is 57.2 gal. Range at full gross weight has been increased to 621 mi., compared with 280 mi. for the Yak-12M. Endurance is increased to almost seven hours. In spite of increase in weight from 3,190 lb. to 3,498 lb., the Yak-12A's rate of climb at sea level was decreased by only 1.6 ft./sec., the Russians report, and service ceiling decreased 525 ft. Service ceiling is 13,120 ft.

Yak-12A designers are reported to have improved ventilation and heating of the four-place airplane and installed additional windows on both sides of the cabin.

A control wheel has replaced the stick control used on the Yak-12M. The control wheel shaft is said to carry a brake lever connected to PU-7 main landing gear brake valve. A locking pin will fix the brake lever in the "brakes on" position.

PRODUCTION BRIEFING

The Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, will produce fuel heaters for Boeing B-52 aircraft under $1.5 million contract. Fuel heaters, which prevent fuel icing,

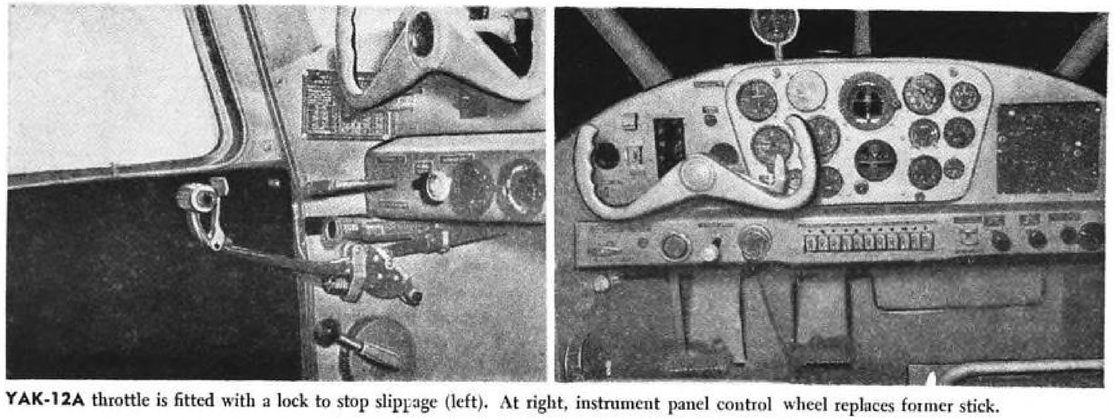


will be installed on production B-52Gs, and will be retrofitted on all other B-52s. Heat exchangers utilize engine bleed air to heat −60F fuel to between 35 and 45F temperature.

Airwork Corp., Millville, N. J., will act as distributor and overhaul facility for Rolls-Royce Dart turboprop engines under agreement with Rolls-Royce, Ltd., of Canada. Aircraft using the Dart engines in the U.S. are the Vickers Viscount, the Fairchild F-27 and the Grumman Gulfstream.

Lockheed Aircraft Service, Inc., Ontario, Calif., will furnish flight data recorders for Boeing, Douglas and Convair for factory installation on Boeing 707, Douglas DC-8 and Convair 880 jet transports. Sales of the Lockheed flight recorder total 229.

Carrier Corp., Syracuse, N. Y., will supply 15 air compressors to furnish



YAK-12A throttle is fitted with a lock to stop slippage (left). At right, instrument panel control wheel replaces former stick.

compressed air to the four internal combustion catapults (AW June 8, p. 89) on the USS Enterprise nuclear aircraft carrier. Three steam turbine driven compressors will furnish the 1,500 psi. air needed by each catapult with one set of three kept as a spare. The Bureau of Ships contract totals $8 million.

Waste King Corp., Los Angeles, Calif., will supply jet transport flight data recorders to Northwest Orient Airlines, Swissair and Scandinavian Airlines System for use on Douglas DC-8s, Convair 880s and Sud Caravelles. The orders, totaling 56 tape recorder units, brings the number of recorders on order to 176, representing a backlog of $1,200,000.

Pre-Flite Industries Corp., Stratford, Conn., a subsidiary of Avco Corp., will deliver stored air type jet starting units to American Airlines. Self-propelled starting units, with a 70 cu. ft. capacity and a 50 min. charge time, will be used for starting the airline's Lockheed Electra and Boeing 707 aircraft.

Lockheed Aircraft Service, Inc., will perform aircraft maintenance and modification work at the National Aviation Facilities Experimental Center, Atlantic City, N. J., under $809,350 FAA contract. Work involves 12 jet and piston engine aircraft used by the FAA to evaluate air traffic control systems.

Robertshaw-Fulton Co.'s Aeronautical and Instrument Division, Anaheim, Calif., will produce stability augmentation amplifiers for the Convair F-106 under $963,338 contract. The transistorized unit is an airborne computer used to dampen pitch, roll and yaw. It commands the autopilot by summing aerodynamic and fire control data when the aircraft is being guided by the Hughes MA-1 automatic fire control system.

North American F-108 Mach 3 long-range interceptor elevons will be manufactured by Rohr Aircraft Corp. and Solar Aircraft Co. has been selected to build the Rapier's wing leading edge and ventral fin.

Metallurgical research center will be constructed by E. I. DuPont de Nemours & Co. at Baltimore, Md., for work in fields of high temperature metals for jet engines, rockets and missiles and atomic power generators. Installation will be completed in 1960.

Aerojet-General Corp., Azusa, Calif., has established an Anti-Submarine Warfare Division to speed completion of a multimillion dollar contract received recently for development and produc-

tion of a new type of anti-submarine torpedo and to expand the company's basic research in ASW detection, underwater communications, weapon systems, ocean surveillance and related activities.

Consolidated Diesel Electric Corp.'s Aircraft Equipment Division, Stamford, Conn., will build transformer-rectifier type power supplies for starting jet engines under $450,000 Air Force contract. Power units will have an output of 1,000 amp. at 28 v.d.c. from an input of 220/440 v. 60 cycle a.c.

Vitro Laboratories, Silver Spring, Md., will build weapon system simulation and training devices under three contracts from the U. S. Naval Training Device Center, Port Washington, N. Y., and one from the Curtiss-Wright Co., Carlstadt, N. J. The four contracts total $225,000.

Lockheed Aircraft Service, Inc. will maintain Navy Lockheed WV-2 and R7V aircraft at New York International Airport and at Honolulu under two contracts totaling $13,100,000. The New York contract covers the Atlantic WV-2 aircraft based at Argentina, Newfoundland, and Paxtuxent River, Md. The Honolulu contract calls for maintenance work on Pacific based WV-2 airborne early warning aircraft and R7V transports and will be performed at the Navy facility in Keehi Lagoon, Hawaii.

Electronic Systems Laboratory is the new name for the Servomechanisms Laboratory at Massachusetts Institute of Technology. Electronic Systems is said to more closely describe the control technology, data processing and measuring system research now being carried out by the laboratory.

Hawker Siddeley Group has formed an advanced design team to work on supersonic transports and space vehicles. Designer of the Canadian Avro CF-105 Arrow fighter, J. C. Floyd, will head the new unit, which is to be staffed by key men from operating companies within the group.

Fokker do Brasil, a wholly-owned subsidiary of The Netherland's Fokker parent plant, has started voluntary bankruptcy proceedings at Sao Paulo. Fokker do Brasil began assembling training aircraft for the Brazilian government in 1953 on a cost-plus-15% basis.

Aerojet-General Corp. will produce 15 liquid-powered rocket engines similar to those used in Vanguard and Thor Able and modified for Delta deep space program under a multimillion dollar contract from Douglas Aircraft Co.

Welded Modules Reduce Component Size

By Philip J. Klass

Washington—Construction technique which slashes the size of avionics equipment by 75% or more and reduces its weight by nearly as much, yet which uses existing conventional components, is arousing industry interest.

The technique, sometimes referred to as "weld-pack," also promises greater resistance to shock and vibration and improved reliability.

Navy recently invited approximately a dozen avionics manufacturers to submit bids for the fabrication of weld-pack versions of the guidance computer to be used on later models of the Polaris fleet ballistic missile. Manufacturers were briefed on the technique at the Massachusetts Institute of Technology's Instrumentation Laboratory (AW Aug. 10, p. 71). The weld-pack version of the computer will be only about one-quarter as large and as heavy as the conventional construction unit used in early missiles.

Technique is the brainchild of Samuel Francis of Francis Associates, Marion, Mass., who several years ago interested MIT's Instrumentation Laboratory in its potentialities. MIT sponsored the development using Air Force Funds initially, more recently with Navy money, for application to inertial guidance computers.

Refinements in the technique also have come from Instrumentation Laboratory engineers and from Raytheon, which was brought in as a manufacturing source for prototype hardware. Francis Associates, a consulting engineering firm, set up an affiliate known as Sippican Corp., Marion, Mass., to fabricate weld-pack units for MIT.

Weld-pack construction is ideally suited to digital computers where there are dozens of repetitive subcircuits, each using transistors, diodes, resistors and capacitors. However, it is not limited to repetitive circuitry and should pay off in many types of avionic equipment, according to Thayer Francis, one of the partners in Francis Associates.

Construction Description

In appearance, weld-pack construction bears a slight similarity to the three-dimensional sandwich type construction employed by some avionics manufacturers in which components are mounted by their axial leads between two printed conductor boards. For example, the modules used in portions of the new Air Force AN/ARC-68 airborne HF radio developed by Hughes Aircraft, employ this sandwich construction.

Upon closer examination, however, the significant differences between conventional sandwich and the new weld-pack construction is apparent. For example, in weld-pack, the components are stacked almost like cordwood, usually with their bodies in direct contact with adjacent components. Such tight spacing is possible because an electrical resistance welder is used to make electrical connections instead of a conventional soldering iron or solder bath. When a soldering iron is used there is danger of damaging nearby components unless sufficient clearance is provided.

Components can be stacked to form almost any desired shape of module. For MIT computer applications, a number of nearly identical logic subcircuits are built up into a module (called "logic stick") which measures approximately an inch square by several inches in length. A group of such logic sticks then is stacked together like building blocks into a solid assembly which is the computer.

Although procedures for fabrication of weld-pack units will vary, depending upon the manufacturer, the general outline is as follows:

Transistors are glued back-to-back with their leads protruding from opposite ends. Then, together with resistors and capacitors, they are placed between two thin Mylar tapes with holes punched to receive the component leads. The Mylar tapes serve as a jig for assembling the individual components, much like the printed conductor boards in conventional sandwich construction. However, the tapes have no interconnecting conductors.

Nickel Ribbons

When the resistors, capacitors, transistors and other components have been installed, with their leads protruding through holes in the tapes, thin ribbons of nickel are welded to appropriate leads to interconnect components into a group of subcircuits.

The stick now consists of a series of subcircuits which are not yet interconnected. The manner in which these subcircuit elements are interconnected will depend upon the function to be performed. Components which need no further electrical connections have their leads clipped off so they do not extend beyond the nickel bus-bars.

The nickel ribbon bus-bars are next insulated from the inter-element connections which will follow by covering them with another Mylar type, also with holes which permit remaining component leads to protrude.

Two more Mylar tapes, each containing a grid or matrix of nickel wires, are then prepared by placing series of wores along the length of the tape on one side, with a series of wores running transversely on the opposite side of the tape. At certain positions, determined by the required inter-element connections, tiny holes have been punched in the tape so the longitudinal and transverse wires can be welded together to provide desired connections. Those wires in the matrix which are not needed for electrical connections for the particular logic function being fabricated are clipped off and discarded.

Component leads which were not clipped off earlier, protrude through tiny holes in the tape and provide the means for connecting the individual subcircuits to the matrix. When all such connections have been made the stick is now a major subassembly of a digital computer.

Until the time the matrix tapes are placed atop the sticks and weld-connected, each stick is identical. The configuration of the matrix tape determines the function the stick will perform.

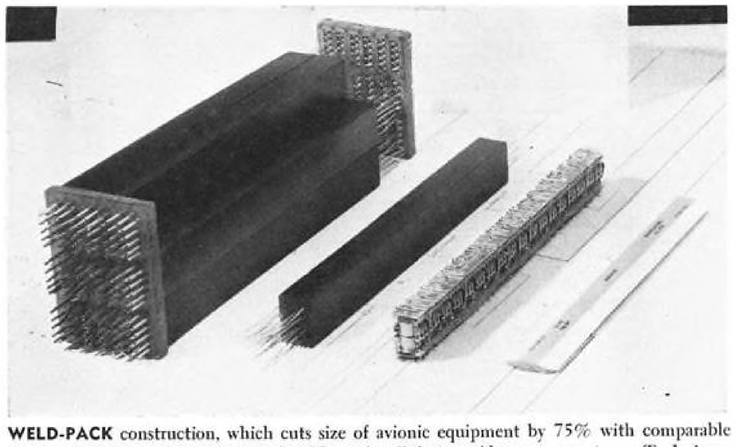
Stick Encapsulated

Input-output connections to the logic stick are provided also by the longitudinal matrix wires which are brought out to a sort of combined terminal block/connector at one or both ends of the stick. Then the stick is ready to be encapsulated. Components which dissipate the greatest heat usually are located along one of the external surfaces of the stick. If this is not adequate, thermal conductors can be brought out to a metal heat sink plate which is attached to one surface of the stick.

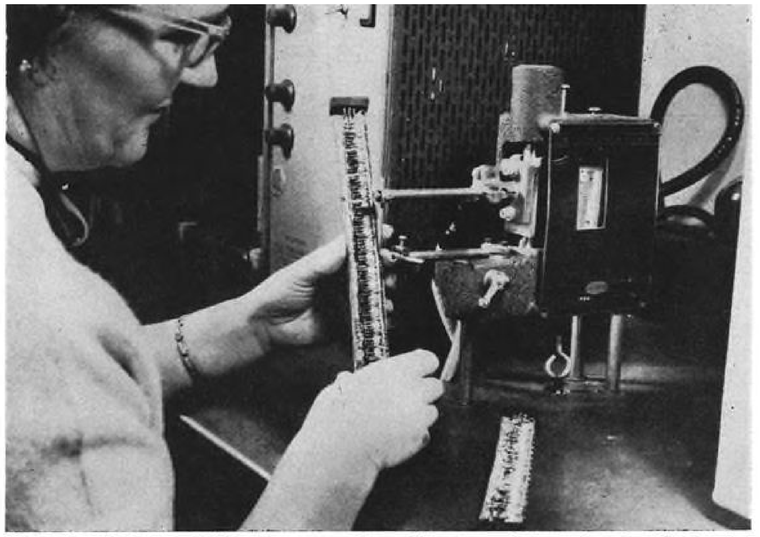
Instrumentation Laboratory has developed a technique whereby an IBM 650 digital computer can be programed to device the optimum layout of components and their interconnections for logic sticks. The 650 computer and its output equipment produce a physical layout which can be photographed, reduced, and used to print a wiring diagram showing required matrix connections on the strip of Mylar tape.

Using conventional subminiature components, it is possible to achieve packaging densities of at least 140,000 components per cubic foot. If microminiature hearing-aid type transistors, resistors and capacitors are employed, figures of up to 260,000 can be achieved. By way of comparison, a density of 35,000 to 50,000 components per cubic foot is about the best that can be obtained with conventional printed conductor board construction.

