Aviation Week

Including Space Technology

5 Cents

A McGraw-Hill Publication

October 5, 1959

Aircraft Firms' Trend to Avionics

•

Gulfstream Pilot Report

Grumman Gulfstream Over Miami Beach



SURVEILLANCE DRONE SYSTEMS BY AEROJET

The Army's AN/USD-2 is today's most advanced drone system for gathering information on enemy battlefields. This high-priority Army program is a major part of Aerojet's acquisition of the Rheem Defense and Technical Products Division at Downey, California. Under the cognizance of Aerojet's Aeronautical Division, the SD-2 project is receiving increased emphasis during its advanced system development stages.

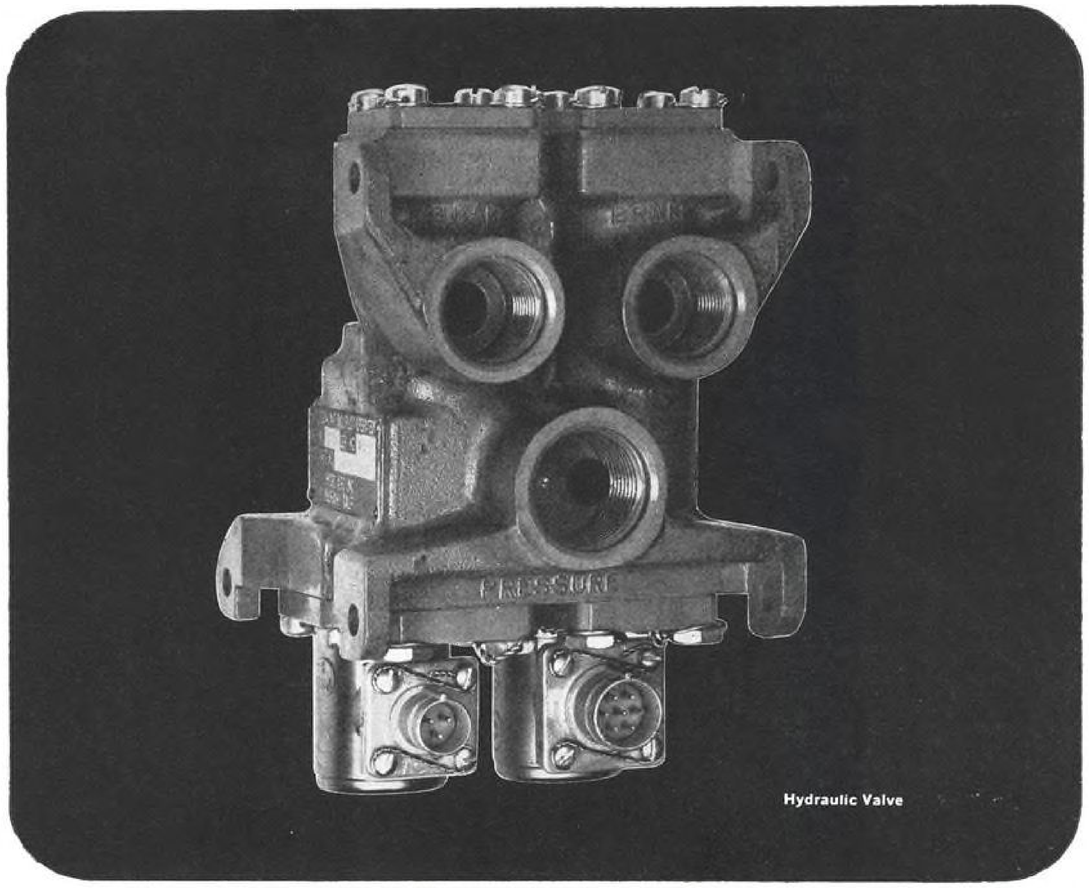
Developed for the Army Signal Corps, the SD-2 is launched from a standard Army trailer and flown by remote control to survey enemy positions. Its sensory compartment accommodates photo transmission systems, infrared, radar or other new electronic devices that transmit or bring back data. Outstanding characteristics of the SD-2 are the stable flight platform, sophisticated navigational system and unique parachute recovery, which make it ideal for a variety of military assignments.



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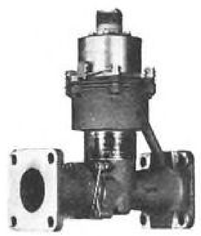


Hydraulic Valve

Another dependable valve from Hydro-Aire... now airborne on the "DC-8" and "880"



High Temperature Regulator and Shutoff Valve



Pneumatic Operated Gate Valve



Linear Actuator



Fuel Booster Pump

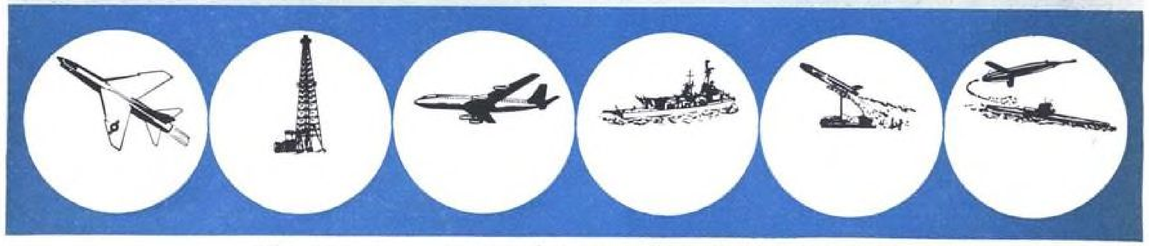
The hydraulic valve shown above is now in use on the "DC-8" and "880" in Hytrol's anti-skid braking systems with "Skydrol 500" fluid at 3000 psi. A dual pilot operated 3-way, 2 position, D.C. solenoid controlled valve, 38-131A, incorporates two separate valves (identical in design) in one housing with a common pressure and return port, and two separate cylinder ports. The operating ambient temperature range is −65°F to +200°F. The inlet flow rate is 20 GPM. Write for further details on this and other reliable products illustrated to:

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"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court

AVIATION CALENDAR

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

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

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

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

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

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

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

Oct. 13-14—National Technical Conference, Society of Plastics Engineers, Ambassador Hotel, Los Angeles, Calif.

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

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

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

Oct. 16-17—Second Annual Technical Conference & Exhibit, American Production & Inventory Control Society, Hotel New Yorker, New York, N. Y.

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

Oct. 19-23—47th National Safety Congress.

(*Continued on page 6*)

AVIATION WEEK Including Space Technology

October 5, 1959
Vol. 71, No. 14

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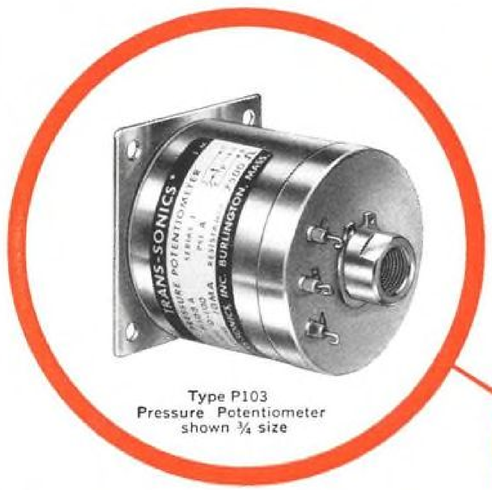
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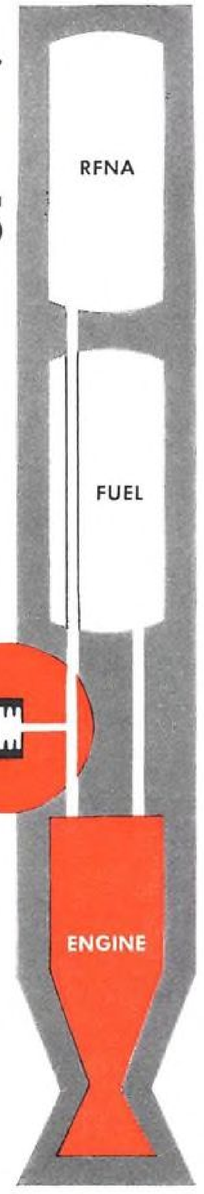
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New Trans-Sonics* Pressure Potentiometers, Type P103, measure pressures of corrosive fluids such as red fuming nitric acid (RFNA) and unsymmetrical dymethylhydrazine (UDMH) for telemetry and control applications at ambient temperatures up to 600F.

Corrosive fluids are contained by a welded Inconel-X bellows which actuates a dynamically balanced mechanism. This mechanism is hermetically sealed in a stainless steel case for protection against corrosion and other environmental hazards.

Accurate and reliable performance has been proven under the following conditions typical of missile environments: *Random Gaussian Vibration* 0.1g²/cps, 15 to 2,000 cps; *Acceleration* 75g; *Shock* 75g.

Flexibility of installation is assured by small size and light weight. Dimensions are 1⅞" diameter by 1⅞" long. Weight is only 6 ounces. Standard ranges are 0-100 and 0-150 psia . . . other ranges to special order. Write for Technical Bulletin P103 to Trans-Sonics, Inc., Dept. 7, Burlington, Mass.

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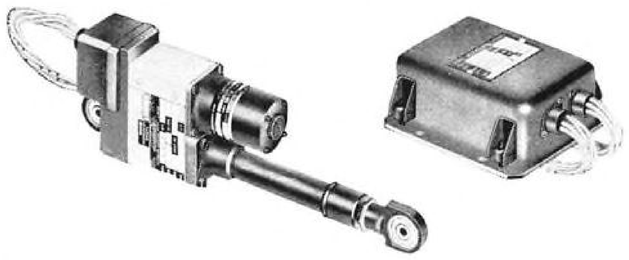
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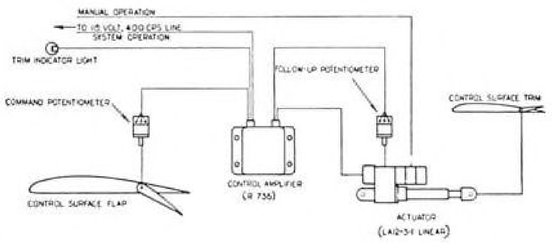
AIRBORNE

electromechanical system provides

automatic trim control for T-38



Schematic diagram shows Airborne automatic horizontal stabilizer trim control system on Northrop T-38 Talon. Control is achieved by d-c signals from 1000-ohm potentiometer on flap and followup from similar potentiometer on actuator. System functions only when flaps are lowered, with signal light indicating completion of adjustment for flap position selected.



Automatic horizontal trim control on Northrop's T-38 Talon high-performance jet trainer is provided by an Airborne electromechanical system comprised of an electronic control amplifier and an Airborne modular-type linear actuator. The system functions when the flaps are in use. At other times, the actuator is manually controlled by the pilot.

Sealed relays especially selected for their reliability characteristics are used in the output stage of the amplifier to control the 115-v, 400-cycle supply required by the brake-equipped actuator. The step function thus provided assures positive release of the actuator brake.

Control is simply achieved by d-c command signals generated by a 1000-ohm potentiometer on the wing flap and followup from a similar potentiometer on the actuator. Hysteresis of the control circuitry is deliberately broad to preclude hunting.

The entire system is designed for extreme compactness and light weight. The actuator is the smallest of Airborne's modular-design series, weighing only 1.4 lb., yet providing 75 lb. output. The control box measures only 1.6 x 4.2 x 3 in. and weighs just 1.2 lb.

Whatever your requirements in electromechanical control systems, it will pay you to check with Airborne. We have the engineering capabilities and production facilities to meet almost any need. Write, phone or wire any one of our offices.

See Airborne's new modular control systems at the Aircraft Electrical Show in Los Angeles

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Engineered Equipment for Aircraft and Industry

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HILLSIDE 5, NEW JERSEY • Offices in Los Angeles and Dallas

AVIATION CALENDAR

(*Continued from page 5*)

National Safety Council, Conrad Hilton Hotel, Chicago, Ill.

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

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

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

Oct. 20-22—Sixth Annual Lubrication Conference, Sheraton-McAlpin Hotel, New York, N. Y. Sponsors: American Society of Lubrication Engineers; American Society of Mechanical Engineers.

Oct. 20-22—16th Seminar-Workshop in Visual Communication, Teenifax Corp., Holyoke, Mass.

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

Oct. 22-23—Fall Meeting, Northeast Chapter of American Assn. of Airport Executives, Bradley Field, Windsor Locks, Conn.

Oct. 22-24—1959 Meeting and special "Cavitation" session, Acoustical Society of America, Cleveland, Ohio.

Oct. 26-28—Sixth Annual East Coast Conference, Institute of Radio Engineers' Professional Group for Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md. (Some classified sessions, sponsored by Air Research and Development Command.)

Oct. 26-30—National Conference, Society of Photographic Scientists & Engineers, Edgewater Beach Hotel, Chicago, Ill.

Oct. 28-29—Sixth Annual Computer Applications Symposium, Morrison Hotel, Chicago, Ill. Sponsor: Armour Research Foundation of Illinois Institute of Technology.

Oct. 28-30—Annual Industry Display, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 29-30—Fifth Annual Electron Devices Meeting, Institute of Radio Engineers' Professional Group on Electron Devices, Shoreham Hotel, Washington, D. C.

Nov. 2-4—National Midwestern Meeting on New Frontiers in Aviation, Institute of the Aeronautical Sciences, Hotel Lassen, Wichita, Kans.

Nov. 2-5—Fall Meeting, Western States Section, Combustion Institute, Institute of the Aeronautical Sciences Bldg., Los Angeles, Calif. Subject: Equilibria and Performance of High Temperature Systems.

Nov. 3-5—11th Annual Mid-America Electronics Conference, Hotel Muehlebach, Kansas City, Mo. Sponsor: The Institute of Radio Engineers' Kansas City Section.

Nov. 4-6—National Automatic Control Conference, Sheraton Hotel, Dallas, Tex. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Instrument Society of America; American Society of Mechanical Engineers. AIEE is conducting a parallel Control System Components Conference on Nov. 5-6.



NOW! B.F.GOODRICH LIGHTWEIGHT DE-ICERS FOR YOUR AERO COMMANDER

During the past six months the FAA has approved B.F.Goodrich Lightweight De-Icing Systems for use on the Beechcraft Twin Bonanza, Cessna 310 and Piper Apache. Now you can get this same practical, low-cost de-icing protection for your Aero Commander.

B.F.Goodrich Lightweight De-Icers are completely mechanical—contain no electronics. Pneumatic power source is a compact, reinforced fiberglass reservoir. One full charge provides enough compressed air for up to 8 hours of positive de-icing. The system designed for the Aero Commander weighs only 61 lbs., and one-third of this weight can be quickly removed for summer flying.

Contact your local B.F. Goodrich Aviation Products distributor and arrange to have Lightweight De-Icers installed. Or write *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Co., Dept. AW-109, Akron, Ohio.*

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As an oxidizer for liquid fuels, Nitrogen Tetroxide has even more to recommend it than its high performance (99% of theoretical I_{sp}, hypergolic at low altitude). The ease with which it can be stored and handled offers another major advantage.

N_2O_4 requires no refrigeration, no high-pressure vessels. It is noncorrosive, can be stored indefinitely in plain carbon steel tanks at the launching site or right in the rocket itself. And it's ready when it's needed—there are no freeze-ups in valves and motors with N_2O_4.