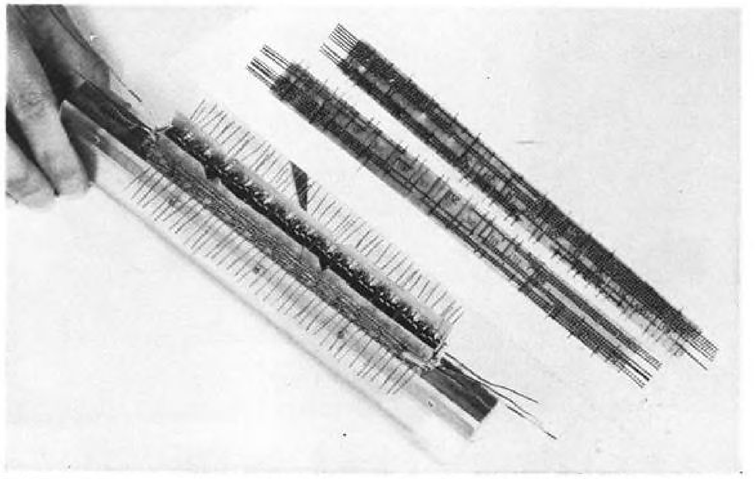
Furthermore, these packaging densities can be achieved for entire equipments, not merely for a few isolated modules. The rectangular configuration of the weld-pack sticks provides maximum space utilization without the wasted areas frequently found in more conventional equipments. All of the



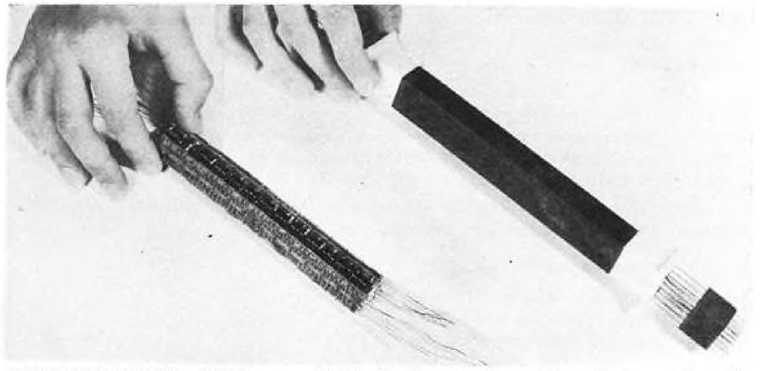
WELD-PACK construction, which cuts size of avionic equipment by 75% with comparable weight reduction, will be used by Navy for Polaris guidance computer. Technique, developed by Francis Associates for MIT's Instrumentation Laboratory, can provide packaging densities of up to 260,000 components per cubic foot using conventional subminiature components, compared with 35,000-50,000 components for conventional printed conductor board construction.



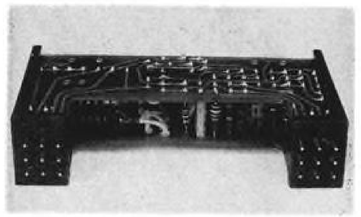
USE OF DISCHARGE WELDER to assemble weld-pack modules and make all electrical connections promises to improve reliability, make unit less vulnerable to shock, vibration.



COMPONENTS are first sandwiched between two thin Mylar sheets with their leads protruding through holes in the sheets. Then nickel ribbon wire is welded in place to connect components into group of individual subcircuits (left). To interconnect individual sub-subcircuits in the module, two more Mylar sheets with grid of wires are prepared (right).



AFTER TWO STRIPS of Mylar are added to insulate previous wiring, the two strips with matrix of interconnecting wires are added and welded at appropriate locations to component leads to form a complete operational module (left). After unneeded component leads have been trimmed off, module is encapsulated (right). Longitudinal matrix wires provide input-output connections to module. Configuration of matrix tape determines function stick will perform.



CONVENTIONAL sandwich construction, as in this unit from Hughes AN/ARC-68 radio, bears some resemblance to weld-pack construction, but uses soldered connection and is less compact.

wiring required to interconnect subcircuits is integral within the stick, while all of the wiring required to interconnect individual sticks into a complete equipment is contained in the end terminal-board/connector to which they are attached.

Once the stick has been encapsulated, it exhibits extremely high structural strength for much the same reason that reinforced concrete is so strong. The matrices of welded nickel wire and ribbon in two planes, and the closely stacked components in the third plane, act much like the steel rods in reinforced concrete.

This, combined with the extremely compact, lightweight construction gives each stick or module a very high stiffness-to-weight ratio. When a group of sticks are stacked side-by-side into a complete assembly, additional structural reinforcement and rigidity is achieved.

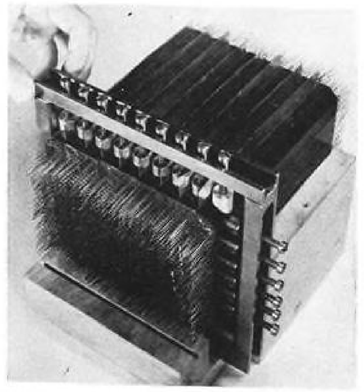
Rugged Construction

To illustrate the ruggedness of the weld-pack construction, Raytheon quotes the following sort of shock-vibration environment which the units can withstand without difficulty or malfunctioning:

- **Vibration:** 50g, swept sine wave from 75 to 2,000 cps. in three minutes, repeated for total of 12 hr.
- **Shock:** 150g of 11 ms. half sine wave; 1,000g of 0.5 ms. impulse.

The use of welding instead of soldering is expected to improve over-all reliability and limited tests to date substantiate this expectation. Although considerable experimentation may be required to determine the best discharge voltage, duration and electrode shape needed to produce a good weld, once these have been established the operation is much more consistent than soldering and far less dependent upon the individual operator's skills, Thayer Francis says.

Furthermore, a defective weld usually is far easier to detect by visual inspection than is a poorly soldered connection. Francis predicts that it should be possible to produce an average of more than one million welded connections



INDIVIDUAL modules are assembled into a complete computer, or device in fixture shown here, after which a connector plate is attached to interconnect all module wires.

per undetected defective weld. Because welding requires only a brief and accurately timed burst of heat, there is far less possibility of damaging heat-sensitive components like transistors and diodes during assembly, according to Stephen Cudlitz of the Instrumentation Laboratory. This makes it possible to weld-connect a component at a point close to its body, eliminating the space and weight of long leads for thousands of components.

Instrumentation Laboratory has been conducting life tests of one complex system, containing 2,500 transistors and diodes and 1,000 resistors and capacitors, subjecting it to voltage cycling, but no shock or vibration. After nearly 2,000 hr. of operation, there has been only a single failure–a silicon transistor –Cudlitz says.

Raytheon, in life tests which now total "thousands of hours," has not experienced a single failure, according to a company spokesman.

Once a weld-pack unit has been encapsulated, replacement of a failed component is impossible. The entire unit must be discarded. Even before encapsulation it is moderately difficult to replace a defective component after the matrix tape has been installed. For this reason, components are thoroughly tested prior to assembly and at key stages in the fabrication process.

At first glance it might appear that weld-pack construction would be considerably more expensive than conventional printed board construction. However, MIT, Raytheon and Sippican all say that it is directly competitive for both pilot and large-scale production quantities. If mechanized assembly facilities were developed, Cudlitz believes the weld-pack technique might prove substantially cheaper than conventional processes.

Francis Associates has been granted one basic patent on the weld-pack technique, has several others pending, according to Thayer Francis. However, the government has royalty free rights because of its funding of the development.

Francis Associates currently is working with several outside companies, assisting them in adapting their circuits for weld-pack construction and in setting up their own in-house weld-pack capability.

Both Raytheon and Sippican, which are producing pilot quantities of weld-pack units for Instrumentation Laboratory, are now building units for outside companies. Newly formed firm, called Ditran Instruments Corp., West Newton, Mass., also plans to produce weld-pack units under contract.

Sippican does not plan to bid on Navy's forthcoming weld-pack guidance computer production program, but Raytheon probably will. Other companies that were invited to bid include: AC Spark Plug, General Electric, Hughes Aircraft, International Business Machines Corp., Kearfott, Lockheed, Minneapolis-Honeywell, Radio Corp. of America, Sperry Gyroscope and Texas Instruments. Hughes and IBM are known to have been investigating welded construction techniques on their own, prior to the recent briefing on weld-pack construction.

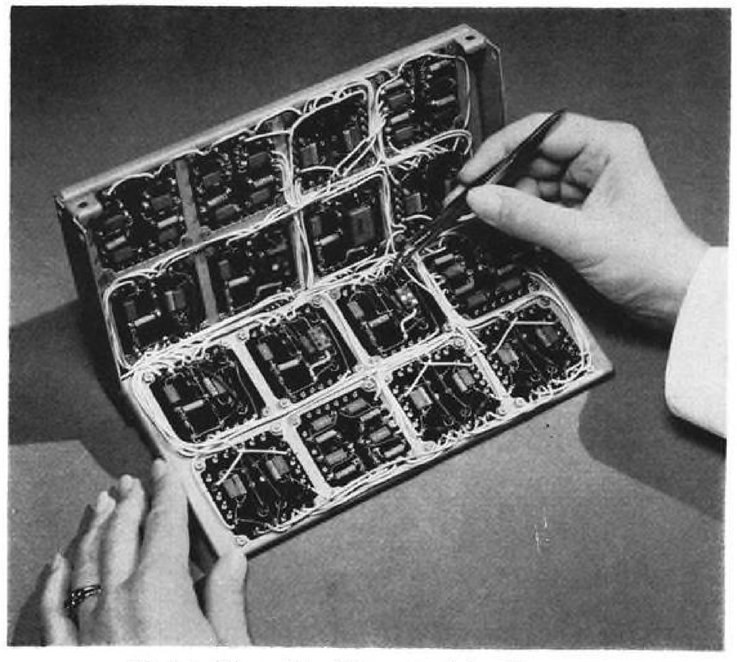
Because many of the techniques involved are similar to those used in the manufacture of vacuum tubes, tube makers may move into the field to compensate for possible loss of market to semiconductors. Raytheon's weld-pack work is handled by company's Industrial Tube Division.

Capital Links Cities With Univac System

Washington–Capital Airlines recently inaugurated its Remington Rand Univac electronic reservations system, linking 12 cities on the carrier's routes with its Washington headquarters. Utilizing 175 agent sets connected by long-line teletype network with a computer in Washington space control, the system handles seat sales and cancellations and provides seat availability, weather and flight status information when the computer is queried.

Capital cities not directly linked to the computer are served by two special agent sets located in the space control headquarters. Telephone transactions and inquiries from these cities are relayed to and from the computer by use of these sets.

The Univac File-Computer makes use of five magnetic drums, each with a 180,000-character storage capacity. It provides information on a 2 million-seat inventory.



Eight Circuits Mounted in Frame

Avionics construction devised by Stanford Research Institute consists of two sets of eight circuits mounted back to back in a hinged aluminum "window frame." Single 20-pin connector provides connection for complete assembly.

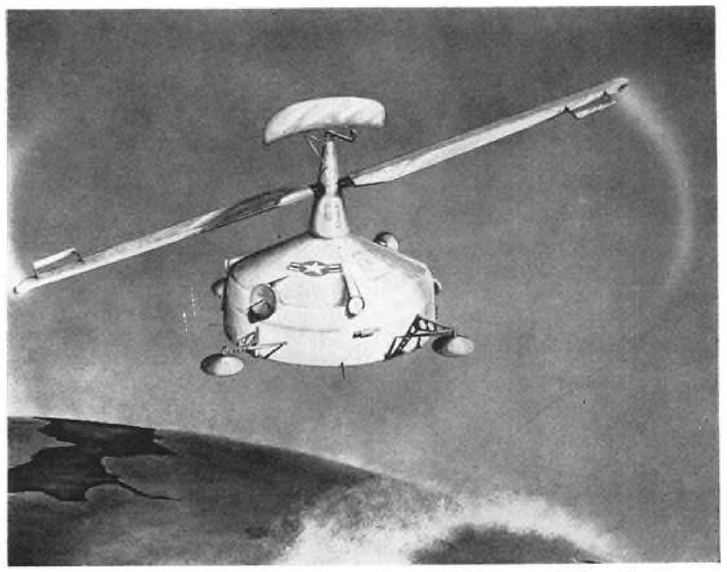
Avionics Profits Rise In 1959 First Half

New York—Avionics manufacturers' financial returns for the first half of 1959 are showing a healthy increase in sales and an even stronger rise in profits over figures reported during the same period in 1958. Here are a few representative examples:

• **Texas Instruments, Inc.,** reports highest sales and earnings for any second quarter and first half in the company's history. Second quarter sales were $51,468,000, up 137% from the second quarter of 1958. Earnings during this period were $3,322,000, equal to 86 cents per common share, an increase of 170% from the previous year. Total sales for six months of 1959 were $94,199,000, up 124% from the first half of 1958. Six months net earnings were $6,305,000, equal to $1.62 per share. The latter is an increase of 145% over the previous year. The company expects 1959 sales to total approximately $200-million, more than double last year's $91.9 million. Present backlog is $85.7 million of which about $42.8 million represents direct government contracts.

• **Lear, Inc.,** reports a 32% increase in sales for six months ending June 30 over the previous year's first half, with a 79% increase in net earnings over the corresponding period. Total sales for first half of 1959 were $38,576,000, with profits of $1,124,000, equal to 44 cents per share. Per share earnings last year for the same period were 27 cents on a slightly fewer number outstanding. Second quarter sales were $21,353,000, with earnings of $728,000, equal to 28 cents per share. This represents a 24% increase in sales and a 75% increase in per share earnings over the same second quarter of 1958. The company reports a June 30 backlog of $74.5 million, 3% higher than as of Jan. 1, and 10% above the backlog of a year earlier. Shipments in the last half of 1959 are expected to exceed $42 million, the company reports.

• **General Precision Equipment Corp.** reports second quarter sales of $55,319,803, an increase of 30% over sales in the same quarter of 1958. Earnings were $1,143,114, equal to 77 cents per common share after dividends on preferred and preference stock. Earnings for the same period of 1958 were $283,239, approximately equal to preferred dividends paid. Sales for the first six months of 1959 were $102,301,439, an increase of 23% over the first half of last year. First half earnings were $2,063,121, equal to $1.34 per share of common stock after preferred dividends, an increase of 174% over the $754,934 profit for 1958's first half, which was equivalent to 16 cents for each share of common stock after pre-



Raytheon Studies Unmanned Space Platform

Raytheon Co. has received a $90,000 study contract from Wright Air Development Center for the company's proposed radio-powered unmanned helicopter, designed to serve as a flying platform for surveillance radar or extended-range communications (AW Aug. 17, p. 34). Platform would be designed to hover on microwave energy beamed to its antenna from the ground.

ferred dividends. The company's backlog as of June 30 is $206 million, 16% above figure on Mar. 31, 1959, and 23% above backlog as of Dec. 31, 1958. Sales and earnings are expected to show continued improvement during second half, the company says.

• **Chicago Aerial Industries, Inc.,** reports first half sales of $6,007,478, up 60% over first half of 1958. Earnings of $400,525, equal to 76 cents per common share, were up 80% over previous year's first half. The company backlog exceeds $6 million.

• **Electronic Communications, Inc.,** reports sales of $25,755,492 for the first nine months of its fiscal year, an increase of 60% over the same period last year. Net earnings were $763,339, equal to $1.90 per common share after a preferred dividend. This is nearly a 1,200% increase over dollar earnings last year. For the third quarter, the company reported sales of $7,784,012, up 26% for the same quarter last year. Net earnings were $267,136, equal to 66 cents per common share, compared with a net loss of $3,556 for same quarter of 1958. Company backlog as of June 30 was $12.2 million.

• **The Siegler Corp.** reports net earnings of $2,203,022, equal to $1.36 per share for fiscal year ended June 30. Per share earnings are up 70% over last year's figure, with about 6% more shares outstanding. Sales for the year totaled $77,074,442, approximately 6% above the previous year's figure.

San Francisco Builds Separate IFR Room

San Francisco—Federal Aviation Agency has unveiled a "hot-line" control tower intercommunications system at San Francisco International Airport which is expected to set a pattern for other such installations in military and civilian terminals across the nation.

Designated the SF-1, the system makes it feasible to maintain a separate IFR room by providing instantaneous, selective voice communication between that room and the control tower. It also provides fast land-line contact with other control facilities in the Bay Area.

Increased volume of air traffic and the advent of the jet transport necessitated extra radar scopes in the San Francisco tower which threatened severe overcrowding of operators and equipment. Under the direction of Chief Controller E. P. Sullivan, a separate radar room on another level was designed. Pacific Telephone & Telegraph was requested to work out an intercom system to replace face-to-face conversation and occasional shoulder-tapping which characterize conventional communication between radar and control personnel.

The result, after 18 months of development and engineering, was the SF-1. Heart of the system is new Western Electric 598A key switchboard, one-fifth the size of the standard Western Electric 102A unit. Through two key switchboards located on panel of each operator, any of the eight stations which make up the control tower-radar room complex can communicate instantaneously with any other station merely by pressing a dimly lighted key.

If the line is busy the key will shine brightly, but an override feature automatically cuts the caller in on the conversation if he presses the key anyway. The system, which contains 36,000 separate wire connections, cost about $51,000 to develop and install. Other features include:

• **Lightweight headsets,** about the size of a large hearing aid speaker.

• **Modular construction** of the keyboards, permitting fast replacement for maintenance purposes.

• **Dual phone jacks** for training purposes.

• **Hot-line backup system,** consisting of a loudspeaker which overrides all point-to-point communications in event of emergency.

• **Tiny loudspeakers** at each scope, which automatically carry the voice of the pilot in flight when the radar operator is speaking on a land line.

Most significant feature of the new radar room is the ease with which the radar equipment can be maintained. Directly behind the instrument bank is a brightly lit work area, in which repairs can be made with a minimum of interruption to operations. The room itself, part of an addition built in 1958 at a cost of $115,000, features subdued, carefully reflection-proofed lighting. Each radar station has compact overhead, cockpit-type controls.

IFR ROOM at San Francisco International Airport has overhead controls, subdued lighting.

Japan Vies for Sales In Avionics Market

Los Angeles, Calif.—Reborn Japanese precision industries are producing high-quality, low-cost semiconductors which are so competitive with U. S.-built products that American companies are "falling over themselves" trying to buy into the Japanese firms, according to Frank A. Kasala, president, Twin Lock, Inc., manufacturer of electrical terminal blocks here. He returned recently from a tour of Japan during which time he was a guest of Japanese industry and closing speaker at the First International Symposium on Rockets and Astronautics held in Tokyo.

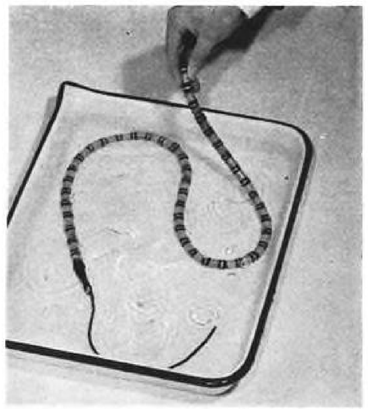
According to Kasala, several large U. S. companies, among them International Business Machines and National Cash Register, already have set up in Japan and are turning out precision electronic equipment on a price basis with which U. S. companies cannot compete due to lower Japanese labor costs.

He dispelled the common American conception of the shoddiness of Japanese-built goods and contends the caliber of their products is excellent. In Kasala's opinion, the quality of Japanese-built computers, memory drums, digital readout equipment, etc., is superior to the products of U. S. labor.

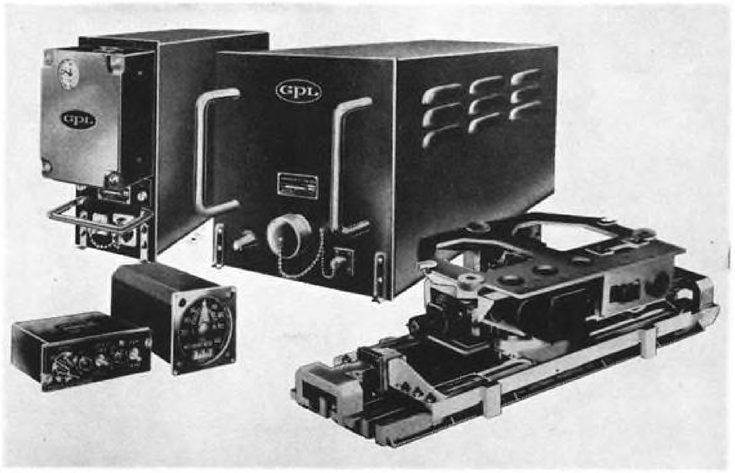
Automation has not been neglected by the Japanese either, he said. Excellent laboratory facilities are available to study automation possibilities and even though labor is cheap, automation is pushed to achieve high volume. One Japanese plant alone, he said, turns out in excess of 1.5 million transistors a month using fully automated processes.

Doors are gradually being closed to U. S. interests, he continued, citing that the American exports Japan needed were U. S. dollars and technology. Capital is now no longer needed due to a steady strengthening of the Japanese yen on the world market and Japanese tech-

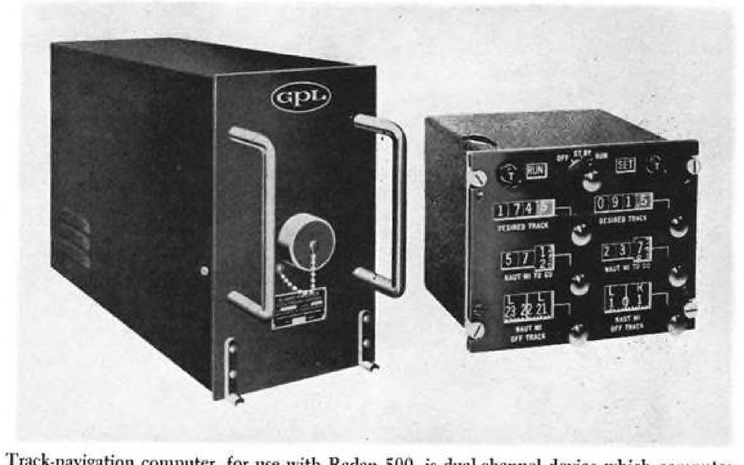
New Avionic Products: Battery, Doppler Radar



"Snake battery" to power repeater amplifiers in submarine cables consists of a series of segmented cells which makes the battery flexible enough to fit inside a cable, even when wound on drums. The zinc-silver chloride battery, developed by Aerojet-General for Army Signal Research and Development Laboratory, is activated when immersed in water. The battery measures § in. in diameter and is 30 in. long. It delivers 5 ma. current at one volt for periods up to one year.



Radan 500 commercial doppler radar, developed by General Precision Laboratory, weighs 68 lb., is accurate to within one knot plus 0.2% for ground speed indication and to within 0.2 deg. in drift angle determination. Equipment is a transistorized, pulsed, self-coherent type doppler radar and is designed to Arinc Characteristic 540.



Track-navigation computer, for use with Radan 500, is dual-channel device which computes distance to go to destination or way point and perpendicular distance off desired track. The transistorized TNC-50 computer and control panel weigh 23 lb. and are accurate to within ¼ naut. mi. plus 0.2%. Computer also provides output signals for use by automatic pilot.

nological capability has progressed to the point where outside help is no longer solicited, Kasala said. Some companies have set up facilities in Japan only to find that getting dollars out of that country is almost impossible, and, he added, trade restrictions are so complex that a firm of American lawyers in Tokyo has been specializing in these problems for some time.

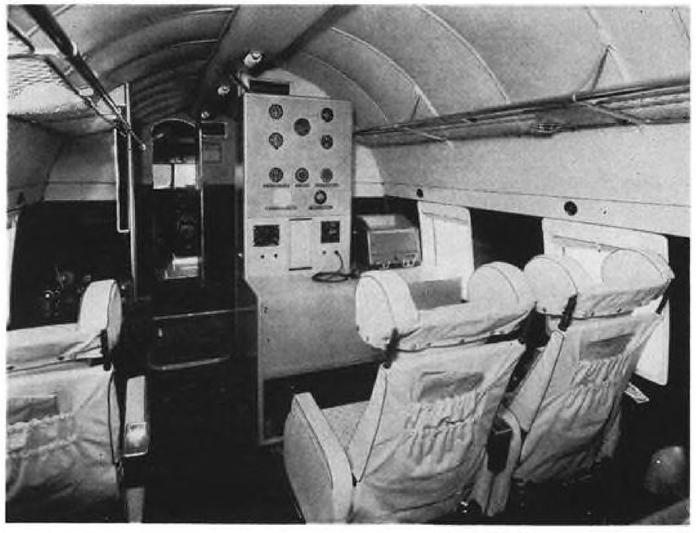
Three methods are open to U. S. businessmen who want to take advantage of low Japanese labor costs, Kasala said:

• **Establish their own manufacturing** facility in Japan. This is difficult because of the "fine print" which creeps into the agreements and results in difficulty in getting money out of Japan.

• **License a Japanese** company to manufacture products. The same drawbacks are inherent in this arrangement as in the preceding one. Additionally, protective tariffs may force prices to the U. S. consumer as high as domestically manufactured goods.

• **Buy into Japanese industry**—difficult because U. S. capital is no longer sought with the same fervor it once was.

In Kasala's estimate, the Japanese lack one important tool used extensively in the U. S. for scientific research; namely, the triumverate composed of industry-university-government. Research in Japan is conducted on an individual basis to solve problems as they are confronted. Industry and government do not seem to take advantage of research skills available in universities and the granting of studies has not been practiced. His opinion is that this is a lack of coordination on the part of industry due to a deficit of trained management personnel. That the Japanese are aware of this is evidenced by their



Marconi Demonstrates Avionic Systems in Air

Marconi radio communications equipment and navigation aids are installed in a Vickers Viking for demonstration purposes. Top photo shows part of the cabin with the demonstration panel on which the primary navigational instruments are installed, in addition to those in the cockpit. Photo at right was taken just aft of cockpit. Equipment includes Marconi AD2300B doppler navigator, Type AD712 radio compass, Type AD722 subminiature radio compass, Type AD307 high-power HF communications transmitter/receiver, Type AD305 VHF multi-channel communications transmitter, with associated Type AD704 receiver, Type AD308 airborne teleprinter receiver, and VOR/ILS equipment.

keen interest in all things oriented toward management training methods.

So far, impact of the Japanese precision industries has not been felt in the U. S. defense buying program, he said, because of our governmental policy toward buying U. S.-made items. This is not to say, according to Kasala, that Japanese-made semiconductors could not be found in a computer manufactured in the U. S. for a commercial company and used on a defense contract. He concluded however, that direct contracting or procurement of items for defense is not being done.

FILTER CENTER

► **British ATC Beacon**—Radio Division of Bendix Corp. will manufacture and distribute its version of an air traffic control transponder beacon developed by Cossor Radar and Electronics, Ltd. of London. These Cossor beacons are now being installed in BOAC's Boeing 707 Intercontinental jet transports. The beacon is said to be 75% transistorized and capable of accommodating 64 identification codes. It occupies ½ ATR and weighs 18 lb.

► **Some Like It Hot**—Jupiter's outer atmosphere reaches temperatures above 10,000F while the planet's ammonia and methane clouds at lower atmospheric levels reach temperatures of −220F and colder. This picture of Jupiter's atmosphere, gathered by radio astronomers at the California Institute of Technology's Radio Observatory, indicates that the planet is surrounded either by a corona similar to the sun's or a radiation belt like that around the earth, scientists say.

► **How High and How Fast?**—An airborne computer that will employ infrared detection to assist it determine altitude and speed of a photo reconnaissance aircraft is being developed by Avion Division of AFC Industries, Inc. The computer, called the V/H (velocity over height computer) is aimed at solving the problem of blurred films which result when filmspeed through the camera is not kept constant in relation to aircraft speed and altitude. The unit uses two infrared sensors set longitudinally and pointed at the ground, one aimed slightly ahead of the other. The time difference between when a target is detected by the two sensors is the basis for computation.

► **Mercury Programer**—Development of a satellite clock and time programer for the Project Mercury capsule is under way at Waltham Precision Instrument Co. under a subcontract from McDonnell Aircraft Corp. Called a chronometric programer, the device will record elapsed time from launch and automatically set in motion on a precise schedule 13 activities including re-entry into the atmosphere. The unit also will generate signals to be transmitted to the ground through the telemetry system.

► **Two-Story Tube**—Super-power microwave tubes will be tested at Raytheon by means of a modulator 100 ft. long, believed to be the largest in the world. The two-story modulator installation will be housed in a special 50,000 sq. ft. wing to be added to Raytheon's Spencer Laboratory.

► **Autonetics Division** of North American Aviation, Inc., has received an $8 million advanced go-ahead contract from Lockheed Aircraft Corp. for electronic armament control systems for installation in F-104G ordered by West Germany. Systems will provide the fighters with all-weather, air-to-air and air-to-ground attack capabilities. Autonetics NASAR radar provides information for both high and low-level missions such as air search, automatic tracking, ground mapping and terrain avoidance.

► **Boeing Airplane Co.** awarded $500,000 Minuteman ICBM test program subcontract to United Electrodynamics, Inc., for design, development and fabrication of FM/FM airborne telemetry systems to be used for collecting and transmitting data during test operations. First prototype system to be off the line in January, 1960, is fundamentally the same system as designed by company for Atlas, Titan, Thor, and Pioneer I.

► **Airborne Instruments Laboratory** heads an eight-company team to design and develop advanced airborne electronic equipment for U. S. Air Force under a $38.9 million contract. Other members are Aerojet-General Corp., Filtron Co., Inc., HRB-Singer, Inc., Raytheon Co., Sperry Gyroscope Co., Sylvania Electronic Systems and Temco Corp.

► **About 75% of the cost** of the Bendix-Navy Eagle air-to-air missile will go for electronic guidance and control, which is under development by Sanders Associates, Inc., of Nashua, N. H. Launcher aircraft has not yet been designated by Navy.

► **Radar equipment** for Air Defense Command's Aircraft Data acquisition network will be manufactured by Crosley Division of Avco Corp. under a $21.5 million contract awarded by U. S. Air Force. Radar is 50 ft. in diameter and is installed on a steel tower which is three stories high.

► **Collins Radio Co.** has received a $3.75 million Navy contract to produce ferrite receivers for ship and submarine use in detecting and analyzing signals from enemy radars. Each ferrite receiver uses 252 vacuum tubes, 176 diodes and transistors and consumes about 1½ kw. of electric power, Navy says.

► **Nation-wide weather facsimile** network which can provide high altitude weather information to 57 U.S. Air Force bases at double present transmission speeds has gone into operational status. Known as Strategic Facsimile Circuit, the network was designed and installed by Western Union Co.

► **Hallamore Electronics Division** of Siegler Corp. has received a contract from Army Ballistic Missile Agency, Huntsville, Ala., to install seven new closed circuit TV camera installations. Unites are designed to withstand shock waves of highest known sound volume level of 150 db.

► **Daystrom-Pacific** was awarded a subcontract for $105,468 for displacement gyros to be used in the Minuteman research and development program by Autonetics, a division of North American Aviation, Inc. Autonetics is associate contractor for Minuteman and is responsible for guidance and control systems.