Availability: excellent. Allied is a major producer of Nitrogen Tetroxide, can ship immediately in cylinders or tank car lots. Allied also produces ammonia, ethylene oxide and methanol for the rocket industry. Write for technical or other information you desire on any of these products.

For specifications and local offices, see our insert in Chemical Materials Catalog, pages 435-442 and in Chemical Week Buyers Guide, pages 35-42.

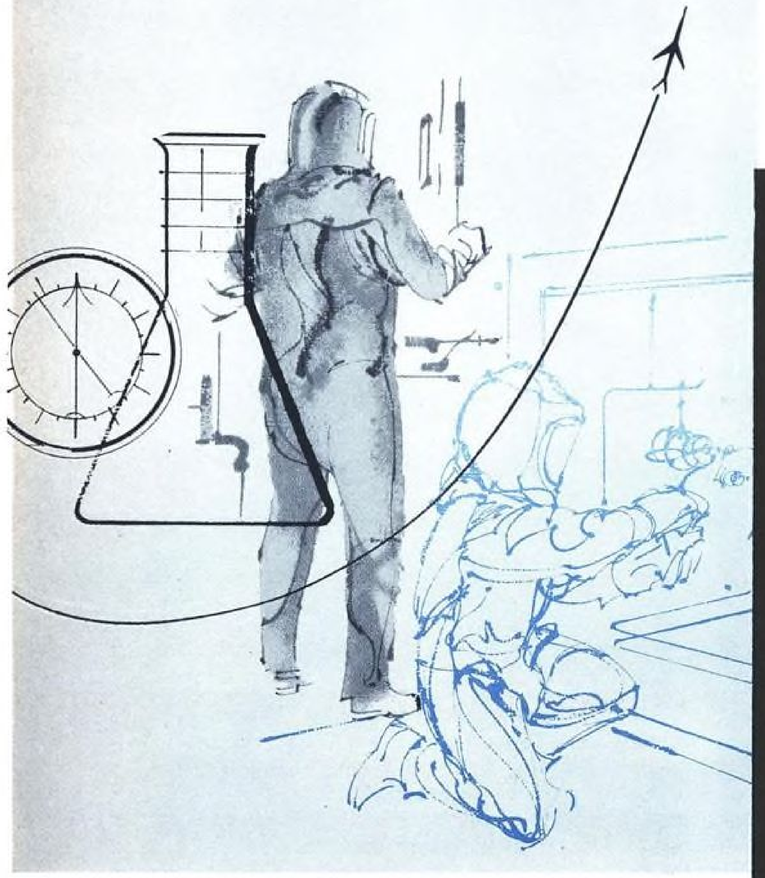
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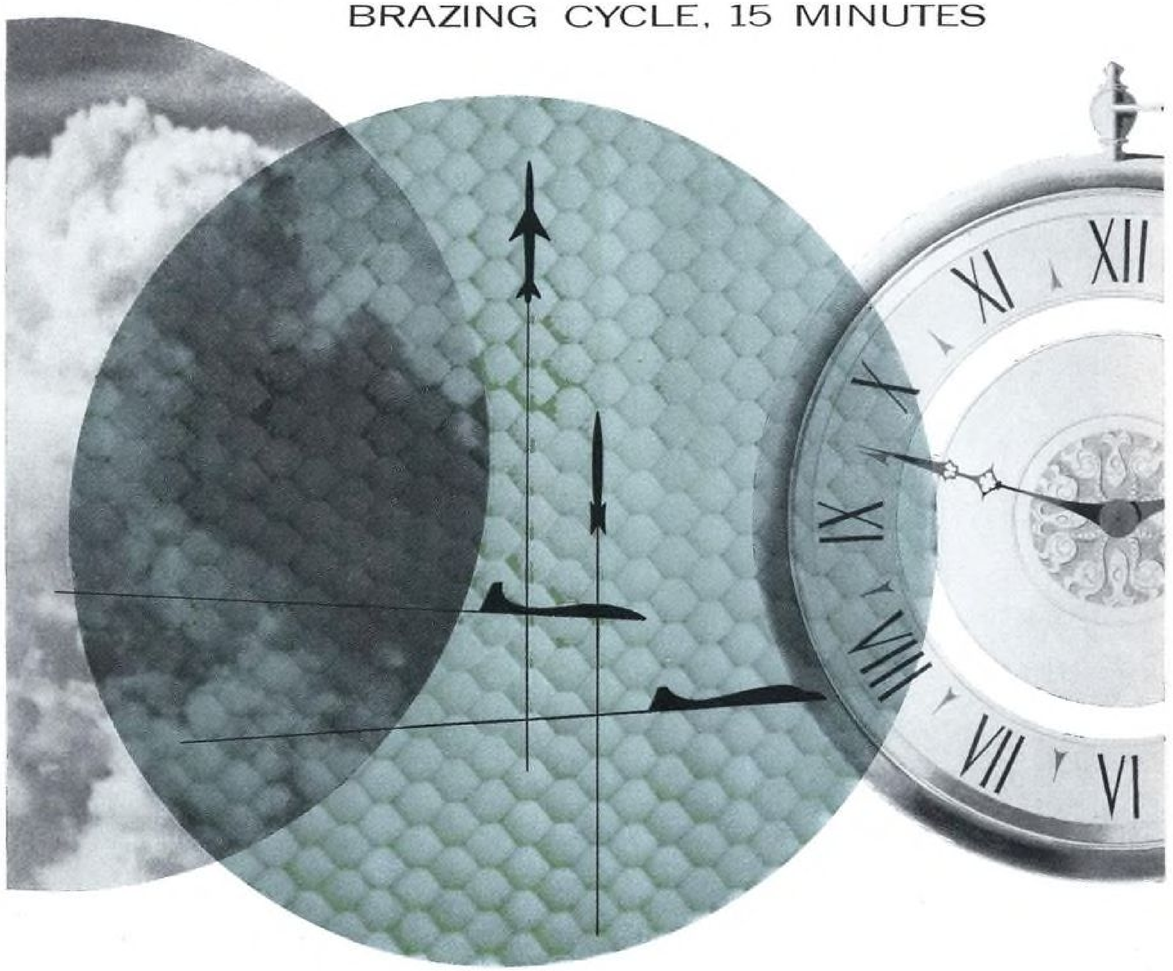
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John B. Wassall, Director of Engineering, Lockheed California Division, is the chief executive of the huge engineering branch which employs 5700 people.



World's speed, altitude and time-to-climb champion, the sleek F-104 Starfighter, is an outstanding achievement in performance and dependability.

This spectacular new plane scorches the sky in 1500 m.p.h. bursts of speed. It climbs to the very fringe of earth's atmosphere in minutes!

Soundly designed, and utilizing the finest of quality products throughout vital systems, the F-104 is giving many hours of trouble-free service—thanks to Lockheed's devotion to dependability.

AEROQUIP PRODUCTS ARE USED BY LOCKHEED ON THE F-104



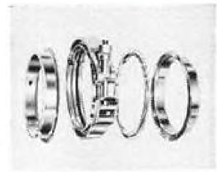
High performance 666 and 677 Hose of Teflon with patented* ***"super gem"*** Reusable Fittings for the hydraulic system.



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Quick-Disconnect, Self-Sealing Couplings for the hydraulic system.



Marman Clamps, Couplings and Joints used in many applications on the F-104.

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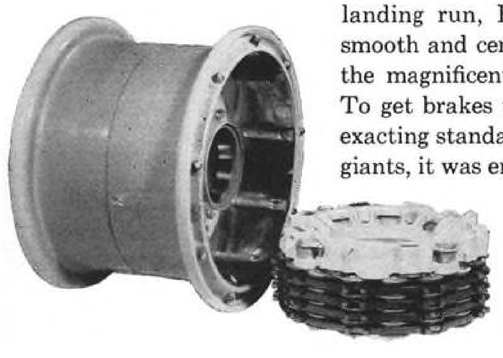
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From touch-down to the end of the landing run, Bendix brakes provide smooth and certain ground control for the magnificent new jet airliners . . . To get brakes that measure up to the exacting standards of these swept wing giants, it was entirely logical to look to the world's most experienced supplier . . . For similar reasons, Bendix brakes are regular equipment on the largest and fastest military jets, as well as fully certified by FAA for the new civilian jets . . . BRAKES BY BENDIX is another important reason why you can fly the jetliners with complete assurance.

Bendix PRODUCTS DIVISION South Bend, IND.

Bendix AVIATION CORPORATION

AMPLISOLVER*



*American Electronics' new Amplifier/Resolver module

GREATER STABILITY IN A SMALLER PACKAGE!

AMPLISOLVER is a compact package only 3 inches long, with a Size 8 winding compensated resolver and a dual channel buffer amplifier, within a Size 15 frame. AMPLISOLVER offers unity transformation ratio with Zero phase shift, over a temperature range from —55°C to +125°C.

AMPLISOLVER is the lightest module of such accuracy in the industry, weighing only 8 oz. The unit features an input impedance of 1 megohm minimum with a low output impedance of 270 + j400 ohms. Direct drive from resolver to amplifier eliminates the cable connections. Trim adjustment on AMPLISOLVER can be made in the field to ± 2% of unity transformation ratio of 1 to 1. Its versatile design features permit adapting AMPLISOLVER to computing resolver chain functions.

SPECIFICATIONS—MODEL 15RA5E-11D

Input Voltage	10
Amplifier Power Supply (Volts D.C.) (Reg.)	30 ± .3
Input Impedance	1 megohm min.
Output Impedance (ohms)	270 + j400
Maximum Null Voltage (volts)	
Fundamental	.010
Total	.015
Maximum Functional Error (%)	0.1
Transformation Ratio (Rotor/Input)	1.000 ± .001
Phase Shift (Degrees)	0 ± 0.1
Meets MIL SPEC MIL-E-5272C	

For complete information write:

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INSTRUMENT DIVISION

9503 WEST JEFFERSON BOULEVARD, CULVER CITY, CALIFORNIA

XXIV

This is the twenty-fourth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Quenching and Tempering Alloy Steels

Of the various methods of heat-treating alloy steels, the most important is that involving quench and temper. This method, which enhances the mechanical properties of the end product, differs materially from normalizing and annealing (previously discussed in this series).

The purpose of quenching is to effect a cooling rate sufficient to develop the desired hardness and structure.

Before quenching takes place, steel is heated to a point above the transformation range. Quenching is the subsequent immersion of this heated steel in a circulated or agitated bath of oil, water, brine, or caustic; or, in the case of austempering or martempering, generally in agitated molten salt baths. Austempering and martempering are preferable where a minimum of distortion is desired.

Quenching *increases* the tensile strength, yield point, and hardness of alloy steels. It *decreases* ductility —that is, elongation and reduction of area. It also decreases resistance to impact. However, by means of tempering, it is possible to restore some of the ductility and impact-resistance—but only at a sacrifice of tensile strength, yield point, and hardness.

The results of mild oil- or water-quenching as related to mass effect can be found in the end-quench hardenability test. Voluminous data concerning this test are issued by AISI and SAE in the form of hardenability bands for the various grades of alloy steels.

If thermal cracking is to be avoided, cooling by liquid quenching should not be carried to a point below 150 deg F. When a temperature of 150 deg F is approached, immediate tempering should follow. Because of residual stresses, no steel should be used in the as-quenched condition.

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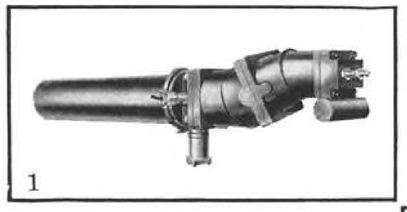
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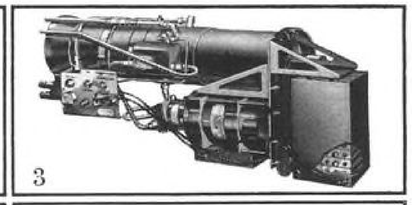

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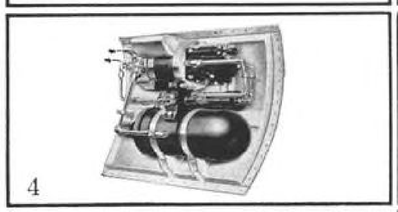
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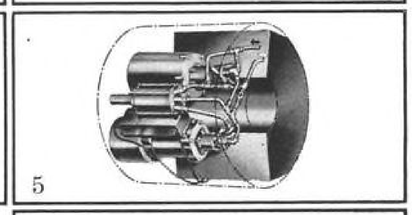
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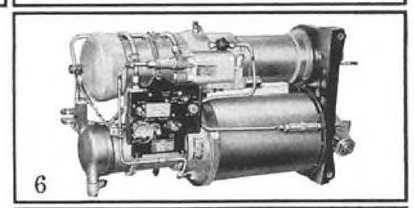
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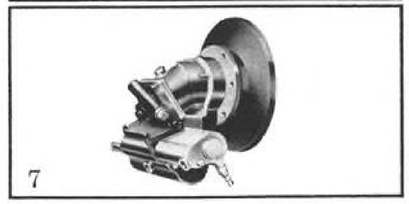

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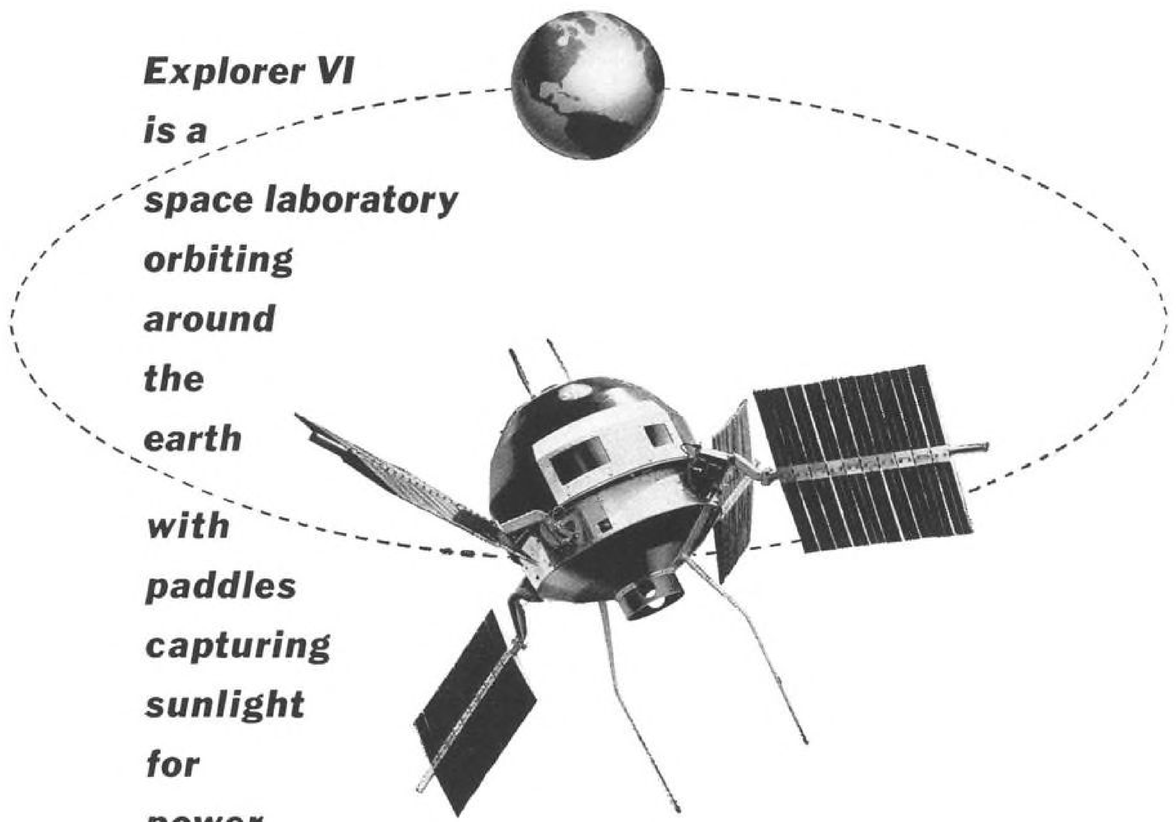
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COVER: Grumman's third production Gulfstream, demonstrator N-703G, is shown during a flight over Miami Beach, Fla. The corporate, 350-mph. airplane, which seats 10 to 12 passengers in executive configuration, has a range of 2,530 stat. mi. Power is supplied by two Rolls-Royce Dart 7/2 turboprops. For Aviation Week pilot report, see p. 52.