► **Air Force** has been selected by Defense Department to act as purchasing agent for three services for common electron tubes used by the three departments, with full implementation of new assignment by Mar. 31, 1960. During Fiscal 1959, three services bought $48 million worth of commonly used tubes, of which USAF accounted for more than 50% of the total.

► **Westinghouse Electric Corp.** net sales were $914,204,000 for the first half of 1959, as against $923,961,000 for the corresponding period last year. Net income was $34,150,000 for the first six months this year, compared with $29,973,000 in the first half of 1958. Earnings were $1.92 a share for the first half of 1959, compared with $1.70 a share for the same period last year.

► **Induction Motors Corp.**, Westbury, N. Y., maker of avionic components for missile and aircraft use, has acquired Mason Electric Corp., Los Angeles, Calif., through a stock exchange. Corporate name has been changed to IMC Magnetics Corp.

Scientists Study Spacecraft Shielding

By Russell Hawkes

Los Angeles—Materials in the closed-loop ecological system of a nuclear-powered spacecraft can save much weight by doubling as a shield against direct nuclear radiation from the powerplant, Robert F. Trapp and Eugene D. Konecci of Douglas Aircraft told a technical meeting of the American Astronautical Society western regional meeting here.

The study covered the shield replacement problem with heat exchanger nuclear rockets and nuclear ionic propulsion systems. Best location for life sustenance materials to serve as shield replacement was found to be the base of the crew compartment. In any nuclear propulsion system the reactor is the prime radiation source. Van Allen and cosmic radiation have no important effect on shield requirements unless prolonged operation in the lower Van Allen lobe is planned.

Radiation characteristics of heat exchanger nuclear rockets and nuclear-ionic systems differ. Heat exchanger systems produce high level acute radiation while ionic systems and secondary nuclear power sources produce low-level chronic radiation. Radio biologists ask for the smallest possible dosage regardless of the source, for no matter how small the exposure to ionizing radiation, there will be some damage to the individual.

Among other requirements for space flight is a recycling ecological system needed to permit life away from the earth environment. It is logical to make any system be useful for more than one purpose because of the strict weight requirements of space flight. The researchers studied the closed ecological system from the standpoint of its usefulness as shielding against nuclear radiation.

Daily requirement of different persons under identical conditions of activity will depend on age, body size and muscular efficiency, but the normally active average man metabolizes about 3,000 kilocalories of carbohydrates, fat and protein.

To satisfy this daily need, he would consume 2 lb. of oxygen, produce 2.5 lb. of carbon dioxide requiring about the same weight of lithium hydroxide to absorb it, need 5.7 lb. of water in food and drink, and eat 2 lb. of mixed food for a total vital payload of 12.2 lb. per day.

Most of the required materials can be carried and jettisoned for trips lasting between one and 20 days, but for trips lasting more than 20 days conservation of materials by conversion and recycling of waste may become profitable if weight of equipment and power supply does not exceed weight of basic physiological requirements.

Present weight estimate for a one-man closed ecological system is about 680 lb. which assumes a few advances in the state of the art as well as availability of power. A more realistic weight is probably closer to 2,000 lb. per man.

It is apparent that for long-duration flights like 1,000-day minimum energy transfer orbits to Mars and back, a three-man crew would need a vital payload of 36,600 lb. without recycling. With recycling, this figure could be reduced to approximately 21,980 lb.; that is, 7.3 lb. per day per man rather than 12.2 lb. per day per man. A complete algae-based recycling system could be expected to weigh approximately the same regardless of flight duration. To avoid the monotony of pure algae diet, it may prove necessary to carry 2 lb. of food per man per day in addition to the complete algae system.

Because hydrogen propellants and boron can be used to thermalize and absorb neutrons, the shielding problem is simplified to attenuation of gamma radiation. Shield replacement capability of the vital payload can be calculated by analyzing its attenuation coefficients and those of shield materials as a function of gamma energy.

Atlas Gets Air-Transportability Test

Assembled Convair Atlas intercontinental ballistic missile is loaded into a mockup of a Douglas C-133B Cargomaster turboprop transport at Long Beach, Calif., as part of a series of air transportability tests. Atlas center nozzle is not installed. C-133B is presently in production at Douglas Aircraft's Long Beach facility.

Sustenance Requirements

High molecular weight absorbers are most efficient for the removal of gamma radiations with energies below about 1 mev and above about 3 mev. Low molecular weight materials which constitute sustenance requirements provide economical shielding in the intervening energy range. Calculations of gamma shield replacement capabilities of the sustenance materials were based on the following analysis of the chemical composition of the sustenance material:

Oxygen—9.80 lb./man-day.
Hydrogen—0.87 lb./man-day.
Carbon—0.80 lb./man-day.
Lithium—0.73 lb./man-day.

Lithium hydroxide is used for carbon dioxide control. Other materials in the basic composition, such as the nitrogen in protein, were assumed to produce little effect.

Direct radiation from the reactor entering the crew compartment will be more energetic than scattered radiation. A large portion of the direct radiation will be in the energy level between 0.5 and 5.0 mev. Most of the scattered radiation will be in the range from 0.1 to less than 1.0 mev. This indicates that life sustenance material is effective as shielding against direct radiation while considerable efficiency is sacrificed by using it to replace scatter shielding.

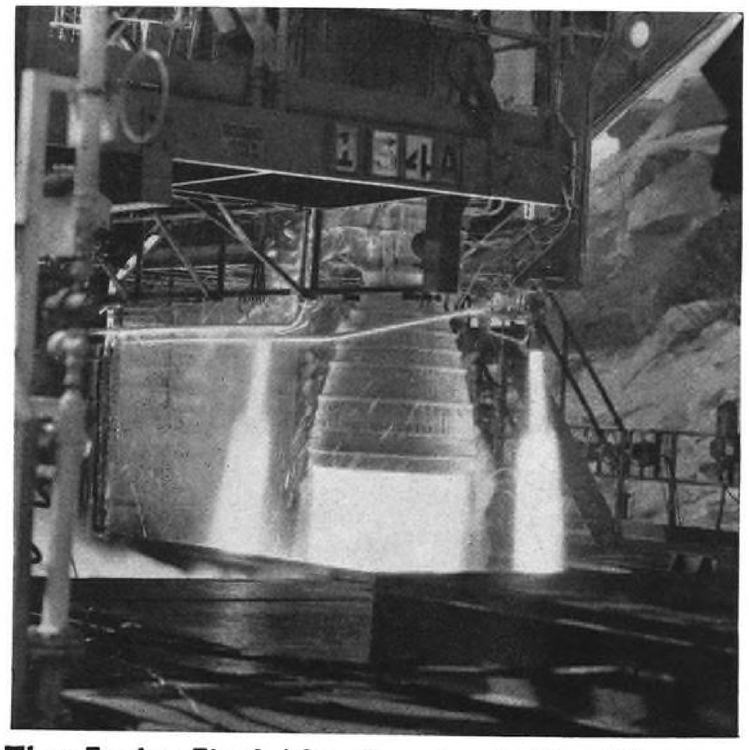
Shield Replacement

Average shield replacement capability for direct radiation may be on the order of 8 lb. of shield replaced by 10 lb. of sustenance material, while a comparable value for scattered radiation may be on the order of 10 lb. for every 3 lb. of shield. Shield capability of sustenance material need not change with time. Since the quantity and composition of sustenance material will remain constant, that which enters the crew compartment will be replaced in shielding by waste products.

Two examples of what can be done by replacing shielding with sustenance material were presented. The examples dealt with round trip flights to Mars using 21,000 mw. reactor power and hydrogen propellants with a specific impulse of 865 sec. Researchers said two examples are as follows:

• "**Reactor is operated** on both earth and Martian atmosphere exists, therefore a scatter shield is required. At a reactor-crew distance of 100 ft., the earth-to-Mars scatter acute dose with 25,000 lb. of mercury shielding would be 5.2 rem (roentgen equivalent man) and the direct acute dose would be negligible since the hydrogen propellant for the return trip would be used as the direct shield. The Mars-to-earth trip would result in 71 rem with 15,000 lb. of the original 25,000 lb. of mercury used as a scatter shield and the remaining 10,000 lb. used as a direct shield, thereby giving the crew another 1.3 rem, or a total of about 77 rem in the 1,000 day trip. Without recycling of any kind, a crew of three would require 36,600 lb. of sustenance material and all of this could be used as a scatter shield for the exit to the earth's atmosphere. As a scatter shield, the sustenance material only replaces 10,980 lb. of the above mentioned mercury scatter shield. The difference of 14,020 lb. would have to be carried in addition to the sustenance material on the return flight through the Martian atmosphere; the 15,000 lb. of scatter shield would be composed of 14,020 lb. of shielding material and 3,265 lb. of sustenance material would be required. The direct shield of 10,000 lb. could be replaced with only 12,500 lb. of sustenance material. The remaining sustenance material would now be waste material and could be left behind.

• "**The reactor is not operated** within the earth or Martian atmospheres, hence no scatter shield is required. At a reactor-crew distance of 100 ft. there would be no scatter or direct dose on the earth orbit to Mars orbit flight. On the return journey, a direct shield of 10,000 lb. of mercury would keep the crew dosage down to 1.3 rem acute direct dose. In this case, if the three crew members did not regenerate any material, they would begin with a payload of 36,600 lb. and would require only 12,500 lb. of sustenance material to protect themselves against the direct radiation on the return trip from the Martian orbit to the earth. It should be noted that in this case if we assume the availability of power and an 80 lb. water purification apparatus, the vital payload for the 1,000 day journey would be reduced to 22,140 lb. With only 12,500 lb. of the sustenance material used as a direct shield, the crew could be protected against the direct radiation. In this case, about 10,000 lb. of biological waste material could be left in the Martian orbit. Another variation could be mentioned; that is, if the previous water purification unit was supplemented by a chemical sealed tube regenerating system. In this case, the



Thor Engine Fired After Freezing in Test Chamber

Rocketdyne 150,000-lb. thrust engine for Thor intermediate range ballistic missile is static-tested immediately after 72-hr. exposure to freezing temperatures in an environmental chamber. Engine was exposed to five days of 160F heat and 95% relative humidity at Rocketdyne Division of North American Aviation's Propulsion Field Laboratory.

vital payload could be reduced to 14,490 lb., of which 12,500 lb. would be used as the direct shield, on the return flight."

These examples show that vital payload properly utilized can save on the order of 10,000 lb. on missions penetrating planetary atmospheres with no recycling of vital payload and can produce savings approximately equal for orbital missions with highly regenerative ecological systems.

Space Vehicle Simulator

Delegates to the American Astronautical Society meeting heard Walter Kuehnegger of Martin's Denver Division describe a proposed reaction control simulator as a flight trainer for manned orbital and space vehicles.

According to Martin studies assuming that 100% reaction control efficiency is reached at zero ambient pressure, reaction controls become practical at altitudes above approximately 18,000 ft.

At present no simulators combine acrodynamic and reaction controls, nor are there simulators which can impose rotational velocities upon the subject. A centrifuge can only reproduce conditions of linear acceleration and deceleration so its simulation is limited to the initial and final phases of space flight. This has led Kuehnegger to conclude that a need exists for reaction control devices to qualify and prepare personnel for the intricacies of orbital and space flight.

Martin has considered the following configurations:

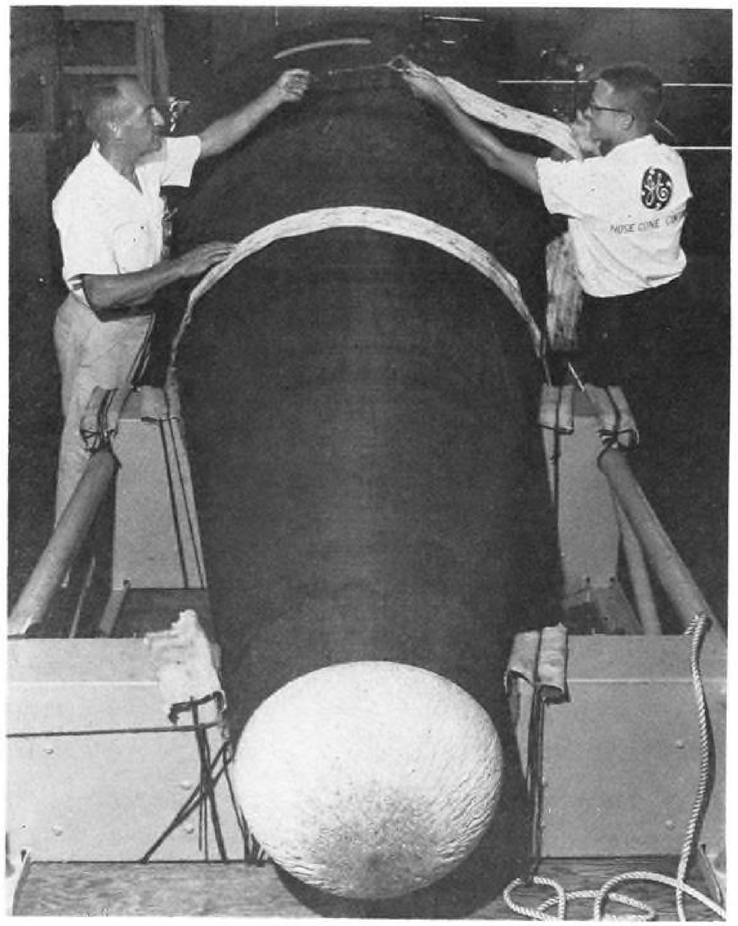
- **Gimbaled, mechanically supported** simulator. This version was abandoned because of the inevitable gimbal lock and because of input, output problems.
- **Hydraulically supported simulator.** This was rejected because it produced noise indications to the occupant and would result in bumping and spillage besides offering many sealing problems.
- **Pneumatically supported simulator.** This appears to escape the problems associated with the other two types and is more amenable to modifications.

How Simulator Works

Heart of the simulator is a 10-ft. sphere pneumatically supported on a contoured base. Sphere resting on the outer ring of the base forms a chamber, into the center of which air is discharged at pressure. In the static condition, pressure will be equally distributed over the spherical surface. If mass flow is adequate, only about 2 psi. pressure is required for the initial liftoff. Pressure distribution then changes over to the dynamic characteristics of the mass flow. Only resistance to the rotation of the sphere by the air bearing support is skin friction of negligible value. However, the sphere must be completely free from the base to permit unrestrained motion. Sphericity of the shell is the significant factor. As tolerance in this respect increases, air bearing pressure increases almost parabolically. Only 5 psi. bearing is needed if tolerances are small. The spherical simulator weighs about 1,600 lb., including weight of the pilot. Almost any structural material may be used if it is rigid enough to keep the necessary sphericity.

Simulator center of gravity will be over the geometric center of the 84-in. diameter base. Everything in the sphere will be located so as to maintain near-perfect balance. A balance mechanism with linear actuators will enable the operator to hold the center of gravity at the geometric center of the sphere and will permit adjustment for a center of gravity displacement to produce oscillatory movements. Pilot seat will be track-mounted to make linear movement possible. Pilot can be located with his center of gravity coincident with that of the sphere or he may be lowered so that his vestibular mechanism can be located at the center of the sphere. This last position would permit physiological testing for otolith sensitivity. Importance of otolith (internal ear) sensitivity for weightless space flight is unknown but must be determined for crew selection. Seat must be counterbalanced to compensate for this change in position.

The simulator requires a specially designed seat with body and limb supports at right angles to eliminate sliding in odd positions. Body retention allows only sidewise head movement and hand movement below the wrist. If the tightly strapped occupant passes through the inverted position, relative pressure stimulus on the limbs is expected to be reduced. This should contribute to



Atlas Ablative Nose Cone Shows Re-Entry Effects

Recovered Atlas 8-C nose cone built by General Electric Co. is prepared for post-recovery inspection. Ablative material on experimental nose cone shows signs of having flowed back during heat of re-entry. USAF-Convair Atlas 8-C flew 6,300 mi. (AW July 27, p. 40).

disorientation of the occupant. Emergency release system to free the occupant of his arm straps is operated by a pushbutton in front of the right arm rest. The rest of the body restraints must be released manually. The hand grips help him leave the simulator if it comes to rest in a non-level position.

Simulator control system is located under the occupant's right hand and requires only fingertip manipulation. Stick controls positive and negative movements about all three axes. Stick movements for pitch and roll control are conventional. Yaw is produced by rotation of the stick about its own axis. Proportional control response is preferred to the "bang-bang" type for vernier control. Studies will be conducted to find whether linear or logarithmic system should be used.

Twelve reaction jets are mounted flush on the surface of the sphere. Only six are needed to produce any compound rotation but the duplication was made necessary by entry problems in the base. Reaction jets must be closed by a detector switch before entering the base while another in the opposite side of the sphere is opened. If a jet were permitted to operate within the base it would distort the mass flow of the support and change its own thrust due to the ambient conditions. Mission programs for evaluation, selection and training tasks can either be carried on board or transmitted into the simulator by radio. No wired connections are possible.

Control systems can be modified to simulate specific dynamic characteristics of a space capsule or vehicle.

Communication between the occupant and the outside operator can be made possible by flush-mounted two-way speakers in the surface of the shell and intercom or miniature chart recorder may be used for telemetry.

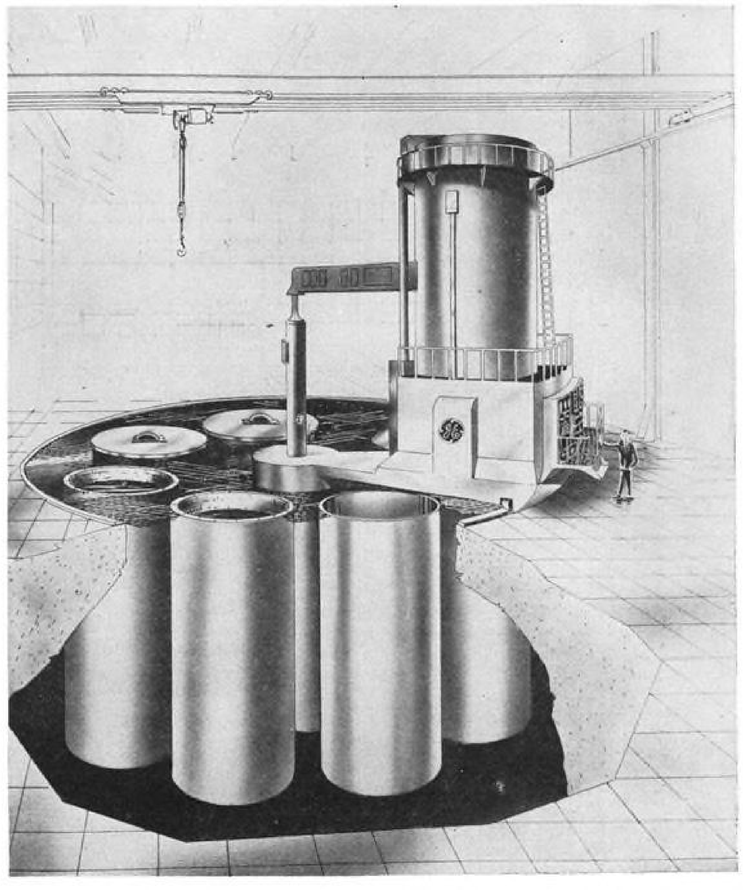
A roller-type velocity and direction indicator can be used to record the test run externally. Closed circuit television will be a later addition. Diameter of the base sets the safe maximum angular velocity at which the sphere can be rotated. With the 84-in. base, this calculation limits the sphere to 20 rpm. Should the air bearing collapse at less than 20 rpm. there would be no danger of the sphere rolling off the base. A larger diameter base would permit more rapid rotation; however, 20 rpm. is more than that expected in orbital or space maneuvers. If the bearing collapses, the simulator can be righted to clear the door by an emergency cylinder of air or nitrogen.

Simulator Projects

First of the possible projects for the simulator would be to determine the limitations of man to rotary velocities and accelerations. Controlled independent variations of environmental phenomena such as pressure, humidity, CO_2 content, temperature and lighting conditions would show their respective effects on pilot capability. Later, it would be used for crew selection and training programs. The simulator lends itself easily to modification and many other missions may be found. For instance, it would be possible to make a celestial navigation device of it by surrounding the simulator with a planetarium dome. The base surface could also be finished in dull black and fitted with simulated stars to give the appearance of complete freedom. The basic unit can be used for evaluating control systems, instruments, and equipment under gravity-independent conditions by continuously changing the direction of the g vector.

Rear Adm. Jack P. Monroe, Pacific Missile Range commander, told a dinner meeting of the AAS the reasons for Navy interest in space.

Adm. Monroe predicted the withering of any service excluded from space. He said the Navy's aim is to use space to accomplish naval warfare objectives and to prevent it from being used to the detriment of those objectives. There is no doubt that the capability of space vehicles already in the realm of feasibility will influence directly the manner in which Navy performs its job of controlling the seas, he said.



Furnace Heat-Treats Rocket Casings

Heat treatment facility, now being built for General Electric's Rocket Engine Section at Evendale, Ohio, will heat-harden solid propellant rocket castings up to 30 ft. long and 10 ft. diameter. Facility, which will cost about $1 million, will be operational next March and later will be expanded to handle 40 ft. casings. Unit consists of quench pits and several 1,300F furnaces arranged in a circle below floor level. A 2,000F furnace will be above floor level, operating on a centrally-located pivot, and riding on a circular track. Rocket casings first are heated to 900F in a pit furnace and then hoisted into the floor-level furnace for heating at higher temperatures. After treatment, rocket casing is lowered into a quench pit and then transferred to another lower level furnace for final tempering.

BUSINESS AIRCRAFT fleet operated by Pacific Automation Products, Inc., includes (l. to r.) Beech Twin Bonanza, Cessna 180, Morrisey 2150, two Beech Bonanzas. Variety of types means there is seldom need to use an airplane on a job for which another is better adapted.

Air Fleet Saves Time, Builds Prestige

Glendale, Calif.—A five-plane business plane fleet is used by electrical cable manufacturer Pacific Automation Products, Inc., to keep pace with missile builders and missile range operators who frequently require custom-made material and often key their orders to quick delivery schedules.

Tight schedules require that Pacific Automation President Arthur P. Jacob and his engineers stay on the move, not only to close contracts, but also to investigate the customer's problems and help in installation of the cable. With orders often depending upon delivery on 24-hr. notice, time en route spent by engineers becomes a critical factor in meeting schedules.

Time Factor

Cables and cable harness used in the missile industry frequently must be designed to incorporate special circuits and adhere to tightly specified electrical properties. Production runs are short. Average in-plant cycle for an order lasts five hours. To maintain this pace, over a million dollars must be tied up in raw materials inventory and at least two shifts must be kept operating in engineering and production. This means that time en route for an investigating or installing engineer can form a large part of the total time from initial contact to delivery. Time lost is extremely costly.

The Pacific Automation fleet includes a Beech E-50 Twin-Bonanza, an F-35 Bonanza, one of the original Model 35 Bonanzas, a Cessna 180, and a Morrisey 2150 two-place trainer. The company's flight department also serves Space Electronics Corp. (AW May 18, p. 26), a subsidiary, and Radio Corp. of America, from which Pacific Automation holds a subcontract for instrumentation at Vandenberg AFB, Calif. A fee charged to outside users of the fleet is intended to cover costs of the service and no more. The company takes its profit in prestige and good will.

The Twin-Bonanza is used on twice-daily scheduled runs between Glendale, Santa Monica and Vandenberg AFB. Santa Monica is the handiest field from which to provide service for RCA. Unscheduled stops are occasionally made at Pacific Missile Range Headquarters, NMC Pt. Mugu. The scheduled trips carry routine mail and light cargo as well as personnel. An extra Twin-Bonanza or Aero Commander is sometimes rented to put a second section on the scheduled run when traffic is very heavy. This happens as often as twice a month. Of Pacific Automation's own 900 employes, a single day may see 300 at Vandenberg and adjacent Naval Missile Facility, Pt. Arguello.

The little Morrisey is used for courier mail or to carry a single high-priority passenger. It and the other single-engined aircraft often carry Jacob and other executives and experts to Burbank or Los Angeles International Airport to catch commercial airline flights when this is more economical than going all the way in company aircraft. This accounts for a major time-saving by avoiding long trips through Los Angeles traffic.

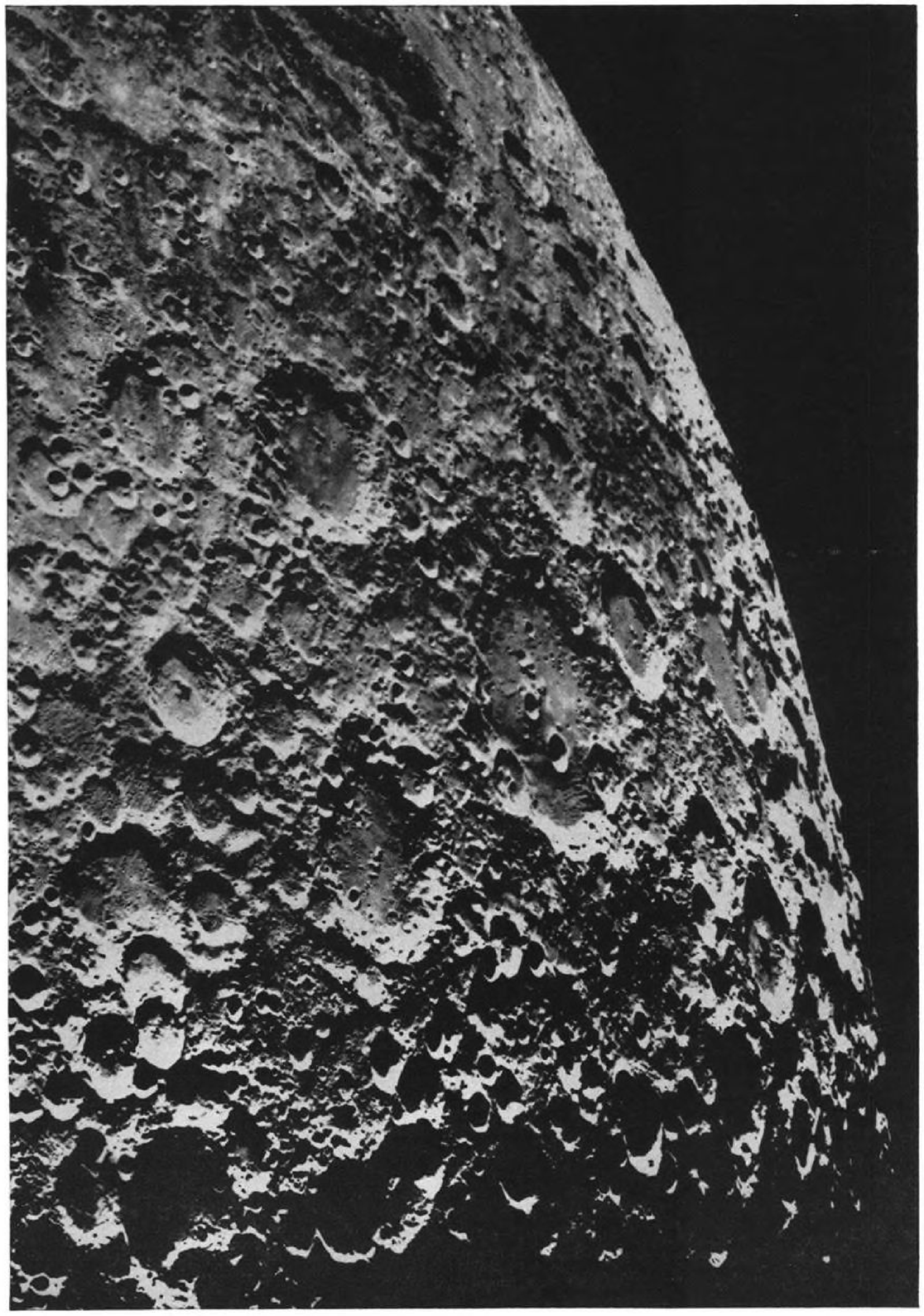
About 90% of the time, the decision about what type of transportation to use is made by a full-time travel clerk in the accounting department who also provides liaison with the Flight Office. Decision is usually based on a comparison of the costs but if the company fleet can deliver the passenger to his destination substantially quicker than commercial air and time is at a premium, cost may be overlooked. On rare occasions, Jacob or other high company officers overrule the travel clerk to obtain some competitive advantage or collect the prestige which the fleet earns.

Pacific Automation's accounting office considers this centralized control of travel an important factor in the profitable operation of the company fleet. As well as avoiding uneconomical use of the airplanes, it reduces the likelihood of all the airplanes or pilots being absent when they are needed for some especially rewarding trip.

Plant Near Airport

One factor which obviously contributes to profitability of the Pacific Automation fleet is the location of the plant at privately owned Grand Central Airport here. This factor will probably be eliminated this month since Grand Central will be closed unless municipal support can be found. Neither Jacob nor chief pilot Ray Cote expects this to alter the pattern of fleet operation very much. The company is now considering purchase of a helicopter to provide factory to flight line transportation and Cote has picked up a helicopter license. Pacific Automation has not yet decided which airport it will move to, but Burbank seems a likely choice.

Particularly in tight competitive situations, Jacob believes fast, immediately available transportation is too important an asset to give up in his business. He cites the time when Pacific Automation was bidding on an important missile umbilical cable contract. The job called for a big, specialized production ma-



chine to braid metal shielding over the conductor bundle and inner layers of insulation. Neither Pacific Automation nor its competitors had such a machine but one was available in Spokane, Wash. At 8 a.m., four men boarded the Twin-Bonanza with Ray Cote. They were experts from engineering, purchasing, manufacturing and plant engineering departments. Five hours later they landed at Spokane where a rental car waited at the flight line. The four experts drove away immediately while Cote filled out the rental agency's forms and had the fee billed to his own credit card.

When they returned an hour-and-a-half later, the braiding machine belonged to Pacific Automation and was being packaged for shipment. Cote had the airplane fueled and box lunches were aboard. At 8:30 p.m., the four were back in the Glendale, Calif., plant finishing up the Pacific Automation proposal.

An unexpected advantage of company-owned aircraft in this type of operation is privacy. In a high-pressure situation, such as the Spokane trip, time en route need not be time lost. Conferences can be held, decisions arrived at and paper work completed during the flight.

Fleet Economics

The economics of company fleet operation are sometimes surprising. Occasionally, Pacific Automation flies truck drivers to Vandenberg to pick up trucks and drive them back to Glendale. This is highly profitable because the drivers earn per diem and the six-hour drive each way would make it an overnight operation to use surface transportation. They can be fitted in on the scheduled morning flights on a space-available basis without incurring any significant costs at all.

Pacific Automation Flight Department logs as much as 280 hr. and 410 landings per month. Time between stops averages about 40 min. Pilot availability rather than aircraft availability sets the capacity of the company's flight department. For its five airplanes, it has only four full-time pilots and one outsider who is sometimes available when traffic is heavy. This is due at least partly to the difficulty of finding people who meet the qualifications. Besides the basic requirements of commercial or air transport rating and instrument rating, Pacific Automation pilots must meet quite high personal standards because they meet influential customers and associates of the company and must often perform non-flying services as steward, business manager and secretary.