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EDITORIAL

Aeroflot Visits U.S.

The recent visit of Nikita Khrushchev, chairman of the Council of Ministers of the USSR, to the United States had a variety of aviation angles. Not the least of these was his delight with the Sikorsky S-58 helicopter which he rode with President Eisenhower on a tour of Washington and nearby Virginia and Maryland. Mr. Khrushchev's avowed intention of buying an S-58 for his personal use and the public disclosure that Soviet officials had warned him against riding in helicopters because they were "unsafe" will certainly not be welcome news to the trio of Soviet helicopter designers-Mikhail Mil, Alexander Yakovlev and Nikolai Kamov who described their designs in detail to the American delegation at the Federation Aeronautique Internationale conference in Moscow last spring.

Considerable interest was aroused by the first full-scale visit of Aeroflot to this country. There was a change in top level Aeroflot direction in mid-summer with Gen. Yovgeny F. Loginov succeeding Marshal Pavel Zhigarev as chief of Aeroflot and its related activities and Gen. Nicolai I. Tsibin succeeding Marshal Simeon Zhavaronkov as deputy chief.

Gen. Loginov and Tsibin are both 33-year veterans of the Red Air Force. Gen. Loginov is a native of Leningrad and a flying school classmate of Maj. Gen. Mikhail Kostiuk, the Soviet air attache in the U.S. who also was a wartime test pilot at Wright Field. Gen. Loginov's military career was primarily in bombardment and he spent most of his time in World War II flying and commanding units of twin- and four-engine bombers in the Red Air Force's first efforts at strategic bombing operations against Germany. Until his recent switch to Aeroflot, Gen. Loginov was deputy commander of the Red Air Force under Marshal Konstantin Vershinin.

The new heads of Aeroflot are considerably younger than the marshals they displaced and represent the newer type of leaders rising in the technical activities of the Soviet Union. They are more technically sophisticated, more conscious of the necessity for, and problems of, foreign relations and considerably more vigorous in the pursuit of their goals. It is typical that they did not leave the job of handling their No. 1 passenger, Mr. Khrushchev, to subordinates on his most important journey. Modestly listed as crewmen of the Tu-114 and Il-18 turboprop transports, they personally directed the sizable airlift that supported the Khrushchev visit to the U.S.

During this visit, Aeroflot operated two Tu-114 giant turboprop transports in a 170-passenger-seat configuration plus 30 seats in a mid-cabin restaurant, an Il-18 with an executive-type interior, and shuttled four Tu-104 twin-engine jets back and forth between Vnukovo and Andrews AFB as courier planes swishing Soviet state papers to Mr. Khrushchev and his entourage and returning with mail, movies and still pictures of the American tour for Soviet audiences. As a result, Moscow television audiences saw Mr. Khrushchev's arrival in Washington just two days after the event.

The Aeroflot jet and turboprop transport operations between Moscow and Washington, coupled with similar Tu-114 operations to New York with Soviet Deputy Premier Frol Koslov last summer, provided Aeroflot crews and operational personnel with some good preliminary route checks for the U.S.-USSR air service that is just around the corner.

Agreement in principal on reciprocal commercial aviation operations was reached in the Lacey-Zaroubin cultural, technical and educational exchange pact signed in January, 1958. The following October, the United States officially informed the Soviet Union it was ready to negotiate the details of such an agreement. Aeroflot made no move to pick up the ball, however, primarily because it was not yet ready with the type of equipment it required to make the Moscow-New York nonstop run.

As long ago as July, 1956, Aeroflot officials indicated a firm policy of not asking for any routes until they had suitable equipment to compete with foreign carriers and were specific that the New York route would have to wait for the giant Tu-114.

The Tu-114 has been getting its shakedown on the New York-Moscow run this summer and fall with some of the most distinguished passengers in the Soviet Union indicating considerable confidence in its operational reliability. So it was not surprising that Gen. Loginov diverted from his Andrews AFB operations long enough to visit Pan American World Airways President Juan Trippe in New York and spent an informal evening with top U.S. civil aviation officials in Washington. Gen. Loginov confirmed designer Andrei Tupolev's earlier indication that the Tu-114 would go into domestic Aeroflot service later this fall on the trans-Siberian route and we predict that Aeroflot will be in the mood to open the New York route next spring.

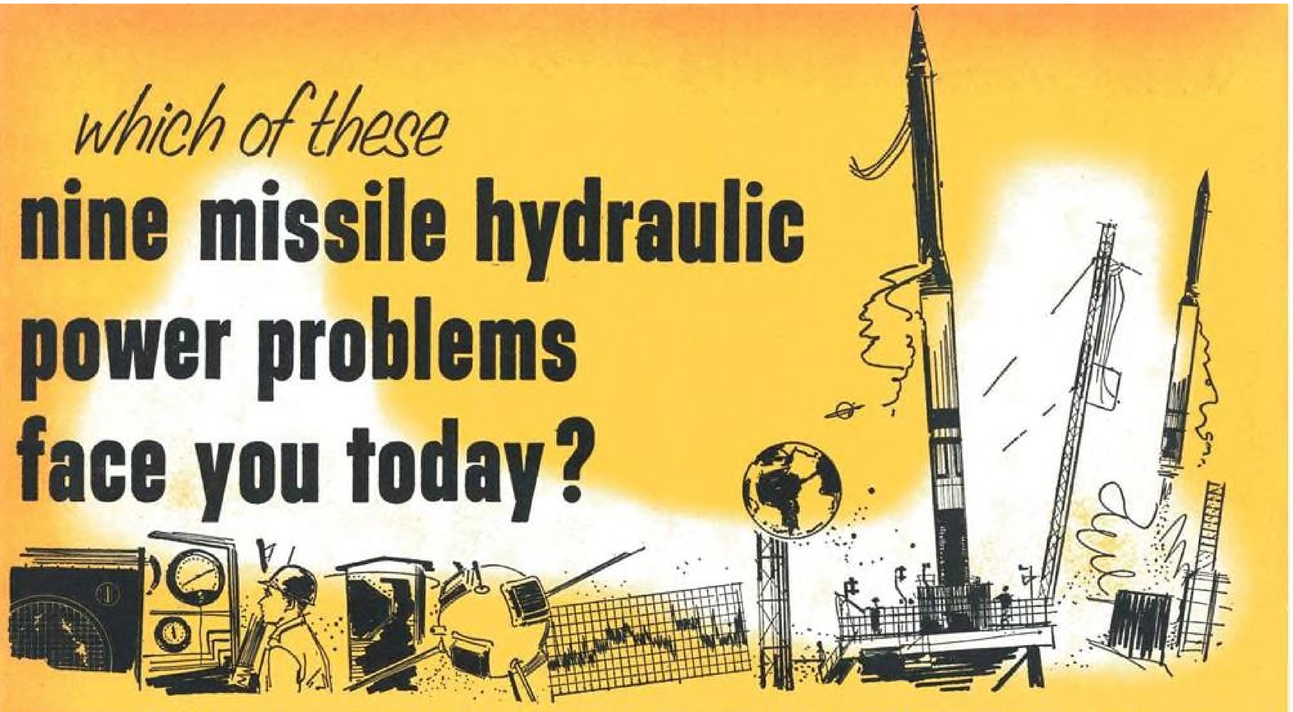
Although it operates consistently in some of the worst winter weather in the world, Aeroflot has shown a preference for making its major new equipment introductions in the spring and summer rather than during the bad weather season. If a bilateral air agreement is concluded with the USSR this winter for operations in 1960, the competition will be between Pan American's Boeing 707-320 Intercontinental model and the Tu-114 which considerable numbers of U.S. aviation people have now had an opportunity to examine in detail in New York, Paris and Washington. The availability of a 10-to-12 hr. transit between the two political poles of the world should prove valuable to improved communications and understanding if the current political climate prevails.

There is a wide difference of opinion among U.S. technical people who have examined the Tu-114 in varying degrees of detail but its performance on the Moscow-New York run will, as always, be the final proof of its capability. Certainly nobody who saw the now familiar Tu-114, No. 5611, hurtle down the 9,000 ft. runway at Andrews AFB, grossing 367,000 lb. including Mr. Khrushchev, and saw it come unstuck at 8,700 ft. will ever forget the sight.

Once again, even a brief and translation-plagued contact between professional airmen on both sides of the Iron Curtain has contributed to poking some holes in that curtain and clarifying some areas of misconception on both sides. It is a process worth repeating. If repeated often enough, who knows but what something solid and significant may be achieved. —**Robert Hotz**

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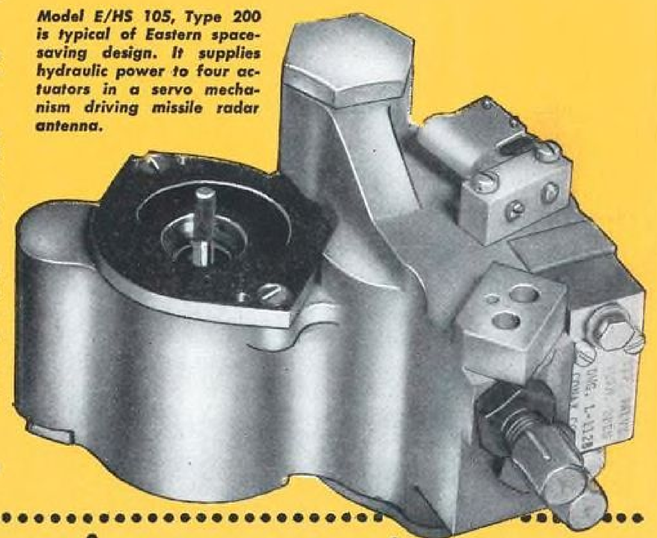
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WHO'S WHERE

In the Front Office

Gordon Banerian, vice president-engineering, Aerojet-General Nucleonics, San Ramon, Calif., subsidiary of Aerojet-General Corp., Mr. Banerian continues as manager of Aerojet's Turbo-Machinery Division.

Brig. Gen. J. A. Cunningham, commander, Air Rescue Service, MATS, Orlando AFB, Fla., replacing **Brig. Gen. T. J. Dubose,** retired.

Stephen F. Leo, a director, National Research Associates, Inc., College Park, Md. Mr. Leo is a vice president of Sverdrup and Parcel Engineering Co.

Emerson Electric Manufacturing Co., St. Louis, Mo., has elected the following as advisory members of the board: **Edward L. O'Neill,** vice president-general sales manager; **William L. Davis, Jr.,** vice president-engineering; **Charles G. Gulledge,** vice president-electronics and avionics.

Brig Gen. H. F. Gregory (USAF, ret.), a director, Midwestern Instruments, Inc., Tulsa, Okla. Gen. Gregory is vice president and assistant to the president.

Philip L. Bradford, board chairman, Aircraft Dynamics, New York, N. Y.

George Gregory, president, Products Research Co., Los Angeles, Calif.

Robert G. Hess, president and general manager, Wright Machinery Company Division of Sperry Rand Corp., Durham, N. C.

W. M. McFarland, president, and **D. M. Stuart,** vice president and general manager, Hazeltine Technical Development Center, Inc., Indianapolis, Ind., recently formed division of Hazeltine Corp.

Dr. William L. Whitson, a vice president, Daystrom, Inc., Murray Hill, N. J.

Raymond A. Runyan, vice president-research and development, Data-Control Systems, Inc., Danbury, Conn.

E. M. Ramberg, vice president-marketing, Titeflex, Inc., Springfield, Mass.

Gordon D. Russell, vice president-sales, Switzer Brothers, Inc., Cleveland, Ohio.

Roger V. Rowe, an assistant vice president, Pan American-Grace Airways, Inc.

Dr. Bennie A. Moxness, chief of the Examiner Training and Control Branch, Office of the Civil Air Surgeon, Federal Aviation Agency, Washington, D. C.

Honors and Elections

Massachusetts Institute of Technology and the Lockheed Leadership Fund have announced the creation of a Dr. Louis N. Ridenour Memorial Fellowship, in honor of the late Dr. Ridenour who was vice president of Lockheed Aircraft Corp. and general manager of the Electronics and Avionics Division. The fellowship for 1959-60 has been awarded to **Joseph Pedlosky,** an MIT graduate who held a Lockheed Leadership Fund scholarship.

Gayton E. Germane, professor of transportation and management in the Stanford University Graduate School of Business, is on leave to serve as the director of all transportation policies, foreign and domestic, for the Department of Defense, Washington, D. C.

(Continued on page 174)

INDUSTRY OBSERVER

► Lockheed Aircraft Corp. and Hughes Aircraft Co. are contemplating a joint effort for the design of a general-utility space ferry vehicle for use in transport and supply missions. Proposal for development of the vehicle may be made to National Aeronautics and Space Administration.

► **T-33 research vehicle consisting of two Thiokol Recruits as boosters and a single Sergeant as the sustainer is tentatively scheduled to be fired from National Aeronautics and Space Administration's Wallops Island, Va., facility in mid-October with a 100-ft. inflatable sphere as its payload. NASA is programing at least four of the vehicles for use in upper atmosphere tests.**

► Navy is asking North American Aviation, Inc., to adapt its A3J attack plane now under development to incorporate a low altitude, high subsonic performance capability similar to that planned for the Grumman A2F which is scheduled to be capable of maintaining a speed of Mach .9 at sea level. Navy originally had planned to cancel the A3J development in view of the stringent Fiscal 1961 budget levels imposed by the Administration in order to divert the funds to other high-priority projects. Plan, however, was vetoed at top Defense Department levels, presumably to avoid the economic impact two major concurrent cancellations would have upon North American. Cancellation of North American's Mach 3 F-108 interceptor project by the Air Force was announced late last month (AW Sept. 28, p. 27).