In addition the pilots do nearly all their own company paperwork without benefit of a secretarial staff and perform

all the maintenance on the aircraft except 100-hr. checks. Two of the pilots are rated mechanics and one is a Federal Aviation Agency-designated Aircraft Maintenance Inspector. The two pilots who lack ground ratings have both rebuilt and maintained aircraft of their own. The airplanes are sent to Beech distributor Norman Larson at Van Nuys airport for 100-hr. checks because Jacob and Cote like the idea of having an outside agency checking the quality of maintenance. Even engine changes are done by the pilots. One reason is that Pacific Automation can make a very large saving by buying engines from the factory at operators' discount.

SWISSAIR-PHOTO'S Dornier Do. 27 is being modified to enlarge photographic capability.

Swissair-Photo Expands Activities To Enter Government Map Work

By Edith Walford

Zurich, Switzerland—Sharp increase in need for aerial photography is leading to expansion in Swissair-Photo A.G.'s activities to permit it to share in the government's aerial survey work. Work will entail surveys of military projects, highway mapping, hydroelectric and other development schemes for the government and private companies.

This program is considered only the first step in the company's expansion—in approximately two years it plans to extend its services outside Switzerland to other European countries.

Survey Orders

Swissair-Photo reached a firm agreement with the Swiss government in March to handle projects formerly done exclusively by the Swiss Federal Survey and Topographic Dept. at Berne. Orders for aerial survey have increased so rapidly in recent years that the government department asked Swissair-Photo for its assistance.

In the future, the Federal Survey and Topographic Department will only undertake government cadastral surveys with its Scottish Aviation Twin Pioneer aircraft bought last year for this purpose. All other orders will be turned over to Swissair-Photo A.G.

So far, the company's activities covered chiefly aerial shots for its parent company's promotion material such as maps, travel brochures and posters. It also worked on orders from private companies for oblique aerial photographs used mostly for educational, industrial and land planning purposes, geographical views for tourist offices, posters, postcards, daily newspaper and book illustrations. Latest published travel book, "Across the Alps," took Swissair-Photo A.G. a year to complete. Using a Piper Super Cub plane borrowed from the Swiss Aero Club at Zurich, the company supplied 92 aerial views of the Swiss, French, Italian and Austrian Alps.

The company also derives a share of its income from the sale of reproduction rights to pictures.

Variety and volume of new assignments now expected have encouraged the company to buy its own plane—a Dornier Do. 27—to do the work. All-round visibility, large interior and minimum speed of 35.5 mph. make it ideally suitable for aerial surveying, but Swissair-Photo A.G. has since found that several additional modifications are desirable.

At Dornier's Munich works, the aircraft is at present being fitted with larger cabin windows, additional fuel tanks for seven hours' flying time and a radio, but no blind or night flying instruments will be installed. Ultimate cost of the plane fully equipped to Swissair-Photo's specifications will be approximately $35,000 instead of the $26,000 price of the standard Do. 27 model.

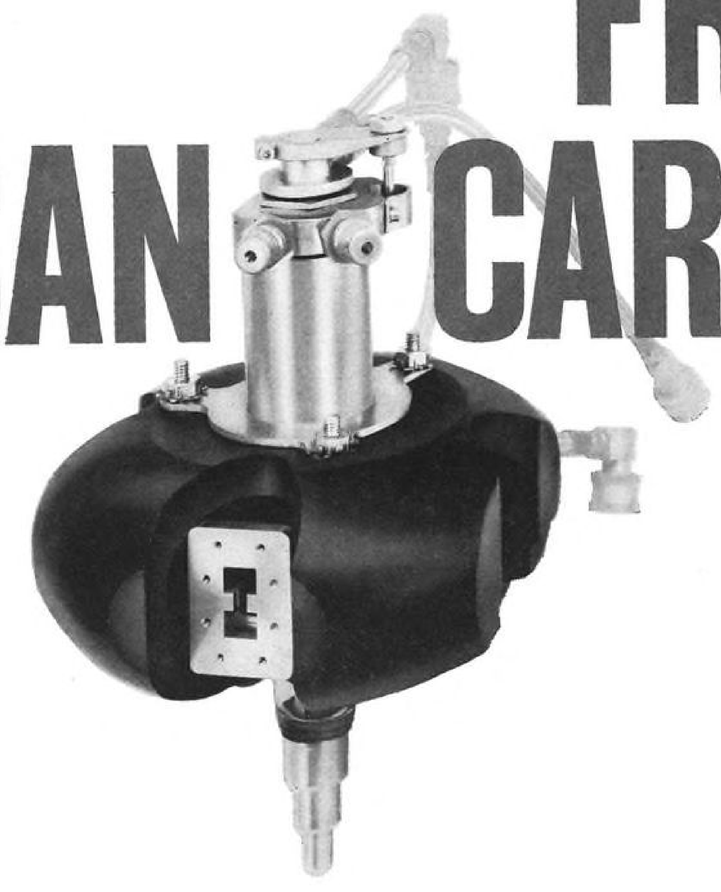
Order of priority of the various jobs earmarked for the utilization of the plane is any kind of aerial survey work; transport of light cargo for Swissair; business flying of Swissair executives; ambulance duty from one Swiss airport to another (Do. 27 can accommodate two stretchers); and technical reconnaissance.

Additional, and probably more powerful, aircraft will be needed for the next stage in the company's development. Foremost among those of future interest are Dornier's modified version of the Do. 27, the recently announced Do. 28, which made its first appearance at this year's Paris air show; the Italian Piaggio P. 149 or P. 166, or the Swiss Pilatus Porter lightplane, which

New Version of Soviet A-13 Glider

New model of the Soviet A-13 glider has a V-tail and retractable landing gear. Gross weight is about 700 lb. Soviets say the glider can do aerobatics and inverted flight.

BIG NOISE FROM SAN CARLOS



BARRATRON is a proprietary brand name for a proprietary product... our powerful new ECM weapon. It is the electronic industry's newest high power transmitting tube, a self-modulating noise generator. Herein are most of the facts permitted to be made public. You can (1) extrapolate from these; (2) if you have a need-to-know, send posthaste for our Barratron brochure; (3) come to San Carlos and see for yourself a quite amazing generation of white noise. This is *really* big!

We make Barratron tubes in either tunable or fixed tuned versions. Both provide broad band white noise, and both are finding their principal applications in present and proposed ECM jammers.

The tunable version is physically and electrically interchangeable with CW magnetrons now installed in obsolescent systems. An added advantage, beyond the incredible increase in quality of the jamming signal, is that the tunable version does not require a modulator, and does not require a noise generator chassis. We are conservative when we say that the white noise emanating from a Litton Barratron tube is ten times more effective for jamming than the power from a CW magnetron. The tunable Barratron tube, then, is designed to upgrade present systems at nominal cost. We are prepared to replace every CW magnetron jammer in existence with this tube.

The fixed tuned Barratron tubes are intended for new systems. They eliminate the need for tuning circuitry or modulators. They are the ultimate in jamming tubes producible at the present time in quantity with reliability. They permit the development of barrage jamming power in systems small enough and light enough for airborne use. They permit truly simultaneous, continuous barraging over any bands you choose; and they permit all this while functioning unattended and automatically.

If you are hesitating because of sophistications you have heard about or have seen in prototype form, hesitate no longer. Those are all deucedly tricky to make, expensive, and everybody has a lot more to learn about them. Meanwhile the Barratron tube is here, ready to cover frequency bands from UHF well into the microwaves and at a cost that is hardly more than a magnetron's.

Our Barratron people will answer any questions you have. Write, or get to the head of the line by sending a telegram. Litton Industries Electron Tube Division, Office A-7, 960 Industrial Road, San Carlos, California.

LITTON INDUSTRIES Electron Tube Division

MAGNETRONS · KLYSTRONS · CARCINOTRONS · TRAVELING WAVE TUBES · BACKWARD WAVE OSCILLATORS · GAS DISCHARGE TUBES · NOISE SOURCES · SPECIAL ECM TUBES · CROSSED-FIELD AMPLIFIERS · MICROWAVE FILTERS · DUPLEXERS · TR TUBES

was also shown for the first time at Paris this June.

Swissair-Photo A.G. uses three kinds of cameras:

• **Automatic Swiss** film camera made by Wild, Heerbrugg near St. Gall, type RC8, 9 in. x 9 in., 150 mm. This is used for vertical shots of large areas.

• **Wild hand camera** Type C2, 13 cm. x 13 cm./170 cm. used for oblique shots in mountainous areas. It was produced by Wild according to Swissair-Photo A.G. requirements and is the only model of its kind in existence.

• **Several Wild** hand cameras for taking aerial pictures from the cabin windows of the airplane.

The company employs one full-time helicopter pilot formerly of Helisswiss, the Swiss helicopter company, and two reserve pilots. All three have been checked out in the Do. 27. The two reserve pilots also serve as regular instructors at Swissair's training school for pilots at Kloten Airport, Zurich.

Two of Swissair-Photo's four photographers deal with the developing of oblique photographs in the laboratory; the other two are employed as photogrammetric operators on the processing of the RC8 and C2 type pictures.

Operating Procedure

A Swissair-Photo client specifies in writing the purpose of the aerial views required; height and direction of flight, longitudinal and lateral overlaps, camera to be used, time of day when the shots should be taken and so on. Swissair-Photo checks these proposals and if necessary makes counter suggestions to the customer. This checking may often entail making a trial flight over the specified territory, particularly if narrow valleys or ravines are involved where, depending on the time of the year or prevailing weather conditions, light effects are subject to rapid change.

If a request covers fortifications or any other project under government or military control, Swissair-Photo A. G. must submit pictures to Swiss security headquarters at Berne for checking and ultimate permission to release them to the client. But this doesn't often happen because Swissair-Photo is familiar with the location of most prohibited areas and is consequently able to give the client advance warning if the desired photographs are unlikely to pass security screening.

The Swiss government pays 80% of the cost of surveys of development schemes such as hydroelectric projects or mapping of new highways, etc., and the local governments pay the remaining 20%.

For the next year or so Swissair-Photo A.G. expects to be able to manage with just the one Do. 27 aircraft, particularly since it can always rent a Cessna 180 or Piper Super Cub from the Swiss Aero Club.

Negotiations between the Swiss government and Swissair-Photo A.G., with a view to pooling their photographic facilities, have been going on for some time.

The situation became acute in 1956 when the government's Percival Prince, then used for the survey work, developed engine trouble on takeoff, crashed and killed its pilot.

First official approach was made to Swissair-Photo A.G. a year later, but it met with a refusal because the company already had enough work and internal problems of its own.

But the government's proposal offered obvious attractions and Swissair-Photo seized the opportunity for possible expansion. First step in 1958 was to come to a loose arrangement with another company in the business—there are nine in all in Switzerland—the Vermessungsburo Karl Weissmann, Zurich, to include mapping for the government in their combined operations on a trial basis of one year. It worked out to the satisfaction of both firms and a firm agreement has now been made. Karl Weissmann, head of the Vermessungsburo, is general manager of both companies. Individual offices and laboratories are still housed in separate buildings in Zurich, but by fall this year they will be combined under one roof in a new office block in the center of the city.

Swissair Background

Swissair-Photo A.G. considers its business an inheritance from aviation pioneer Walter Mittelholzer, one of the two founders of its parent company, Swissair. Swissair-Photo A.G. was established at the same time.

Son of a St. Gall baker, Mittelholzer took up photography as a profession, but his real interest was always in flying.

During the 1914-18 war he served as a pilot with the Swiss air force and joined Ad Astra, one of Switzerland's two original airlines—the other was Balair—when he was demobilized.

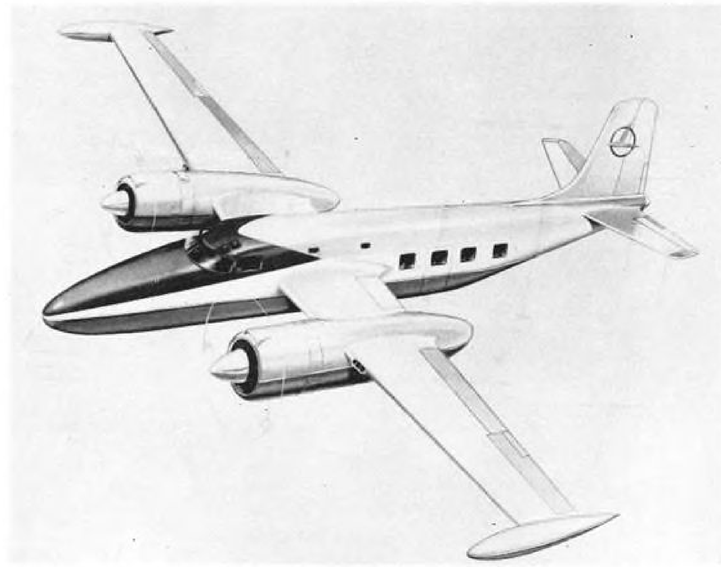
He was the first pilot to fly over and take aerial photographs of the Alps. When Ad Astra merged with Balair to form Swissair in 1931, he was appointed commercial director and later president.

Tempo II Nears Initial Flight Tests

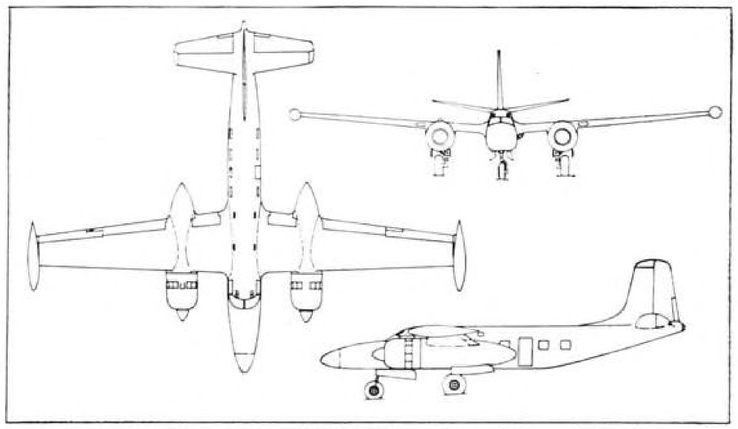
Pressurized executive version of a Douglas B-26 attack bomber (AW June 15, p. 109) is nearing completion at L. B. Smith Aircraft Corp. production facility at Miami, Fla.

Airplane, designated Tempo II, is scheduled to make its first flight in October. Second production aircraft is now entering jigs. Another model, Tempo I, utilizes the same pressure-sealed fuselage but is not pressurized.

Company said Tempo II carries from seven to 10 passengers in executive configuration, has a 350 mph. cruising speed and features a 28-ft. walk-through cabin. Tempo II will cost about $375,000 for basic pressurized plane, plus interior and electronics. The price of



TEMPO II version of Douglas B-26 has elongated nose section for radar and cargo.



Three-view emphasizes longer, streamlined fuselage. Note addition of 185-gal. tip tanks.

Tempo II Design

Estimated Performance:
- Cruising true air speed at 20,000 ft. at 31,000 lb. gross, 67% power ..... 350 mph.
- Stall speed at 35,000 lb. gross, flaps and gear extended... 95 mph.
- Rate of climb at sea level, 35,000 lb. gross, maximum continuous power ..... 1,650 fpm.
- Rate of climb at 5,000 ft. at 35,000 lb. gross, critical engine inoperative and propeller feathered, remaining engine at maximum continuous power... 300 fpm
- Runway requirement (CAR 4b) at sea level, 35,000 lb. gross, standard air ..... 4,130 ft.
- Land over 50 ft. obstacle at sea level, 31,000 lb. gross, standard air ..... 3,200 ft.