► **Defense Department interest in Project Orion, the nuclear bomb powered rocket under development by General Atomics Division of General Dynamics Corp., is increasing with the apparent solution to a number of the most critical problems that previously had blocked practical application of this type propulsion. Problems now believed to have been overcome include the previous low average thrust-to-weight ratio, specific impulse and the need for very large-size vehicles.**

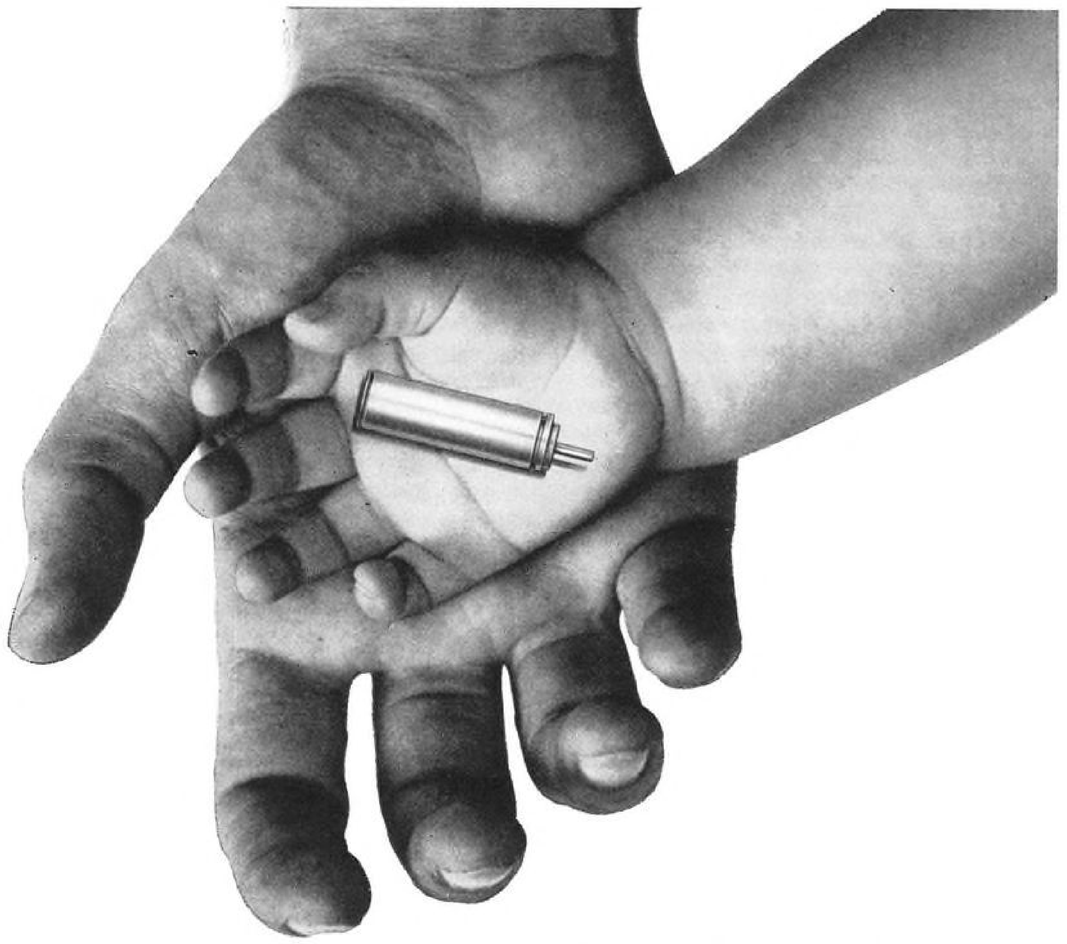
► Navy is considering the development of a small—possibly two-man—low-cost killer submarine equipped with hydrofoils for relatively fast surface speeds. Vehicle, which would be equipped with Subroc-type missiles for use against enemy submarines, would operate from a surface mother ship.

► **North American Aviation is studying the commercial jet transport market to determine the feasibility of marketing its Sabreliner transport developed for Air Force as a corporate-type aircraft.**

► Air Force Cambridge Research Center is establishing a Lunar-Planetary Exploration Branch within the Geophysics Research Directorate's Space Flight Physics Laboratory. Mission of the new branch is to plan and devise instrumentation for use in upcoming Air Force lunar and planetary probe programs.

► **Electronic countermeasures system planned for the Boeing B-52H and under development by Sperry Gyroscope Co. barely escaped the Defense Department economy cutbacks now under way. Cancellation was prevented by strong objections of ranking officers of the Strategic Air Command who termed the system vital for successful mission completion and said they would prefer a reduction in the over-all number of aircraft ordered rather than cancellation of the countermeasures contract.**

► Navy has completed 25-hr. tests on two Gyrodyne YRON-1 rotorcycles at the Naval Air Test Center, Patuxent River, Md. Three more rotorcycles are being delivered to Quantico, Va., for tactical evaluation by the Marines. Two of these will be powered by the 182-lb. Porsche GP-102/2 piston engine; the third by the 55-lb. Solar T62 turbine. The Navy has ordered a total of 10 rotorcycles for evaluation. The remaining five are Hiller XROE-1s scheduled for delivery in December.



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Washington Roundup

Technical Youth Movement

Calling for fresh faces in U.S. scientific and technical efforts, Dr. George Kistiakowsky, the President's assistant for science and technology, said last week that "we, the tired weaponeers of World War II, would do well to make room for youth and new ideas."

Dr. Kistiakowsky told Air Research and Development Command's sixth annual science and engineering symposium here that the President's Science Advisory Committee is seeking ways to bring "a new generation of scientists and engineers into our panels and other types of advisory service to the government . . . without handicapping their professional development or curtailing their vital contributions to science."

"I feel very keenly about this matter of injecting more youth into our advisory activities because of my own experience when I was still reasonably youthful and was just beginning my military work in 1940," Kistiakowsky said. "I vividly recall the elder statesmen, who had been important in World War I, who volunteered advice in 1940 that was difficult to refuse and still more difficult to use."

U. S. Helicopter for Khrushchev?

Soviet Premier Nikita Khrushchev may buy a U.S. helicopter as a move in his campaign to expand Soviet-U.S. trade. At the end of his U.S. tour, Khrushchev said he was impressed by his Sikorsky S-58 helicopter rides with President Eisenhower, and that "I'd like to buy one of yours, I like them so much. I like the flights and the helicopter itself." Later, Eisenhower said Khrushchev would ask Undersecretary of State Douglas Dillon to represent him in negotiations for a helicopter. Dillon offered to arrange a meeting between Soviet officials and industry representatives, although he pointed out that Khrushchev will have to buy a commercial model because military models, such as the machine Eisenhower uses, are banned from sale to Iron Curtain countries.

Khrushchev's enthusiasm was generated when he rode in Eisenhower's personal helicopter, in spite of warnings from his Soviet advisors that helicopters aren't safe enough for him to use. Soviet premier will have to buy the S-58 civil counterpart of the Marine helicopter used by the White House if that is the model he wants.

This Sikorsky machine is in the same general class as the Russian Mi-4.

U. S.-Canadian Meeting

A House Foreign Affairs subcommittee reported favorably last week on Canadian efforts to get U.S. defense contracts. After meeting with its counterpart in the Canadian House of Commons, the subcommittee commented that "there was general realization that the defense problems of the U.S. and Canada are so inextricably intertwined that, for all practical purposes, the two countries should, in this area, be considered as a single entity." The subcommittee added that "the Canadian group placed particular emphasis on the desirability of utilizing Canadian engineering skills and industrial capacity in defense production, both in the production and in the research and development field. The U.S. representatives agreed that there was considerable merit to the Canadian point of view but stressed that implementation of such a policy must of necessity be subject to numerous practical considerations."

New Cost Principles

Department of Defense plans to issue a complete new set of cost principles by the first of the year. They have been in preparation for over five years. Several congressional groups, notably the House Appropriations and House Armed Services Committees, have persistently demanded uniform cost policies for all contracts, but without success. They have pointed out that costs account for over 90% of the total contract price to the government, "profits" for only a small amount. Because of the large stakes involved, there is still sharp controversy between defense and industry accountants on what costs should be allowable.

MATS Growth Criticized

Rep. Emanuel Celler (D.-N.Y.), chairman of the House Judiciary Committee, has joined in congressional demands that the Air Force hold the line on the expansion of Military Air Transport Service. He said:

"MATS is now the largest airline in the world. This year it carried four times the cargo traffic it carried in 1951. Last year it hauled 62% of all transatlantic cargo. The regular U.S. air carriers handled 17%. MATS carried 25% of all transatlantic passengers. It has 400 planes and 480 stewardesses. Its unusual expansion can only be justified if its flights are essential for training of the crews. This is not the case. MATS figures show that only a small part qualify on this basis. Or the growth could be justified on the score that the planes serviced areas not covered by commercial airlines. This is not the case. Ninety per cent of MATS' flights duplicate routes already served by scheduled U.S. flag carriers. . .

Capital Equipment Plans

Capital Airlines plans to complete its refinancing program within the next month as a first step toward the launching of its long-delayed re-equipment program. Other than the letter of intent given General Dynamics Corp. in 1958 and amended early this year providing for the purchase of 10 Convair 880 turbojet transports, the airline has signed no contract for the purchase of turbojet or turbofan equipment. Now, however, the airline is leaning heavily in favor of the Boeing 720 turbofan transport, although the transaction has not gone beyond the discussion stages.

Budget Cut Effects

Congressional action cutting the Administration's overall Fiscal 1960 budget requests by $1,245 million should have little effect on 1960 expenditures, the Council of State Chambers of Commerce said last week. Changes made by Congress in defense appropriations will tend to increase 1960 expenditures, but will decrease spending in subsequent years, the group said, pointing out that although over-all defense funds were cut by $20 million, near-term spending items, mainly personnel costs, were increased about $100 million. Long-term procurement funds were reduced. —Washington staff

Defense Plans to Clarify Space Missions

Orders defining individual service roles expected; duties of NASA, Pentagon also may be reassessed.

By Evert Clark

Washington—Steps clarifying space responsibilities within the Defense Department and between the Pentagon and the civilian space agency are expected to follow the recent transfer of active space projects from Defense's Advanced Research Projects Agency to the individual military services (AW Sept. 28, p. 27).

Obvious organizational and technical advantages will result, but the attempts to untangle the confused military space picture also will be aimed at forestalling the political criticisms that an election year could produce.

Shaking down of the Pentagon space effort is interpreted as an overdue result of the most-recent Defense Department reorganization early this year, which was intended not only to streamline the department's operation but also to help settle the continuous problem of which service has what mission.

Since Air Force is emerging as the dominant service in the space field, it, in turn, is re-examining its own organizational structure to be sure that it is properly organized to handle its space missions.

Both the over-all organizational structure and the size and scope of the USAF space program were major topics of discussion at air staff meetings and at a conference of the chiefs of all USAF commands held at the Pentagon last week.

Although the Air Force has had a larger portion of the military space effort from the beginning, the recent transfer of projects generally is being interpreted by the services as a green light for USAF to expand its efforts even beyond the scope of the transfers.

This is expected to strengthen the hand of those within the Air Force who have been directly connected with the space programs, and who have felt that other elements of the Air Force did not fully appreciate the importance of space to the service's future.

An increase in space responsibilities, however, is not expected to affect the upcoming reorganization of the Air Research and Development Command, which is now awaiting approval of Air Force Secretary James Douglas. Since ARDC has been the closest USAF agency to the space effort, the reorganization plan already takes space missions into account. Most observers do not believe any increase in responsibility would require reorganization elsewhere in the Air Force, but the question is under examination.

Among the steps being taken to clarify the space picture are:

• **Preview of the organization** and management of missile test ranges and satellite tracking facilities. Defense Secretary Neil McElroy recently appointed Walker L. Cisler, president of the Detroit Edison Co., as a special consultant to conduct this review. Cisler has been touring facilities and receiving briefings by the services and National Aeronautics and Space Administration. The review is expected to take several months and could lead to employment of the "single manager" concept, giving one service responsibility for operation of the USAF-operated Atlantic Missile Range, the Navy-operated Pacific Missile Range and the Army-operated White Sands Missile Range.

• **Appointment of USAF** Maj. Gen. Donald N. Yates, commander of the Atlantic Missile Range, as Defense Department's agent for support of NASA's Project Mercury man-in-space program. Yates continues to head the Air Force Missile Test Center, of which the Atlantic range is a part. He has a Navy deputy—Capt. James G. Franklin, who is head of the Naval Ordnance Test Unit at the range—and reports to Defense Secretary McElroy through the Joint Chiefs of Staff.

Both of these moves are a part of the attempt to settle roles and mission controversies and to solve the extremely complex problem of "electronic bookkeeping" involved in detecting, identifying and tracking friendly and unfriendly missiles and satellites and conducting world-wide communications.

Navy recently proposed a Military Space Command, with the top two jobs to be rotated among the services. A major feature of the command would have been operation of the three missile ranges. Navy also proposed a joint task force to handle Defense's support of the Mercury orbital flights.

The assignment to USAF of the responsibility for development, production and operation of all military space boosters is being interpreted as a defeat for Navy on the space command proposal, and the appointment of Gen. Yates as Defense representative for Mercury support is considered a defeat for Navy on the second proposal. At present, Navy's primary area of responsibility is in the area of navigation satellites.

Army's future role in space is even less clear than Navy's, even though it has been assigned responsibility for development of a family of communication satellites, with USAF supplying the boosters.

Chief area of doubt is what will happen to Army's Ballistic Missile Agency, which was responsible for the early Explorer satellites and the Pioneer III and IV lunar probes.

ABMA lost a major round in its fight for existence when its Jupiter intermediate range ballistic missile was assigned to USAF for deployment and operation.

Its scientific and technical team escaped being taken over by NASA last year because Army fought hard to retain the team and won.

Defense has now said that USAF eventually will take charge of the Saturn booster being developed by ABMA. If this happens within the near future, it would give USAF control over something close to two-thirds of ABMA's budget. ABMA's workload now is divided with approximately one-third for USAF on the Jupiter; one-third for ARPA—most of it on Saturn—and the final third divided between Army and NASA work.

Army frankly fears that USAF will be given both Saturn and ABMA and that the dislike of each service for projects and hardware inherited from another service might lead the Air Force to abandon both eventually, in favor of its own space teams and projects.

NASA, once burned, apparently will not ask again for ABMA to be made a part of the civilian agency as it did last year. This leaves the future of the technical team headed by Wernher von Braun in doubt even if USAF or NASA should be directed to absorb ABMA. Saturn recently survived an attempt to kill it in connection with the preparation of the Fiscal 1961 budget. Since both military and civilian requirements exist for it, it apparently will continue.

Transfer of active space projects out of ARPA already has caused a decrease in criticism of that agency. ARPA was created shortly after Sputnik I, partly as a technical and political answer to concern over the Russian space challenge but also to circumvent roles and missions disputes such as the USAF Thor-Army Jupiter and USAF vs. Army anti-missile missile controversies.

It was subsequently criticized for dabbling too freely in what were considered to be development projects when its primary mission was very advanced research, and for appearing to parcel out space missions to each of the services more on a basis of keeping each service happy than on a basis of need or competence in a particular field.

Both Secretary McElroy and Herbert York, Defense Department director of research and engineering and former ARPA chief scientist, have insisted in recent months that ARPA divest itself of well-established projects and redirect its work toward advanced research.

Even ARPA's severest critics agree that the agency initiated some projects in both the research and development areas that the services were not able or willing to initiate. If it concentrates on advanced work that is not likely to be done otherwise, it apparently will continue to exist at least through the present Administration.

Meanwhile, the services expect further clarification of the project transfers announced two weeks ago and further steps to straighten out the lines of responsibility. All three still are privately expressing some dissatisfaction with the lack of clarity in the relationship between the military and the civilian aspects of space exploration and with the pace at which the civilian space effort is moving.

Since political critics of the Administration's handling of the space challenge have expressed the same dissatisfaction, this is the next major area that is expected to get top DOD attention.