Weights:
- Maximum takeoff gross.... 35,000 lb.
- Maximum landing gross... 31,000 lb.
- Empty weight, less interior and avionics ..... 23,000 lb.

Structural design speeds: (TIAS):
- Never exceed ..... 328 mph.
- Diving ..... 365 mph.
- Flaps down ..... 208 mph.
- Gear down ..... 160 mph.

Dimensions:
- Span ..... 71 ft. 4 in.
- Length ..... 60 ft. 1½ in.
- Height ..... 20 ft. 0 in.
- Wing area ..... 558 sq. ft.
- Fuselage width (maximum).. 5 ft. 2 in.
- Fuselage height (maximum). 7 ft. 0 in.
- Fuselage length ..... 60 ft. 1½ in.
- Landing gear tread..... 21 ft. 1½ in.
- Wheel base ..... 13 ft. 4 in.

Fuel:
- Wing tanks ..... 800 gal.
- Outer wing panel tanks (optional) ..... 200 gal.
- Wing tip tanks..... 370 gal.
- Total capacity ..... 1,370 gal.

Tempo I is about $100,000 under that figure.

Tempo II fuselage is 9 ft. 7 in. longer than the original B-26, although the B-26 wing shape and control surfaces have been retained. Height is 1 ft. 3 in. greater and fuselage has been considerably streamlined from the wartime configuration.

Redesign of wing attachments freed the cabin of wing structure, engineers said. Wings now are attached to two pairs of fuselage frames made of 1¼ in. thick rolled aluminum plate, resulting in additional 10 in. length of the wing, increasing its area by 18 sq. ft. Tip fuel tanks carry 185 gal. each.

Nose has been considerably elongated to contain an integral radome and 1,000 lb. of cargo. Nacelles, empennage and landing gear remains relatively unchanged. Powerplants are two Pratt & Whitney R2800-C engines producing 2,100 hp. each (AW Oct. 20, 1958, p. 111). Propellers are Hamilton Standard three-blade 33E60/6899-20 models.

Aircraft is designed to cruise at 16-17,000 ft., with cabin altitude maintained at 5,000 ft. Fail-safe cabin design was aimed at withstanding differentials of more than 8 psi.; company engineers said maximum pressurization in operation will be only 4.17 psi. Cabin includes Douglas DC-6 type side windows, which also act as escape hatches.

Tempo II cabin pressure system incorporates a Stratos engine-driven compressor located in the right engine nacelle. Air cycling and heat transfer equipment is located in the wing roots. Components are all off-the-shelf hardware, with exception of plumbing and ducting.

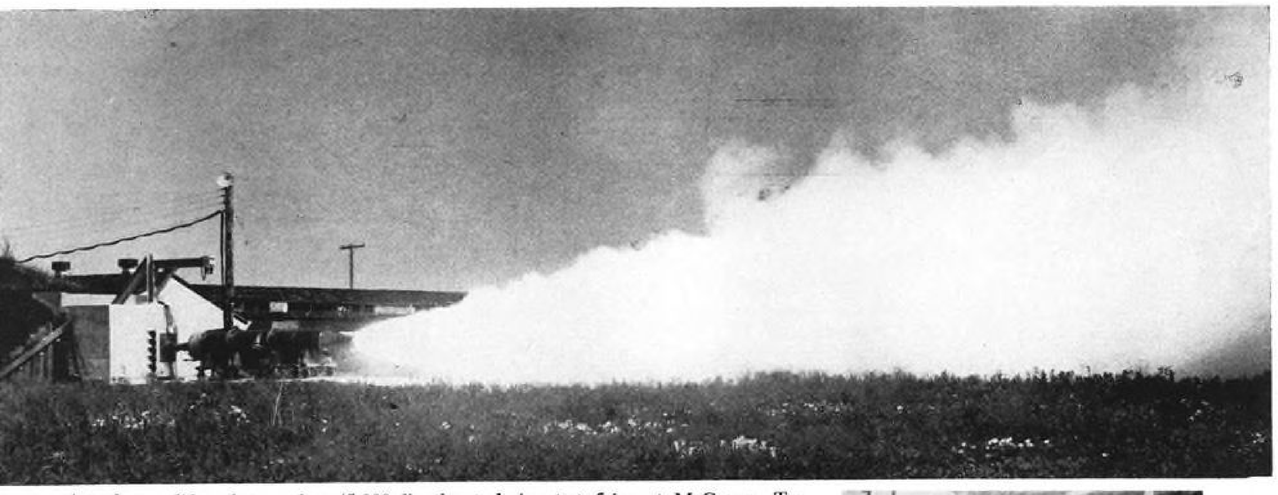
Aircraft's cockpit has been modified to include a copilot station with dual controls. Overhead window panels have been installed in the cockpit and main windshield is curved and fitted with ⅜th in. thick laminated glass.

Company said optional equipment will include drag chute for landing and JATO bottles for takeoff.

Tempo will be certificated for takeoff weight of 35,000 lb. and landing weight of 31,000 lb. Fuel capacity is 1,170 gal. (1,370 gal. with optional wingtip tanks). Range with full fuel will be 2,200 mi., with 45 min. reserve.

Fairchild to Build the Umbaugh 18s

Fairchild Engine & Airplane Corp. will manufacture Umbaugh 18 rotary wing aircraft under a subcontract from Umbaugh Aircraft Corp. Tooling will get under way immediately; aircraft will sell for $9,995. Forward motion is obtained by pusher propeller driven by Lycoming 180 hp. engine. Three-bladed rotor provides lift and can be clutched into engine for vertical takeoff. Prototype now is undergoing tests at Fairchild's Hagerstown, Md., plant.

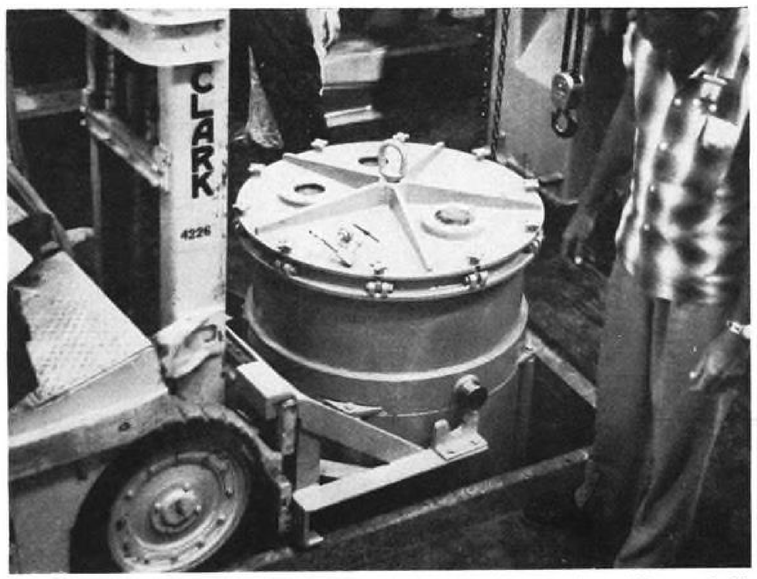


Astrodyne solid rocket reaches 45,000 lb. thrust during test firing at McGregor, Tex., facility. Unit produced pressure-time curve exactly as precalculated, company said.

Astrodyne Builds Solid Rocket Motor

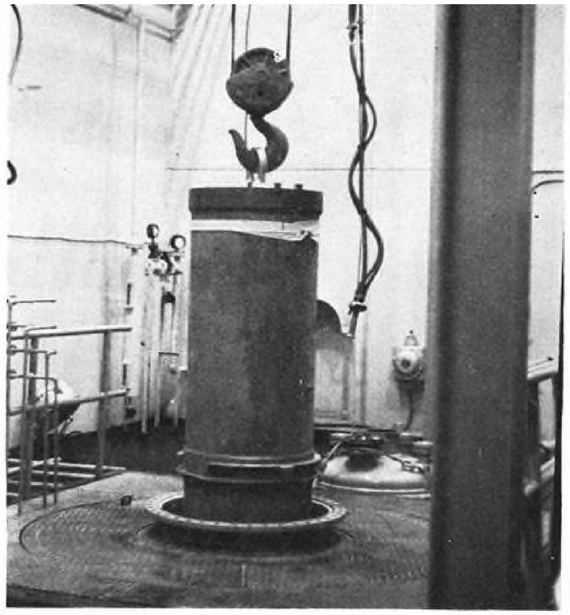
Large solid propellant-fueled rocket motor, successfully fired by Astrodyne, Inc., at McGregor, Tex., produced 45,000 lb. thrust and a specific impulse which the company said compared "very favorably" with the most powerful solid propellants now under development in the solid rocket industry. Motor used an ammonium perchlorate aluminized propellant and a modified XM-34 rocket case and contained 40 times more propellant than any cast motor Astrodyne had previously fired. The XM-34 case was used for the booster Astrodyne produced to zero-launch a North American F-100 jet fighter. The case is 16 ft. long and 27 in. in diameter. A new aft head with a smaller throated nozzle was designed for the case; aft end of the case and the aft head were coated with a new Astrodyne-developed insulation that protected them from the 5,000 deg. flame temperatures. Rubber-based insulation material was ¾th in. thick.

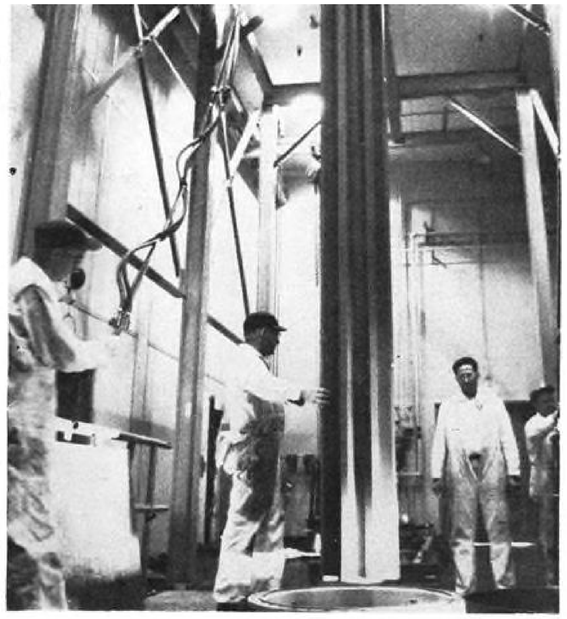
Quality and consistency of propellant is checked as it is poured into casting can.



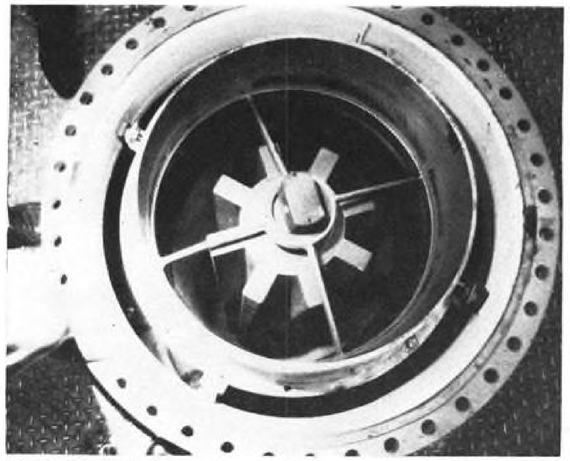
Propellant casting can is lowered into a pit for the pouring operation. The can holds approximately 1,200 lb. of propellant and is water-jacketed to aid in maintaining the proper propellant temperature. Unit is transported by a fork-lift with special adapter.

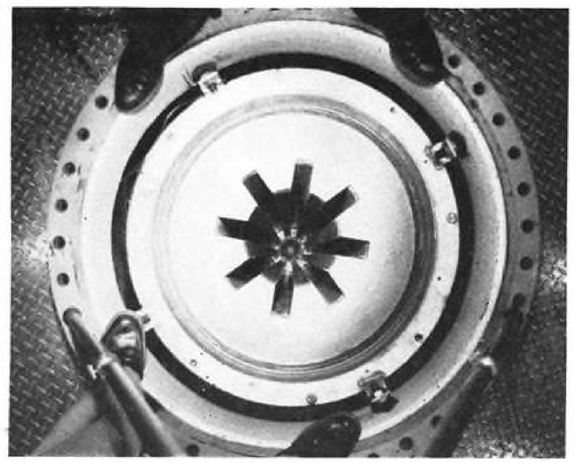
Technicians place casting can on top of the de-aerating valve and contents are dumped into the rocket case below.





Rocket case is lowered into casting bell (left) in preparation for pouring; motor is cured in bell for 72 hr. at 170F after final pour. At right, star-shaped mandrel is poised for insertion into the case. Mandrel is coated with Teflon, which acts as a lubricant.





Mandrel is locked into place, ready for the start of the casting operation. Unit was ignited from forward end (aft-end view is at left), and burned simultaneously along all surfaces and aft end. At right, view directly into case shows full 13-ft. charge.

Aft head is placed in assembly to vulcanize rubber-based insulation to inside (left). At center, the rocket motor has been removed from casting bell for application of the nozzle assembly. Special jig (right) is used to align aft head assembly to rocket case.

ARDC Tests Remote-Controlled Sweeper

Remote-controlled decontamination ramp sweeper is undergoing tests by USAF's Air Research and Development Command for use in cleanup operations following a nuclear explosion.

The sweeper, which can be driven conventionally for daily ramp cleaning, would be remotely controlled to avoid exposing personnel to radioactivity in cleaning up fallout debris from a nuclear attack or an accidental nuclear explosion. The Air Force says that even with utmost precaution and elaborate safety devices, the probability of a peacetime nuclear accident increases directly with increased number of flights with the weapons. All Air Force bases have special directives dealing with aircraft accidents with nuclear weapons aboard.

Air Force Special Weapons Center, ARDC, Kirtland AFB, N. M. will test the sweeper, which was produced by the G. H. Tennant Co., Minneapolis, Minn. After tests, lasting about one year, the Air Force will contract for production of the vehicle.

REMOTE control capability of decontamination sweeper is demonstrated with electrically connected control panel. Vehicle will be radio controlled.

SWEEPER demonstrates its time-cycled automatic dumping operation. The 4 cu. yd. hopper is lifted to full height three times to dislodge all residue.

Television Use

Television cameras fitted to the vehicle will permit radio controlled operation from distances up to 10 mi. At present, the brush-vacuum sweeper is controlled from an electrically connected control panel to demonstrate its remote control capabilities. The operator, using the control panel, can perform the following operations: start the engines; adjust the throttle, brake, shift gears (four forward, one reverse); control brush pressure or clearance; discharge dust from the vacuum filter; turn right or left and dump the 4 cu. yd. hopper.

One of the three shock-mounted television cameras will rotate 360 deg. and will have a zoomar lens focusing to 18 in. If necessary, the cameras will be equipped with avionic cooling devices to prevent overheating of the electron tubes during extended operation.

In operation, the sweeper will be equipped with Geiger counters and other radiation detection devices and will indicate areas of high intensity radiation.

Microphones on the sweeper will broadcast engine sounds to the controller along with the television picture. This will aid the operator in detecting engine malfunction and improve his "feel" of the machine. Safety devices on the sweeper include an automatic brake which actuates upon loss of the radio control signal.