New Lunar Schedule

Washington—Attempt to place a 370-lb. payload into orbit around the moon using an Atlas Able IV booster now is expected to be made sometime in a three or four day period beginning Nov. 28. Shot was scheduled for the Oct. 3-6 period but was postponed when the first stage of the launching vehicle exploded following a flight readiness firing of its first-stage engine (AW Sept. 28, p. 30).

Vehicle was an Atlas-C. Replacement probably will be the Atlas-D, left over from NASA's Big Joe tests.

Next favorable period for the launching begins Oct. 31 but does not allow enough time for preparation of the vehicle. Payload was not in place when the first vehicle exploded. Engines of the Atlas first stage had been closed down following a successful static firing at the Air Force Missile Test Center, but a rupture somewhere above the propellant cutoff valve allowed either fuel or liquid oxygen to leak, resulting in the fire and explosion. The project is being handled by Air Force Ballistic Missile Division and Space Technology Laboratories, Inc. for the National Aeronautics and Space Administration.



Navy Displays Zuni Rocket

Newest view of Navy's Zuni air-to-air and air-to-surface missile shows configuration details, with four-rocket weapons pod visible on F4D wing background. Zuni, produced by the Bridgeport Brass Co. at Riverside, Calif., can mount various types of warheads. One is general purpose type, another has armor-piercing capability and another is effective against aircraft in flight. The solid-propellant weapon was developed by the Naval Ordnance Test Station, China Lake, Calif. It can be fired singly, in pairs or salvoed.

Chance Vought Confirms SLAM Contract

Dallas—Chance Vought Aircraft, Inc., confirmed last week that it has an Air Force study contract for a low-altitude nuclear-powered intercontinental missile system which can deliver nuclear weapons "anywhere on the globe with extreme accuracy."

The company, confirming earlier reports (AW April 20, p. 33) of its work on Project SLAM (Supersonic Low Altitude Missile), stated that study thus far has convinced it of the feasibility of the nuclear-powered missile and its value as a deterrent weapon in the U. S. defense arsenal. Indications of its enthusiasm for the project is reflected by the fact that Chance Vought has made a considerable outlay of its own funds in follow-up activities on the original USAF-financed study contract. Project SLAM would be powered by a nuclear-powered ramjet engine, giving it virtually unlimited range. A propulsion system study designated Project Pluto is under way to determine the feasibility of applying heat from nuclear reactors to ramjet engines in a combined effort involving the Atomic Energy Commission's Lawrence Radiation Laboratory, Livermore, Calif., North American Aviation's International Division and Marquardt.

North American Aviation, Inc. and Convair Division of General Dynamics Corp. also have similar USAF study contracts. North American proposal is designated Bolo. Convair's is know as Big Stick.

Space Technology

Lockheed Builds WS-117L Nerve Center

Washington—Nerve center for Air Force's WS-117L advanced reconnaissance system is being established at Sunnyvale, Calif., to serve as a focal point for collection and evaluation of data inputs from remote tracking and telemetering-reception centers tied in with the system's scanning satellites which are scheduled to orbit in a north-south direction to cover the world.

WS-117L's optical reconnaissance satellite phase of the program is now known as Samos (formerly Sentry). Infrared early warning satellite will be known as Midas. Early satellite trials with the optical phase are projected to recover the film from orbit by accurate re-entry trajectory and parachute let-down (AW May 25, p. 26).

A building already is under construction at Lockheed Missile and Space Division's Sunnyvale site to house the new WS-117L facility, which is officially designated a development control center.

Lockheed is system prime contractor for the WS-117L.

Radiation, Inc., Role

Equipment for the center is being designed and built by Radiation, Inc., Melbourne, Fla., under a letter contract from Lockheed which was awarded after an industry competition.

Scheduled to be manned by an Air Force-Lockheed team, the center is projected to represent a considerable advance in human engineering state-of-the-art as related to display, interpretation and fast use of intelligence from orbiting satellites.

Requirement for the development control center was generated early in the WS-117L weapon system program, but implementation of the facility was delayed until recently, probably because of the relatively sparse and tenuous funding the over-all reconnaissance project has received.

Observers close to the program feel that the development center's capabilities would fit the development and operational phases of the Air Force Dyna-Soar boost-glide vehicle now under study by both Boeing and Martin, although it is not scheduled specifically for use with this system. It is likely, however, that if Dyna-Soar is brought to the development stage of actual vehicle flight, the development center will be used to track its trajectory and receive its radioed signals from space.

Primary feature of the development control center probably will be a visual readout capability, presenting on a very wide, curved screen the satellite tracking and instrument-measurement information collected by remote relay stations around the world and fed almost instantaneously to the central development control center at Sunnyvale.

Reason for the visual readout requirement will be to permit fast, intuitive decisions to be made in the successive programing of the orbiting reconnaissance satellite with respect to its data-gathering function or trajectory aspects. Ultimate refinement of the optical capability of the advanced reconnaissance system's Samos version, including direct transmission of pictures to a ground station, as well as the Midas infrared scanning version should emphasize the control center's value.

Pictures of the earth already have been relayed from National Aeronautics and Space Administration's Explorer VI elliptical-orbit satellite carrying a facsimile television camera (see p. 29). WS-117L Samos optical capability, however, is projected to give considerably more photographic definition in order to meet reconnaissance requirements. Systems to give considerable refinement already are under extensive study.

Under the operational plan for the development control center, data from remote tracking and telemetering and reception centers would be relayed to the Sunnyvale site, where automatic equipment would process it for feeding to a battery of camera-type projectors aimed at the wide-angle screen. Each projector probably would cover only a portion of the screen so that the total projection capability would cover the entire screen. In this way, a particular projector could display data such as altitude, temperature, velocity or other related satellite information on a particular segment of the screen.

Corrective Action

USAF-Lockheed specialists, trained to read this satellite information and initiate whatever corrective action or quick decisions may be required, would view the screen presentation, with each man charged with the task of monitoring a specific portion of the visual readout.

A single observer probably will not be required to look at the entire screen for the particular segment of intelligence in which he is interested. Each observer probably will have an individual small-screen console at his particular station so that he can concentrate on one particular phase of the intelligence being received from the satellite. He also probably will have the capability of eliminating one presentation and tuning in another, much in the same fashion that television channels are switched on a home-receiver today.

Decisions relating to the satellite could be relayed from the development control center to the remote stations which have the command capability to affect satellite conditions at specific portions of the trajectory. In the same way, remote stations could be alerted to watch for new orbital factors which might be fed to the satellite from the control center itself.

While the development center building probably will be completed before the end of the year, it is unlikely that it will be fitted with equipment for a complete systems checkout before early next year.

Tracking Sites

It also is improbable that a complete chain of tracking stations for the WS-117L advanced reconnaissance system will be ready before at least another year. Stations in the chain probably will include two sites in Alaska, with others in Hawaii, New England, the United Kingdom, Turkey and North Africa, although the latter two sites have not yet been contracted.

These same tracking sites could be earmarked for Dyna-Soar but are not now programed for it.

The launching pads for WS-117L rockets at the Navy's Pt. Arguello, Calif., site probably won't be ready for at least another six months. For this reason, if any WS-117L test firings are attempted earlier than pad-readiness at Arguello, it is likely that these first trial launchings will be made from the Air Force Missile Test Center, Cape Canaveral, Fla.

Meanwhile, Eastman Kodak's Research and Development Division is pushing work on the camera for the Samos version of the WS-117L reconnaissance system. Specialist personnel from Lockheed Missiles and Space Division have been collaborating with Eastman at the latter's plant for the past few months.

The camera will be gimbaled for pointing and probably will be activated by radio command from a ground station. It will be contained in the satellite sphere, which will measure somewhere between three and four feet in diameter. Camera sighting will be through an elliptical window measuring about 12 in. along its major axis. The entire unit may be ready for test within the next few months.

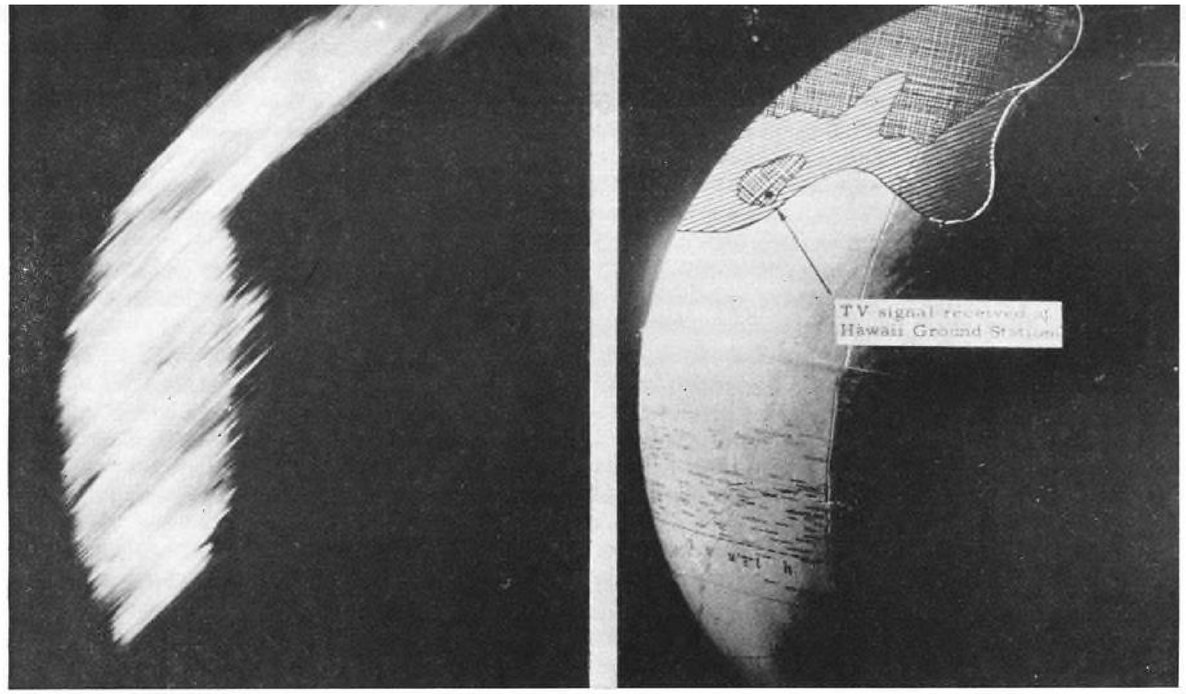


IMAGE of central Pacific Ocean, though crude, demonstrates feasibility of satellite picture transmission. NASA interpretation is at right. Weather key is: dark cross hatched area represents overcast (100% cloud cover); lined area represents broken to scattered clouds; unmarked area is clear or scattered clouds.

Space Technology

Explorer VI Reveals New Radiation Data

By Craig Lewis

Washington—Early data from National Aeronautics and Space Administration's Explorer VI satellite is revealing new radiation patterns, including a high energy band near the earth, as well as demonstrating the feasibility of relaying pictures from space vehicles.

NASA and its contractors are still in the preliminary stages of processing and analyzing the large amount of data already transmitted from Explorer VI, and only tentative conclusions have been drawn. But scientists are generally highly satisfied with the data the satellite is gathering from the broad space region it traverses in its elliptical orbit.

Orbit Estimates

Present estimates indicate Explorer VI will stay in orbit for at least a year, and probably much longer, although it is not known how long the telemetry equipment and experiments will continue to function. Orbit analyses indicate the moon's gravitational field causes variations as high as 50 mi. at apogee and 5 mi. at perigee in the satellite's orbit, depending upon its position relative to the moon.

Malfunctions in the solar power and transmitter systems have impeded data transmission slightly, but information has been transmitted from all the experiments. Analog transmitter telemetering on 108.06 mc. has failed, but the 108.09 mc. analog transmitter is still broadcasting as is the digital transmitter operating on 378 mc. Analog and digital systems are redundant, so all experiments report data on the digital system, and half of them are reporting duplicate data on the one analog transmitter which still works.

Although the digital system is reporting data from all experiments, its transmission are impened somewhat by a malfunction of one of the paddles. One of the arms failed to extend fully and lock during the launch, and its solar cells are not producing their planned share of power for the satellite batteries. Since the paddle which failed is in a vital position in relation to the sun, the system is only producing about 65% of the power expected, but this percentage will improve as satellite orientation to the sun changes and other paddles get better exposure.

The imbalance resulting from the paddle malfunction caused the satellite to precess, but it damped out relatively quickly to a new spin axis which is about 8 deg. away from the original spin axis. Power loss from the paddle malfunction means that the digital transmitter cannot be run as much as planned, but NASA obtained full backup data from the complete analog system about 20 hr. per day for 35 days before one of the transmitters failed. Four ground stations are used for telemetry, and there is some difficulty getting data from the satellite when its perigee falls between two stations. NASA tried to use the Minitrack net to fill in some of these gaps, but that approach has not been too successful.

Radiation Data

Preliminary analyses of radiation data indicate more complex and detailed patterns than those outlined in the Van Allen belt maps. It shows a pattern of higher energy particles near the earth, with energy declining as distance from the earth increases. General pattern is one of lower intensity but more penetrating radiation close to the earth—less penetrating radiation but greater intensity as the altitude increases.

Radiation picture emerging from preliminary Explorer VI data indicates a continuous radiation field extending away from the earth with peaks of particular types of radiation at certain altitudes rather than the more distinct radiation belts associated with the Van Allen pattern. Explorer VI data has the advantage of continuous reading across

a wide altitude range, while earlier data was pieced together from data obtained from satellites nearer the earth and space probes that made only one trip through the regions farther from the earth.

One new piece in the pattern is a proton belt discovered inside the inner Van Allen belt. This high energy belt is a narrow proton band 310 mi. thick and centered about 20 deg. from the geomagnetic equator and at an altitude of about 1,250 mi. Data was taken from instruments which measured protons of 75 million electron volts or greater and electrons of 13 mev or greater. Peak counting rate was 1,400 counts per square centimeter per second.

Shielding Question

This proton belt presents no major new shielding problems since a space vehicle traveling at high velocity would be through it quickly. Also, the fact that Explorer VI failed to record data from the belt on one pass indicates it may span only about 40 deg. of altitude.

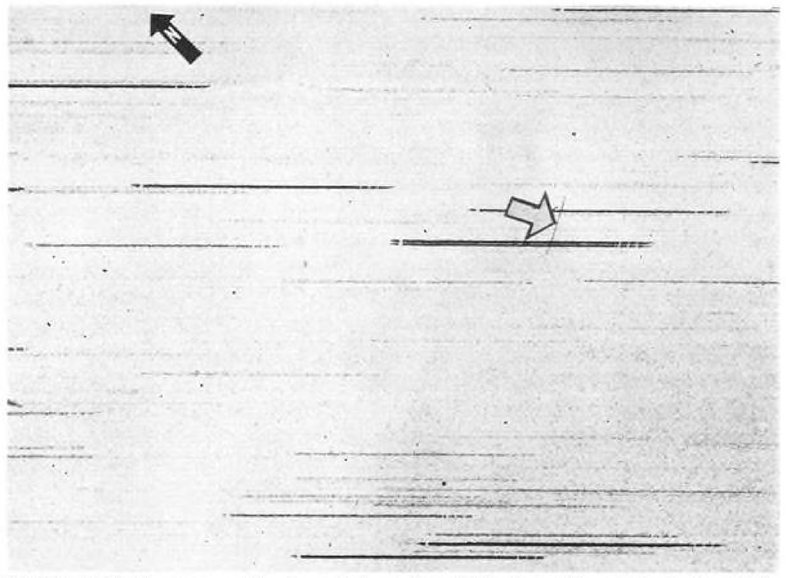
Past the proton band, readings taper off to essentially zero level beyond about 2,500 mi. and out to the satellite's 26,000 mi. apogee. Dr. John Simpson of the University of Chicago concludes that "in the vast outer radiation region which contains the vast amount of low energy radiation, there are no energetic particles of proton energies greater than 75 mev or 13 mev for electrons."

Explorer VI contains a Geiger counter similar to those in the Pioneer III and Pioneer IV space probes, giving a correlation with that earlier data. Early Explorer VI data shows radiation intensity dropping faster and lower than the measurements made by the two Pioneers and the Soviet Mechta solar satellite. According to Dr. John R. Winckler of the University of Minnesota, Explorer VI measured radiation intensities at extreme altitudes which were about 10 times lower than those found by Pioneer III and 5,000 times less intense than the Pioneer IV readings.

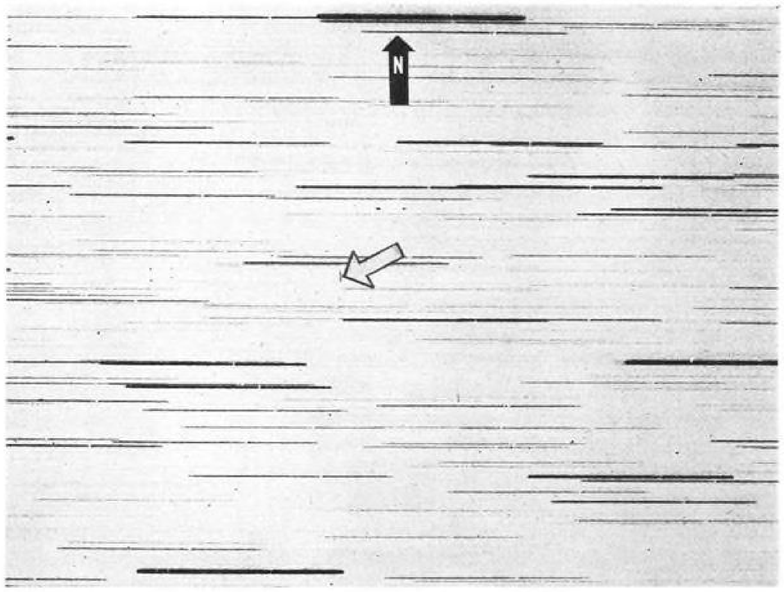
Radiation Pockets

Preliminary analyses of later Explorer VI data indicated that radiation intensity at very high altitudes began to increase and approached the levels measured by Pioneer III. Explorer VI also detected pockets of radiation at extreme altitudes which appear and disappear.

The beginning of the increase in radiation level coincided with observation by radio astronomers of a long-lasting radio noise storm originating on the sun, according to Dr. Winckler, and there appears to be a connection between the solar outburst and the increase in radiation. Winckler said that one theory is that the radio noise storm was generated by electrons in the solar corona, and that there is an interesting correlation in the fact that the radiation which suddenly appeared in the exposure of the earth apparently consisted of electrons with approximately the same energy.



WHITE ARROW above points to rocket carrier of Explorer VI paddlewheel satellite (short diagonal line) in this first photograph of the satellite made by the Smithsonian Photographic Satellite Tracking Station, Arequipa, Peru. Time exposure of about 35 sec. was made when the carrier was in the constellation Eridanus. Below, station photographed the actual paddlewheel satellite (white arrow) in the constellation Grus. Very bright star trail at top of photo (dark, heavy lines) is Beta Grus. Satellite was traveling in southwest-to-northeast direction.



Very low energy radiation in the radiation belts is measured by a scintillation counter in Explorer VI which is activated by electrons with energy greater than 200 kev or protons with energy greater than 2 mev. On days of relatively low solar activity, peak intensity measured was greater than 100 million particles per square centimeter per second, but on Aug. 20, maximum intensity increased by a factor of 10 to 100 over the maximum on quiet days, according to Dr. Alan Rosen of Space Technology Laboratories.

No simple, direct correlation between increased intensity and solar activity has been determined. There was high solar activity and an intense magnetic storm on Aug. 16, but there was no corresponding increase in radiation intensity that day. However, there was a definite increase a few days after the magnetic disturbance.

Data from 140 passes through the radiation field is being used to map out the low energy radiation zones. Dr. Rosen said preliminary analysis shows the low energy zone has a gross structure similar to the Van Allen pattern. Fluctuations of intensity in the inner and outer zones indicate that both zones are considerably more complex than previously indicated.

Image of the earth transmitted by Explorer VI (see p. 29) was very crude, but it proved the feasibility of using video techniques to get pictures of the earth, the moon and other bodies and from equipment in space vehicles. The image was made while the satellite was about 17,000 mi. above the earth and opposite the longitudinal meridian of Mexico City. It shows the crescent of the central Pacific Ocean illuminated by the sun at the time. A map of cloud cover in the area drawn from corresponding meteorological data indicates to NASA that there is a very rough correlation between the satellite's picture and actual cloud conditions.

Satellite used the very small video bandwidth of 1.5 cycles per second, and it took 40 min. to transmit the picture. Commercial television uses a four million cps. bandwidth and transmits a complete picture in 1/30 of a second.

Explorer VI is spinning at about 2.5 rpm., and the scanner records a dot for the picture on each revolution as it detects the sunlight reflected by the earth and its cloud cover. Each line in the picture is composed of 64 of these dots.

The dots are recorded in one of eight levels of light intensity, and a computer in the system advances the dot in each scan so it won't record the same point each time.

NASA has more pictures, but Dr. Charles Sonett of Space Technology Laboratories said it is difficult to determine how many there are or what quality they possess. The Explorer VI orbit is designed for magnetic field and radiation work rather than to provide the best opportunities to get good television images, and the video equipment was flown primarily to see whether it would work well enough to be considered for future space probes.

Magnetometer complex in the satellite produces data that will require considerable time to reduce and analyze. A large ring of charged particles circulating around the earth and producing an added magnetic field has been a matter of theoretical interest and was observed by Mechta at an altitude of about 8,700 mi. Thus far, Explorer VI has not detected such a ring, nor has it detected any difference in the inclination or the crossing points of the planes of the geographic and magnetic equators as measured on earth and high altitudes.

Explorer VI measures micrometeorite impacts with a sensitive crystal microphone held against a flat plate on the satellite shell. Between launching Aug. 7 and Sept. 1, 56 impacts were recorded of particles with a radius of 1.8 microns or more. System can also detect separately particles larger than about 4.4 microns, and two particles of this size impacted the plate.

Herbert A. Cohen of Air Force Cambridge Research Center said there is a possibility that the satellite detected a meteor trail. There were 16 impacts during a 12 hr. period on Aug. 7 and 8. The rate of impact then decreased quickly to half that level. There is a possibility that these particles came from the Perses meteor stream, and the data could provide information of the age of the stream.

Intense X-Ray Radiation Detected By Rockets During Solar Flares

Washington — X-ray radiation with sustained energy levels as high as 80,000 electron-volts, many times larger than any previously detected, has been measured at altitudes of about 140 mi. above the earth during solar flares, Naval Research Laboratory scientists disclosed here last week. The X-rays produce changes in the ionosphere which disrupt long-range high-frequency radio communications during solar flares.

The new data suggests that temperatures in the solar atmosphere may be as high as 100,000,000C, many times hotter than the sun's surface. Measurements also show that even a quiet sun emits a broad spectrum of X-rays, covering the spectrum of energy levels, but with very low flux densities.

Measurements were made recently using a series of eight Nike Asp rockets, fired from Point Arguello, Calif., on the Pacific Missile Range under a program known as Project Sunflare II. The program, sponsored by the National Science Foundation as part of the International Geophysical Cooperation—1959, was aimed at providing a better understanding of the basic mechanism responsible for solar flares.

The Nike Asp rockets, equipped with extremely sensitive scintillation counters, were able to detect X-rays of extremely low flux density encountered in the vicinity of the earth. Soviet Sputnik III failed to detect these X-rays during a period of strong solar flares in June, 1958, since the threshold of its scintillation counters was about 100 times higher than those employed in Project Sunflare II. Earlier U.S. measurements made in Project Rockoon (rockets launched from balloons) in 1956 disclosed the presence of X-rays, but it was not possible at that time to firmly establish that they came from the sun, nor could their energy level be accurately determined.

One theory on the cause of solar flares advanced by Soviet scientists suggests that they may be produced by a magnetic pinch effect similar to that being attempted by scientists to produce controlled thermonuclear (fusion) power (AW Aug. 24, p. 34). If this theory is correct, the solar flares should produce X-rays with energies as high as several million electron-volts in the first few seconds of the burst, according to Dr. Herbert Friedman, head of NRL's Atmosphere and Astrophysics Division. One measurement made by University of Minnesota scientists disclosed a brief burst of X-rays with energies of about one-half million electron-volts.

Another theory suggests that electrons in the sun's atmosphere, accelerated to relativistic speeds by changes in the sun's magnetic field in the vicinity of sun spots, produce X-rays by a process similar to that employed in the synchrotron particle accelerator.

One method of checking the validity of the different theories is to obtain an accurate measurement of the spectral energy distribution of the sun's X-ray emission, since a markedly different distribution of X-ray energy would be produced by the different mechanisms.

It is difficult to obtain such data using sounding rockets because at present it is impossible to predict when a solar flare will occur and because of the several minutes required to launch and get a rocket above the earth's atmosphere.

For this reason, astrophysicists are anxious to use a satellite to make continuous measurements in order to measure the initial burst of radiation from a flare. The recently launched Vanguard III, which has one scintillation counter aboard, will provide more data than all the previous measurements made by rockets. However, the Vanguard instrument can measure X-rays only over a limited range of energy levels.

Dr. Friedman estimated that a 50 lb. payload could provide sufficient instrumentation to cover the full range of X-ray energy levels of interest to scientists. He said that National Aeronautics and Space Administration has been approached and has authorized $100,000 for laboratory experimentation. NASA, however, has not yet authorized a full program.

Air Force Seeks Improved Cost, Contract Controls in Procurement

Los Angeles—Contractors must give the U. S. Air Force "more defense per dollar" or incentive type contracts may be discontinued, Lt. Gen. Mark E. Bradley, deputy chief of staff for materiel, told the Los Angeles Chamber of Commerce last week.

He added: "Even though 1959 was a bad year for procurement . . . 1960 will be even rougher."

Gen. Bradley cited these ways in which industry can cooperate with the Air Force and give taxpayers a better break on defense expenditures:

• **Improved management** and cost control (AW Sept. 14, p. 26). "Management must give this problem of getting the most for every dollar its closest attention. But it appears from congressional hearings and General Accounting Office audits that, collectively, the defense supporting industry has not given this matter the required study. The Air Force is not questioning the integrity of industry. But it is looking with some doubt on industry's management procedures. Increased pressures for reduced budgets in defense and increased complexity in costs of our future weapons require that industry cooperate in enforcing the most rigid controls on costs."

• **Target prices** must be based on current and completely accurate information. "If you give us inaccurate or out-of-date information, you defeat the purpose of the incentive type of contract," Gen. Bradley said. "It is up to companies to give each other and the Air Force negotiators proper and up-to-date prices. If we don't get better cooperation in this respect, we may be forced to discontinue using the incentive type contract. We would rather not do this." He continued:

Contractor Certificate

"The Air Force requires contractors to provide a certificate attesting to the accuracy and currency of cost information. "We don't like to require such a certificate—it increases our work as well as yours—but recent audits and investigations have clearly shown that some such mechanism is necessary for everyone's protection. In the revision of the Armed Services Procurement Regulations, this requirement will be extended to include all first-tier subs where the sum involved is over $100,000 and where there is no effective competition. We have recently increased our audit staff substantially."

"Gold-plating" is another reason why defense expenditures have risen so sharply in recent years, he contended. "We have gone too far in the direction of super-fancy equipment which does everything. It's too much to expect every piece of equipment to do every possible job. Our bomb navigation systems are a good example of this. We have designed them to do so much that they have become not only too expensive, but sometimes almost impossible to maintain.

"It's true that some enthusiastic people in the Air Force have asked for this kind of design, but we ask industry to help us by making a definite effort to hold the line against such over-complication. We ask you to hold back on items that your engineers or individuals in the Air Force may request until you are absolutely convinced that these are necessary. On your part, produce simple designs for us, produce items that are easy to maintain and less costly to maintain. Modern weapon systems are so costly in themselves that we can't afford to let any unnecessary costs creep into the price. We don't want to let costs run us out of business."

The general stressed reduction of overhead by trimming excess manpower and facilities, noting: "I suspect that many of our contractors are holding on to expensive technicians and facilities which they acquired to meet programs of a magnitude which we no longer have and which I think we will never again have. We have dropped off from 1944 production of 95,272 military aircraft to an estimated figure of 1,900 missiles and aircraft in 1960.

"As these production runs have decreased, direct labor hours have also decreased. Yet overhead expense continues to rise. I cannot emphasize too strongly that industry working for defense must take a realistic view of personnel and facilities—those things that make up overhead—and retain only what is needed for the job at hand.

"They must face the fact that the good old days of the '40s' are gone forever."

Gen. Bradley also said that the Air Force wants even more defense money to find its way to small business. In Fiscal 1959, $920 million in prime contracts went to small business, a 22% gain over Fiscal 1958. Even though more than 25% of the dollars the Air Force places with prime contractors are subcontracted to small business, the Air Force would like to see the percentage increased, he said.

Budd Co. Moves Into Avionics Field

New York—Budd Co.'s acquisition last week of the Lewyt Mfg. Co. of Long Island City, N. Y., is another consolidation in what may become a growing trend in the avionics field.

The straight cash purchase, revealed by Budd President Edward G. Budd, Jr., at a New York Society of Security Analysts meeting, does not include a second—and younger—Lewyt company which makes vacuum cleaners and other home appliances.

There have been a number of avionic mergers and consolidations such as that of Stavid Engineering, Inc., and Lockheed Aircraft Corp., the final papers of which were signed last week. Some consumer companies also are known to be disillusioned with the electronics field because of the high research and development expense necessary and are ready to sell subsidiaries (AW Aug. 24, p. 23).

This was not exactly the case for Lewyt, according to the former owner, Alex Lewyt, who will remain as president of Budd Lewyt Electronics, Inc., the new wholly owned Budd subsidiary. His reason for selling:

• **Electronics business** is moving so fast that a company has to run at top speed to just hold its relative position.

• **Lewyt Mfg.** needed money and facilities to keep up in the race.

Lewyt told AVIATION WEEK the company could have gone into the money market itself. However, it also needs facilities and by joining with Budd it can draw on Budd facilities available now rather than wait for construction and also will have Budd's capital resources for backing.

If Budd Lewyt were to enter the large antenna field, Lewyt said, it might, for example, be able to draw on Budd's Railway Division facilities which could handle this sort of fabricating and which are feeling the decline in the railroad car business.

The vacuum cleaner business was an outgrowth of the basic Lewyt business, which originally was in the electric field and later in electronics.

For its part, Budd believes the Lewyt acquisition will:

• **Provide an excellent investment** in a corporation with established manufacturing and research capabilities and with potential growth possibilities.

• **Improve Budd**'s corporate earnings.

• **Tie in well** with several of Budd's divisional activities and plans in the defense field.