The 10-ton vehicle cleans a path 87 in. wide and can sweep at a maximum speed of 35 mph. Most efficient sweeping speed, however, is approximately 18 mph. at which anticipated efficiency is 99% in sweeping up pea gravel, fallout debris and runway soilage.

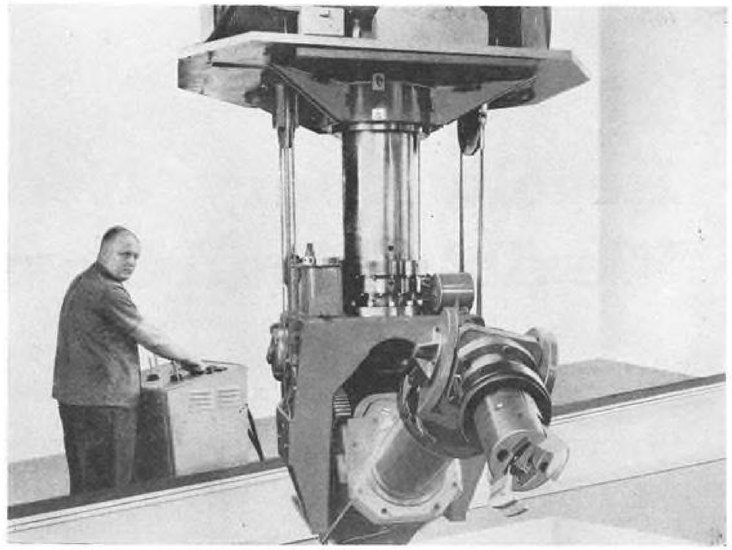
The dirt pickup system utilizes a rotating broom which rotates in a dust-sealed hopper. Air jets are used to force minute dust particles into the main vacuum airstream. The dust laden air is filtered through a five micron filter which can be remotely agitated to deposit the radioactive dust into the main hopper.

Powering the sweeper are two Hercules 93 hp. engines. One engine propels the vehicle and the other powers the rotating brush, vacuum fan, jet blowers and the 24 v. generators.

The Air Force also is considering the possibility of using remote controlled bulldozers which would clean up heavy debris before using the decontamination sweeper.

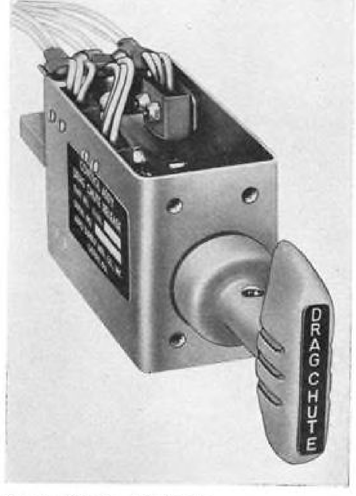
In addition to clearing away heavy debris, the bulldozers could be used to dig disposal pits for radioactive dust and dirt. After cleaning up the fallout material, the radio controlled vehicles would be driven to a remote area and allowed to "cool" until they can be approached by personnel.

NEW AVIATION PRODUCTS



Mechanical Arm for Project Rover

General Mills Mechanical Division is completing tests of a mechanical arm for use in connection with Project Rover nuclear propulsion studies for University of California's Scientific Laboratory. Unit, capable of lifting 5,000 lb., will be used in remote disassembly work at Nevada Test Site (AW May 4, p. 83).



Drag Chute Release

Electro-mechanical release mechanism for aircraft drag chutes weighs 0.8 lb. and is qualified for 10,000 endurance cycles.

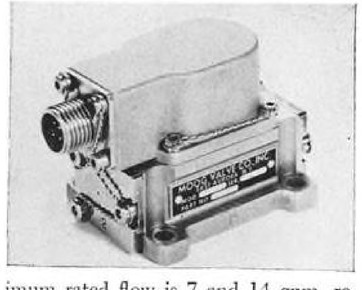
The mechanism, No. 11-2161-000, functions in two operations; first deploys the chute, the second disengages it from the aircraft. Control may be designed to other specific aircraft applications.

Aero Supply Mfg. Co., Corry, Pa.

Flow Control Servovalves

Mechanical feedback electrohydraulic servovalves are designed for aircraft and missile flight control systems and industrial control installations.

Valves are available in Series 31 and 32, which differ in that Series 32 has a larger hydraulic port circle and second-stage sliding spool permitting greater maximum flow. The Series 31 has a higher dynamic response. Maximum rated flow at a 1,000 psi. valve pressure drop is 4 gpm. for Series 31 and 8 gpm. for Series 32; at 3,000 psi. drop, max-



imum rated flow is 7 and 14 gpm. respectively. Operating supply pressure is 50 to 4,000 psi. Temperature range (fluid and ambients) is −65 to +350F standard, to 600F on special order. Weight is 0.75 lb.

Moog Servocontrols, Inc., E. Aurora, N. Y.

Fuel Gage Tester

Capacitance-type fuel quantity gage tester is said to be 15% lighter and 30% smaller than previous models.

Type 1429-A fuel gage tester contains a pair of 3-terminal air capacitors, continuously variable from 20 to 220 uuf (micro-microfarad); one to simulate the jet-fuel compensator, the other in conjunction with fixed silvered mica units, to simulate the main sensing capacitor of the fuel gage. To maintain accuracy, the capacitors are enclosed in a shock-proof aluminum case measuring 10½ x 17½ x 10½ in.

General Radio Co., West Concord, Mass.

Pressure Switch

Absolute pressure electrical switch, designed to actuate control and warning systems in aircraft and missiles, has one moving part.

Pressurmite, Model 655, consists of two precious metal contacts within an evacuated hermetically sealed chamber and is encased in a thermo-setting plastic housing. One contact is welded to a Ni-span sensing diaphragm that responds to outside pressure changes. Switch specifications include: weight

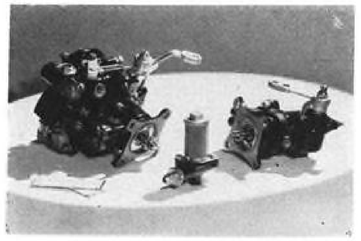
2.2 oz., temperature range −65 to +150C, pressure range 2 to 14.7 psia. or sea level to 50,000 ft. altitude; proof pressure 0 to 35 psia. Contact current rating is dependent on application, consistent performance at 0.2 amp., maximum at 28 v.

Friez Instrument Division, Bendix Aviation Corp., 1400 Taylor Ave., Baltimore 4, Md.

Turbine Control System

Turbine engine control system is designed for gas turbine engines in the 100 to 750 hp. range.

Control system consists of three components: a main fuel control, a power turbine governor for free turbine engines, and an optional air temperature compensator. Total weight of the three



components is less than 4 lb. On applications where all three components are not required, system weight would be reduced. System is designed to fit all small gas turbine engines.

Engine Equipment Section, Bendix Products Division, South Bend 20, Ind.

WHAT'S NEW

Reports Available:

The following reports were sponsored by the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.:

Heat Transfer to Boundary Layers With Pressure Gradients—by R. A. Seban and H. W. Chan, University of California for Wright Air Development Center, U. S. Air Force, May, 1958. $2.25; 97 pp. (PB 151414).

Annotated Bibliography of Applied Physical Anthropology in Human Engineering—by R. Hansen and D. Y. Cornog, H. L. Yoh Co. for Wright Air Development Center, U. S. Air Force, May, 1958. $5.00; 311 pp. (PB 151447).

Human Pilot Dynamic Response in Flight and Simulator—by E. Seckel and I. A. Hall, Princeton University, and D. T. McRuer and D. H. Weir, Control Specialists, Inc. for Wright Air Development Center, U. S. Air Force, Aug., 1958. $1.75; 66 pp. (PB 151465)

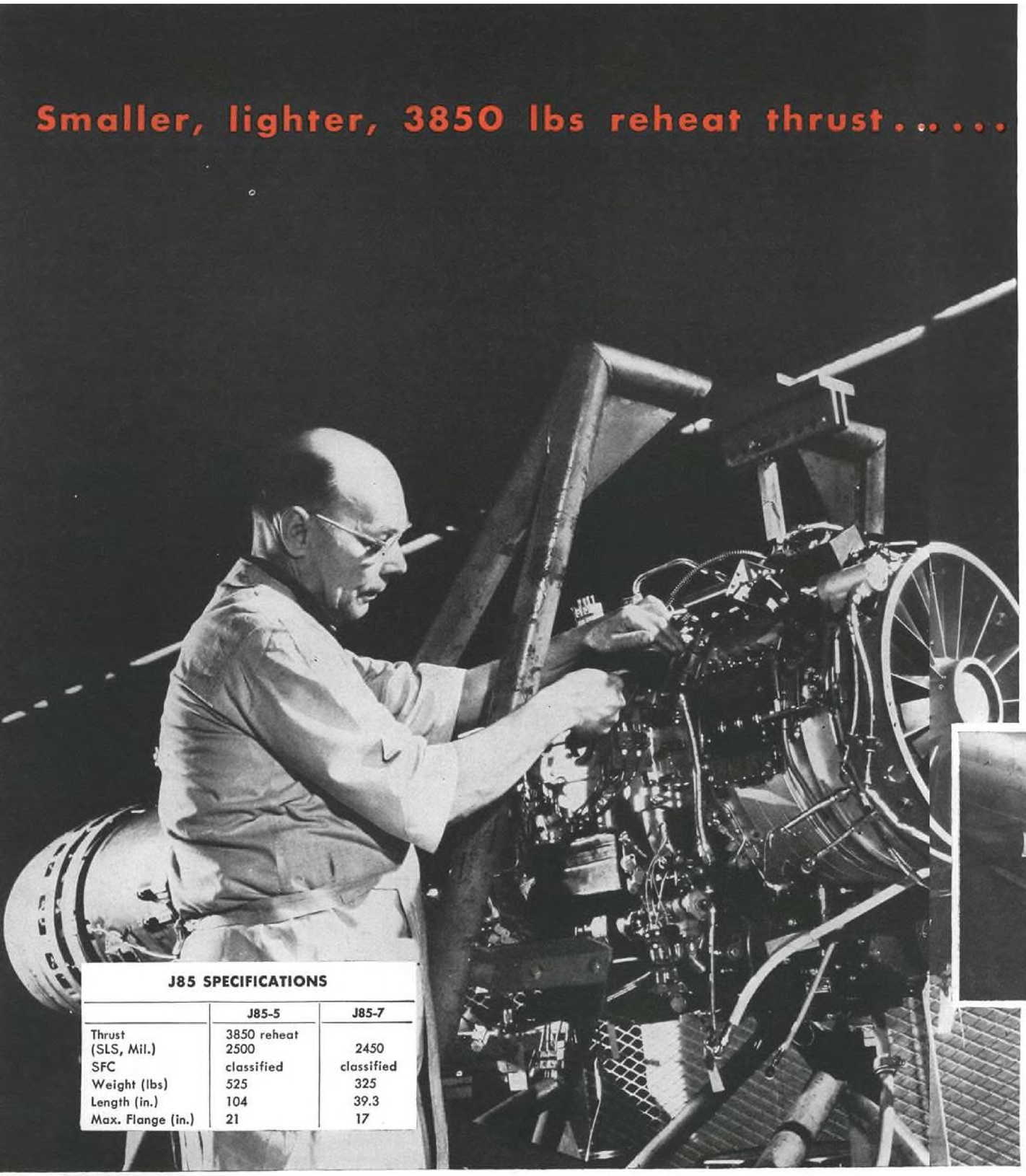
Bibliography of Technical Reports on the Effects of Fallout—by R. Wallace, University of California Radiation Laboratory for the Atomic Energy Commission, July, 1958. $2.00; 70 pp. (UCRL 8412).

Reports of Crystal Research—Three new catalogs dealing with research on crystals may be obtained at $.10 each from OTS. Part I, 1935-1958 includes germanium, selenium, and silicon crystals; measurements, tests and equipment. Part II, 1938-1959 includes crystal lattices and structure. Part III, 1932-1959 includes quartz and other piezoelectric crystals; grown and synthetic crystals.

Development of An Improved Air Force Sunglass—by J. A. Hirsch, Wright Air Development Center, U. S. Air Force, August 1958. $.50; 14 pp. (PB 151490).

Navy Portable Jet Engine Tester

Portable turbojet engine test system has been developed for the Navy by Space Corp. System has a capacity of 30,000 lb. thrust and can provide complete functional and operational testing on any turbojet engine the Navy has in service. Trailer shown here carries a fuel tank, auxiliary power unit and sound-proofed control cab. Engine is mounted on a second trailer. Only ground work required is excavation for a thrust restraining device.



J85 SPECIFICATIONS

	J85-5	J85-7
Thrust	3850 reheat	
(SLS, Mil.)	2500	2450
SFC	classified	classified
Weight (lbs)	525	325
Length (in.)	104	39.3
Max. Flange (in.)	21	17

General Electric J85 engines are now in production at the Company's Small Aircraft Engine Dept., Lynn, Mass.

NEW General Electric J85 turbojet helps reduce airframe size, weight, cost... boosts mission performance

SMALLER AND LIGHTER than comparable turbojets, General Electric's new J85 reduces airframe size, makes possible significant savings in airframe weight . . . corresponding reductions in airframe costs.

RATED AT 3850 LBS REHEAT THRUST, and 2500 lbs dry thrust, the J85-5 weighs only 525 lbs. Its missile counterpart, the J85-7, delivers 2450 lbs thrust . . . weighs only 325 lbs.

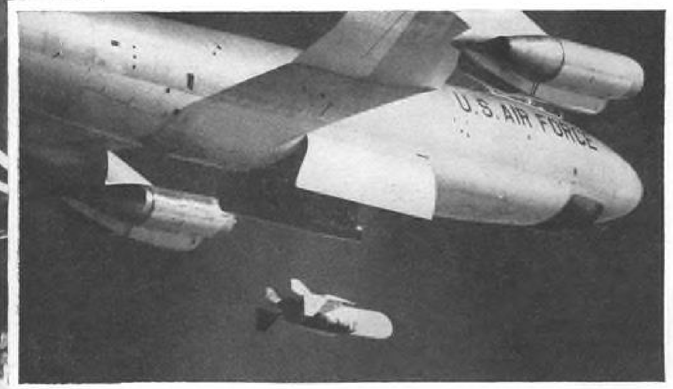
SHORT AND COMPACT, with a better than 7 to 1 thrust-to-weight ratio and low SFC, the J85 makes possible greater mission capabilities.

PERFORMANCE PROVEN, the J85 has accumulated more than 6000 test hours. On North American's T-39 utility transport, individual prototype (50-hr) YJ85's have logged over 85 hours of engine flight time before overhaul.

DURING ALTITUDE TESTS at Arnold Engineering Development Center, the J85 has exceeded thrust and SFC guarantees. At Wright Air Development Center rugged environmental tests have demonstrated the J85's low temperature starting and accelerating characteristics.

THESE EXAMPLES are typical of the rigorous flight, field and factory tests that have verified J85 ruggedness, reliability and safety margins.
The J85 has been developed under USAF contract and is now in production.

A NEW ILLUSTRATED BROCHURE that describes General Electric's J85 engine is now available. For your copy, write Section 233-23, General Electric Company, Schenectady, N. Y.



McDONNELL'S GAM-72 DECOY MISSILE, powered by General Electric's J85, will give the U.S. one of today's most effective diversionary weapons. The GAM-72 is shown above being air dropped from a B-47 during flight test.

NORTHROP'S N-156F "FREEDOM FIGHTER" AND T-38 "TALON" TRAINER—With lightweight, compact General Electric J85 engines, these high performance, low cost aircraft offer significant airframe size and weight savings.

Progress Is Our Most Important Product

GENERAL ELECTRIC