Budd told the analysts that Lewyt Mfg. is the reverse of most avionic companies in that it is primarily a manufacturing company, secondarily a scientific research laboratory. Or as Lewyt put it later, it is not a group of scientists surrounding an underwriter.

Lewyt's Fiscal 1959 sales were $12 million, virtually all to the government. It has a backlog of $24 million. It is a major contractor for the SAGE display system and for USAF's 433L weather system, which United Aircraft is managing (AW July 20, p. 70).

Though he does not necessarily agree that the trend in avionics is toward fewer and bigger companies, Lewyt said he felt this was a point to be considered.

Budd's Defense Division ranks third in volume in the company, Budd told the analysts. The company hopes to gain new business, particularly in advanced metal fabrication, but is primarily interested in contracts in which it can do the primary engineering and building of high strength, light, heat resistant sheet metal structures. Budd said the company had successfully fabricated and welded beryllium, which he called the most interesting of the exotic metals because of its lightness and high modulus of elasticity. The company also has worked with titanium, columbium, tantalum, molybdenum, zirconium and hafnium, he added.

NASA Flight Research Centered at Edwards

Washington—National Aeronautics and Space Administration is concentrating all high speed aeronautical flight research at its Edwards AFB facility which has now been renamed the NASA Flight Research Center.

NASA is reorienting its high speed aircraft research to move it away from congested airlines and heavily populated areas and to save money by concentrating it at one facility. The move also reflects the decline in military and industry interest in high-speed aeronautical research.

Langley Research Center and Ames Research Center will continue to conduct flight research in the low speed range, largely with VTOL and STOL aircraft, and Lewis Research Center will continue its small-scale flight program with low-speed propeller and turbine aircraft. The Lewis program includes zero gravity research.

The Edwards facility, formerly designated the High Speed Flight Station, has been used for high speed flight research for several years, especially with the family of advanced research aircraft which included the X-1 and X-2 and has now moved on to the X-15. NASA is currently studying high speed programs at Ames and Langley to determine which of its high performance aircraft will be shifted to the new Flight Research Center and which of them will be returned to the military services.



Kaman H-43B Exhaust System Modified

Kaman Aircraft Corp. has modified exhaust system on its turbine-powered H-43B helicopter to eliminate rotor blade turbulence caused by former short-stack "sugar scoop" tailpipe. New tailpipe extends past tail section and is turned downward slightly; engineers say extension adds 80 lb. thrust and downturn acts as trim to combat nose-up tendencies when power is applied to rotors. In addition, helicopter now can be loaded from rear clamshell doors while rotors are turning. Powerplant is Lycoming T53.

Contract End Clouds T61 Future

Washington—Air Force contract for the development of the 6,500 shp. Allison T61 turboprop engine expired last week and continuation of the approximately four-year-old project with either company or government funds is still under consideration. Four test T61s were running on the test stand when the contract expired, according to company officials.

The T61 is the projected powerplant for the Lockheed Super Hercules which has been the strongest turboprop contender in both the military and civil air freight market. A decision to buy either turboprop or turbojet freighters to modernize the Military Air Transport Service has been deferred until the next session of Congress, leaving the future of the Super Hercules and T61 programs in doubt.

Commercial interest has been shown in the aircraft-engine combination with Pan American World Airways and Slick Airways tentatively ordering a total of 18 Super Hercules. These orders are not binding on the manufacturers or the airlines since no military orders were received by Sept. 30, a stipulation spelled out in both commercial contracts.

Prices in the contracts were based on the assumption that Air Force purchases would lower over-all costs.

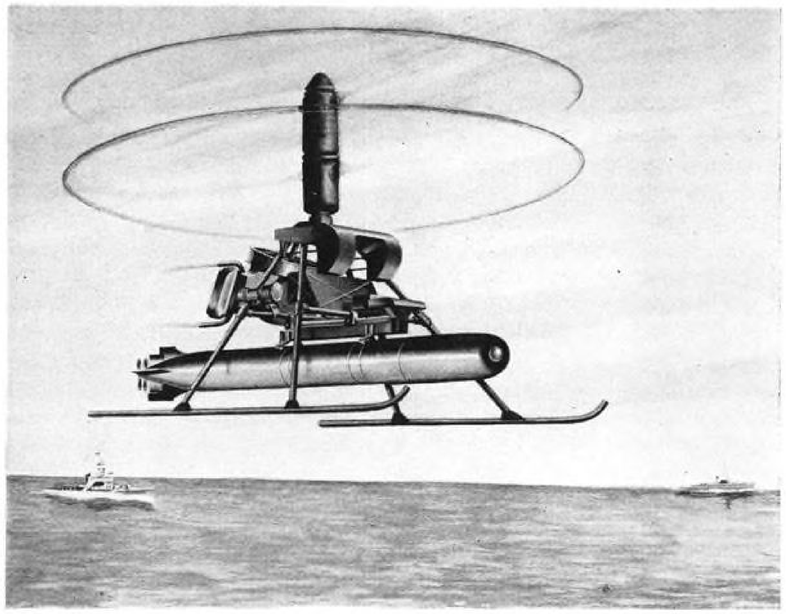
The T61 superficially resembles the Allison T56, although the new engine has a split compressor section rather than a single stage.

The T61 weighs 2,240 lb. and has an improved power-to-weight ratio of 30% over the T56. Guaranteed fuel consumption of the T61 at normal power is .51 lb. per hp. per hr. at 35,000 ft. and a speed of 320 kt.

A propeller for the T61 is under development by the Aeroproducts Division of Allison under a $4 million Air Force contract which is still in force.

Allison T61 Specifications

Ratings	Equiv. shp.	Prop. shp.	Jet th. lb.	Min. sfc. lb./hp./hr.	Inlet Temp. (F)
Takeoff	6,500	6,102	995	0.500	1,855
Military	6,235	5,873	905	0.505	1,855
Normal	5,635	5,294	853	0.515	1,775
Cruise (90%)	5,070	4,770	750	0.535	1,735
Cruise (75%)	4,225	3,966	647	0.560	1,650



Gyrodyne DSN-1 Drone Helicopter

Artist's conception of Gyrodyne DSN-1 drone helicopter prototype, developed by the company in line with its management of DASH (Destroyer Anti-Submarine Helicopter) weapon system. Drone is aimed at delivery to USS Hazlewood before the first of the year for test evaluation. Prototype, first flown last winter, has a total of about 100 hr. to date with safety pilot aboard. It will fly without pilot when Gyrodyne completes its new tethering rig this month. DSN-1 will carry a homing torpedo. Company also has Navy contract for DSN-2 which will carry different weapon in different configuration. Prototype powerplant is Porsche GP-702/2, used in Gyrodyne's YRON-1 rotorcycle. No contract has yet been received for the company's DSN-3 drone.

B-58 Launches ALBM In Trajectory Test

Washington—Air Force fired an air-launched ballistic missile from a Convair B-58 at Discoverer V shortly before the satellite was scheduled to re-enter the atmosphere and burn, but the test failed because of telemetry problems.

The B-58 launched an air-launched ballistic missile test vehicle over the Gulf Coast Test Range at Eglin AFB, Fla., in the direction of Discoverer V. Test was made to obtain data on the trajectory of an ALBM, but it failed when the missile failed to telemeter information on the flight.

Later, the Air Force canceled a similar test scheduled with a Boeing B-47 from the Atlantic Missile range. The B-47 was to fire a test vehicle into the vicinity of Explorer VI to refine guidance data on the ALBM trajectory. Since the precise orbital position of the satellite was known, an accurate measurement of the miss distance could have been made. Measurement was to have been made both from the missile and through tracking data from ground stations. The B-47 test also was designed to provide information on the use of a very high incidence angle at launch. It was postponed for technical reasons.

ALBM test vehicle fired by the B-58 was an experimental missile built for Convair Division of General Dynamics Corp. by Lockheed Aircraft Corp. and using a Thiokol Chemical Corp. solid propellant motor and a North American Aviation guidance system. The B-47 was scheduled to fire a Bold Orion solid propellant vehicle built by the Martin Co. and using a Martin guidance system.

News Digest

Ramo Wooldridge Division of Thompson Ramo Wooldridge established an intellectronics laboratory last week headed by John M. Salzer. Work already in process includes approaches in automatic translation of languages and design of electronic information processing systems to aid the military.

Convair Division of General Dynamics Corp. named Harvey C. Tafe to the position of director of foreign sales-military last week. Convair also appointed Clifford E. Laechelin foreign military sales representative in Washington and Charles W. Tuck European military sales representatives with headquarters in Geneva, Switzerland.

McDonnell Aircraft Corp. has received a $137.6 million second production contract from Navy for the F4H-1 all-weather fighter.

Lockheed Aircraft Corp. last week received a $67.8 million contract for production of the P3V-1, Navy anti-submarine warfare patrol plane version of the Electra turboprop transport. New contract amends a $10.4 million pre-production contract awarded Sept. 19, 1958, for preliminary design, engineering and long lead time items.

North American Aviation has completed purchase of Astrodyne, Inc., (AW July 20, p. 28) and has merged it into the parent firm. Solid propellant operations of Astrodyne at McGregor, Tex., will be continued there as part of North American's Rocketdyne Division. Thomas E. Myers, former Astrodyne vice president, has been appointed manager of Rocketdyne's Solid Propulsion Operations.

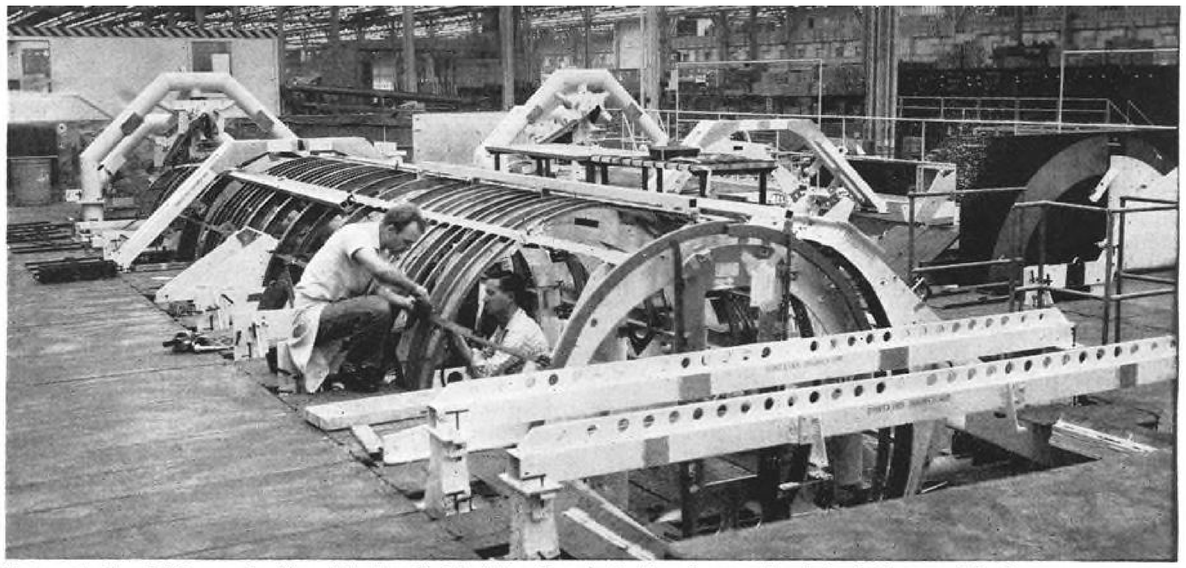
Modernization program on early production F8U-1 and F8U-1P Crusaders, costing $9.5 million, has been awarded to Chance Vought Aircraft, Inc., Dallas, Tex. Modification, involving 147 F8U-1s and 17 F8U-1Ps will involve installation of new liquid oxygen, electrical, fuel transfer, hydraulic, escape and control systems and calls for inducting 11 aircraft monthly through February, 1961. An earlier program, started January 1958, involves 103 airplanes.

Aerojet-General Corp. has been awarded an $8 million subcontract from Grumman Aircraft Engineering Corp. for development of a high-performance propulsion unit for Navy air-to-air Eagle missile.

Production contract worth $11,355,000 for the Westinghouse J34-WE-48 turbojet engine has been awarded by U.S. Navy for use as powerplant for the North American T2J jet trainer. Aircraft is scheduled to enter regular training schedules this month.

William G. Key will resign Nov. 1 as director of public relations of Fairchild Engine & Airplane Corp.

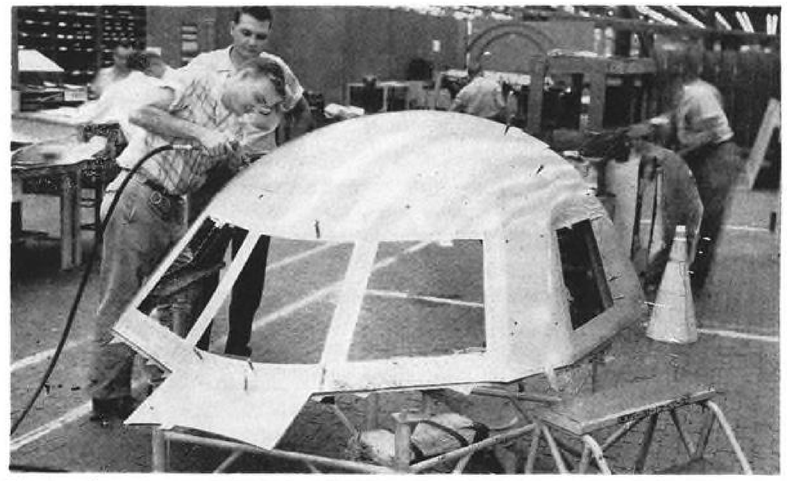
West Germany will support development of two twin engine medium-range civil jet transports. A draft calling for $14 million will be submitted to the German cabinet this month. The two types were selected out of 13 German designs. One will be an 80-passenger plane, the other 23.



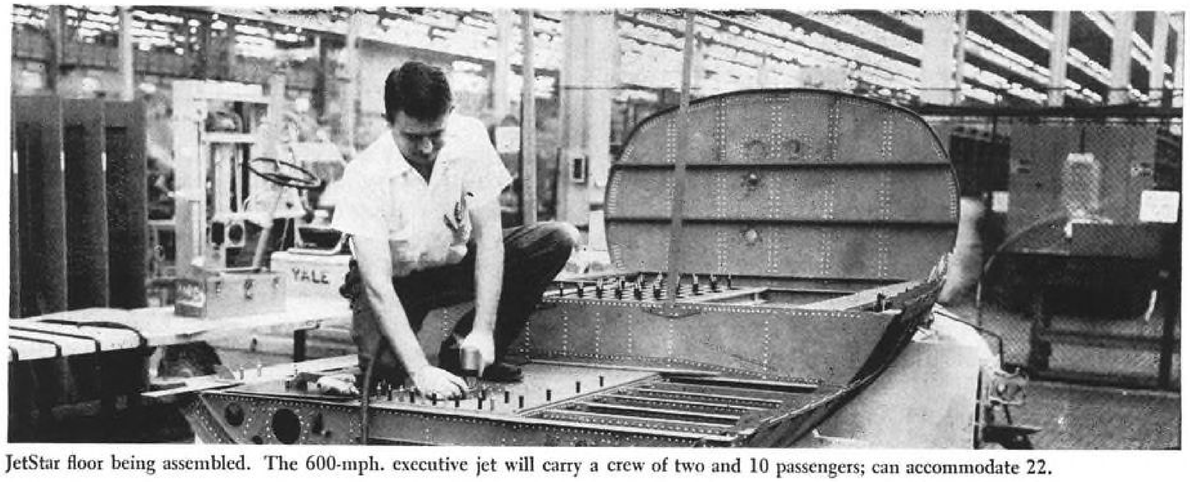
First production JetStar on the line at Lockheed's Marietta, Ga., plant. Here is assembly of the jet transport fuselage.

Lockheed JetStar Production Models Take Shape

Fuselage of Lockheed's first production JetStar now is in the mating jig at the Marietta, Ga., plant. On the line are subassemblies for the first three production aircraft. Lockheed, which has firm orders for 30 of the 600-mph. executive jet transports, expects to have the first production model flying in July of 1960. First aircraft, not a certificated airplane, will be delivered to Pratt & Whitney Aircraft next fall. Company will install its own JT12 engines and, following engine tests, will later return the JetStar to Lockheed for certification. First certificated aircraft, powered by four of the JT12s, will go to Continental Can Co. in January, 1961. The 10-passenger jet transport will seat 22 in high density configuration. Pressurized cabin will hold to 8,000 ft. at flight altitude of 45,000 ft. Landing weight of production aircraft has been increased to 28,000 lb. compared with 21,000 for the two prototypes.



Riveting the cab top of the JetStar CL-329. Length of pressurized cabin is 257 in.



JetStar floor being assembled. The 600-mph. executive jet will carry a crew of two and 10 passengers; can accommodate 22.

Management, Pilots Split on FAA Plan

Proposed changes in training program, age limits could affect airline profits and income of pilots.

By Robert H. Cook

Washington—Series of proposed rule changes regarding pilot training and jet transitional age limits and establishing a mandatory retirement age for airline pilots is creating a widening gap between airline managements and their pilots.

Outcome of the regulation amendments proposed by the Federal Aviation Agency and designed to improve flight safety, could affect both the airline profit picture and the potential earning powers of the pilots. Essentially, the amendments would:

- **Set a mandatory retirement** age of 60 for airline pilots.
- **Limit airline jet training** to pilots under 55.
- **Monitor airline pilot** training programs and increase the requirements for copilot ratings.

Major point of contention is the age proposal. FAA feels that its analysis of the subject warrants imposition of the age limits. The airlines, speaking through the Air Transport Assn., support the 60-year retirement age but strongly oppose FAA's age-limit restriction on jet training, contending that it is neither practical nor necessary from a safety standpoint.

Air Line Pilots Assn. rejects both the proposed age limits on the grounds that FAA is exceeding its authority in attempting to pass such a regulation and has also failed to offer factual evidence that there is any relationship between a pilot's age, physical fitness or competence as a flier. ALPA estimates that loss of what it terms the "golden years" between 55 and 60 when a pilot might be flying jet aircraft could result in a potential income loss of more than $200,000 per pilot in salaries and fringe benefits which, they indicate, would have to be recovered through new contract negotiations between the unions and the airlines.

The union has asked for a public hearing on the matter.

ALPA, however, is giving full support to FAA's proposed regulations covering airline training programs and increased qualifications for copilots. A long-sought goal of the pilots' union, the planned change was bitterly criticized by the airlines. ATA contended that FAA already has adequate regulations to cover both training and copilot qualifications and said that airline costs to provide just one extra proficiency check for copilots, as suggested by FAA, would boost industry expenses by an estimated $28 million annually.

Civil Aeronautics Board also has entered the case with a listing of 132 pilot-involved aircraft accidents dating back to 1951. The Board, however, advised the FAA that the study fails to indicate anything that might relate "accident proneness" rates or trends to pilot age.

CAB also asked the agency to clarify some of the regulatory language to specify whether the 55-year age limitation also is intended to apply to turboprop transition training.

Strongest medical support for the FAA plan came from the Civil Aviation Medical Assn., a private organization of physicians, which said that "when 100-plus lives and a $5 million airplane are dependent for survival on the physical and psychological well being of one or two individuals . . . arbitrary decisions must be made."

The organization said that pilot flight checks are "too subjective in interpretation to be the final answer" and added that FAA must choose the "lesser of two evils . . . that of barring the exceptional pilot by an arbitrary age limitation or endangering the safety of the public by allowing pilots of questionable physical infirmities to pilot high-performance aircraft."

Union Contentions

ALPA's objecting comments were contained in a detailed 105-page legal brief centered around the philosophy that the age limitations are more properly a matter of economics than safety. Its major contentions include:

- **FAA lacks authority** to offer the proposed regulation.
- **Agency is violating pilots'** legal rights by attempting to change airmen certificates without first granting a full hearing
- **Proposed regulation attempts** to bypass established Federal Aviation Act procedures governing FAA powers to limit, revoke or suspend airmen certificates.
- **Existing ALPA contracts** contain no age limitations and would be broached by passage of the regulation.
- **Proposed changes are "arbitrary,"** have no bearing on safety and are based upon incomplete information.
- **No medical basis exists** using age as a measure for physical fitness and competency.

Basically the pilots' union contends that the question of pilot age is not a matter of safety but one of economics that belongs under contract negotiations.

"The fact is," ALPA said, "no airline management has considered this an important enough problem to set age limits in their contracts."

Section 401 of the Federal Aviation Act states that the FAA administrator cannot restrict the right of pilots to obtain more favorable working conditions, the pilots' union said, "but this is exactly what he has done" by the proposed age limitations.

ALPA suggested that FAA could either intensify physical examinations for pilots over 60 or give them quarterly, instead of semiannual, examinations.

Asserting that imposition of the regulation would result in a waste of trained pilots which are costly to replace, the union said that airlines would be forced to restore the "career potential earnings" of pilots for the shorter working period.

Present system of FAA and company physical and proficiency checks for pilots make the use of such an age limitation unnecessary, ALPA said, so that "to say a 60-year-old pilot cannot demonstrate competency, when he has already done so, seems like an exercise in futility."

So far as jet training is concerned, the pilots' union said that while individual pilot transition to jets varies, transition problems will not differ greatly from those of the past and that age has little to do with it. Older pilots, ALPA said, are often qualifying in half the time required by younger, less experienced fliers. It added:

"There is a tendency for some people in the airline industry to view the pilot as a 'young and intrepid birdman of exceptional daring and endurance.' We think the public prefers to ride an aircraft piloted by a mature individual of exceptional conservatism."

Stand taken by the pilots on better airline training programs stems from a 1956 study by the union, in which ALPA said it found that many airline programs were "little more than home study courses." Training programs, it added, too often follow a "legal concept" and barely comply with FAA regulations since airlines are aware that the agency will not officially monitor them. The union also charged that economic factors with many airlines, sometimes result in the training courses being shortened to a point where pilots are getting inadequate training.

Backers of the FAA plan contend that existing regulations allowing copilots to be qualified by obtaining a commercial certificate and instrument rating are not enough to assure that he is familiar with the aircraft and can be an adequate aid to the pilot in command. FAA wants to give the copilots two annual proficiency checks and require a type rating for each type of aircraft on which he serves.

The reasoning is that a commercial certificate can be obtained by logging the necessary hours on the smallest type aircraft and that pilots in command are often forced to spend much of their time in instructing their own copilots.

ALPA says it would tighten this by requiring the type ratings plus a new airline transport copilots' license requiring at least 1,000 hr. of dual and solo flight as a pilot on aircraft of less than 12,500 lb. or 750 hr. on larger planes.

In addition, the union advocates that any other crew member with a commercial and instrument rating be permitted to log 50% of his flight time toward a copilots' license.

Flight Engineers International Assn. also is backing FAA's suggested training regulation and has asked that the agency provide similar regulations to cover its members. The organization has complained in the past that many airlines are giving flight engineers insufficient training and that FEIA members have sometimes been forced to pay for their own training programs from independent sources.

ATA Stand

The Air Transport Assn. says its members are "very much opposed" to the proposed training regulations on the grounds that they contribute nothing to safety and duplicate present FAA regulations on the subject.

ATA said the proposal also would create additional flights over congested areas and add an unnecessary expense to the carriers. In addition, ATA added the agency failed to spell out just what training procedures and maneuvers are contemplated, leaving the proposal "vague and indefinite" and subject to legal attack if adopted.

In detailing the additional $28 million annual expense this could cause the airlines, ATA said it is not suggesting that FAA "place a price tag on safety" but added that if feels that the agency should be concerned with the reasonableness of costs where "improvement of safety is at best marginal."

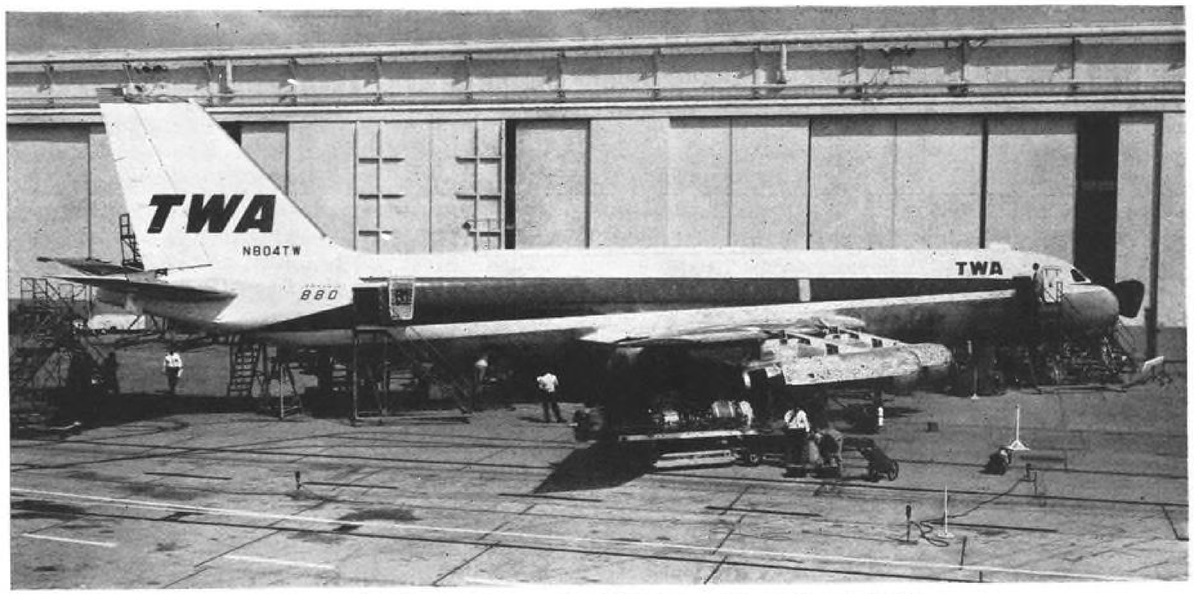
Swissair Orders Convair 600s

Geneva—Swissair has bought seven Convair Coronado jet transports and canceled its earlier order for five Convair 880s. Deliveries of the Coronados, equivalent to the Convair 600 series, are scheduled to begin in spring 1961. Under terms of a previous agreement between the Swiss carrier and Scandinavian Airlines System, SAS will lease two of the Coronados for a period of four years.

Sources here also report the purchase of two more Coronados by SAS. When deliveries are complete, Swissair will be operating five, and SAS four of the transports.

The Coronado is powered by four General Electric CJ805-23 aft fan engines each rated at 16,100 lb. static thrust. Guaranteed cruise speed is 635 mph. at a cruise altitude of 21,500 ft.

Swissair and SAS want the name Coronado but Convair, although authorizing its use, will not yet confirm it as final. Reports here are that Convair wants to get American Airlines acceptance of name before a final okay. Convair had a Coronado flying boat during the war.



First Airline Convair 880 Readied for TWA

First Convair 880 jet transport scheduled for delivery to an airline was rolled out of factory at San Diego last week in Trans World Airlines markings as detail work is completed. It is the fifth 880; four now are in flight test programs. Top four feet of vertical stabilizer has not yet been installed on plane in photo. Field operations work is scheduled to start this week; plane will be delivered to TWA next month. First delivery to Delta Air Lines is set for January.

Route Gains Proposed for Lake Central

Washington—Major expansion of Lake Central Airlines' route structure was recommended last week by Civil Aeronautics Examiner Barron Fredericks in his report on the Great Lakes Local Service Case.

Fredericks said he favors expansion of the Lake Central route pattern in the airline's present Midwestern service area and extension of the pattern with routes to new East Coast terminals. He also would give North Central Airlines several new routes in the Michigan-Wisconsin area.

Great Lakes Local Service Case will continue the overhaul of airline service in the area which was begun with the Great Lakes-Southeast Service Case. Great Lakes Local Service Case also is a link in the chain of area local service cases which CAB is using to modify and expand the nation's local air service pattern.

Fredericks recommended these new routes for Lake Central for a three-year trial period:

- **Columbus, Ohio,** to Washington and Baltimore via Zanesville, Ohio, and Wheeling and Morgantown, W. Va.
- **Cincinnati to Washington** and Baltimore via Portsmouth, Ohio; Marietta, Ohio/Parkersburg, W. Va., and Clarksburg/Fairmont and Elkins, W. Va.
- **Detroit to Pittsburgh** via Toledo, Sandusky, Cleveland, Akron/Canton and Youngstown, Ohio.
- **Charleston, W. Va.,** to Erie, Pa., via Elkins, Clarksburg/Fairmont, Morgantown and Wheeling, W. Va. and Pittsburgh.

The examiner also recommended routes between Bloomington and Columbus, Ind., and Cincinnati; between Akron/Canton and Columbus, Ohio; between Portsmouth and Columbus, Ohio, and between Detroit and Toledo, Lima and Findley, Ohio, as well as nonstop authority between Columbus and Cleveland.

LCA Restrictions

A number of restrictions were recommended which would generally maintain the local service nature of the route pattern. Lake Central would be required to serve at least one intermediate point between Columbus or Cincinnati and Washington or Baltimore and between Charleston and Pittsburgh. No flights could be operated between Pittsburgh and Washington or Baltimore.

Fredericks would require Lake Central to serve at least two intermediate points on Detroit-Pittsburgh flights and one intermediate point on Cleveland-Pittsburgh flights. Otherwise, full skip stop authority would be given the carrier, including the right to serve Cleveland and Detroit through any combination of airports and to carry local traffic between airports in the same city.

If the CAB approves, the routes would add significantly to Lake Central's economic potential. One of the smallest of the local airlines, the carrier is in the midst of a building program and probably would acquire more modern equipment than its current Douglas DC-3s to serve any major new routes. A number of the Lake Central route proposals in the case were keyed to Fairchild F-27 turboprop operations.

The case also presents the Board with an opportunity to strengthen Lake Central in the wake of its decision not to permit a merger between Lake Central and North Central. North Central has objected to the CAB decision and is appealing it to the Supreme Court.

North Central Proposals

The routes recommended for North Central in the report would provide considerable new service in Michigan and between lower Michigan and Wisconsin and the upper Michigan peninsula. They are:

- **Sault Ste. Marie, Mich.,** to Chicago via Cheboygan, Traverse City, Manistee/Ludington, Cadillac/Reed City, Grand Rapids and Benton Harbor/St. Joseph, Mich.
- **Sault Ste. Marie to Detroit,** via Cheboygan, Alpena and Saginaw/Bay City/Midland and either Pt. Huron or Flint and Pontiac, Mich.
- **Milwaukee to Muskegon,** with any flight serving both Milwaukee and Detroit required to make two intermediate stops.

Fredericks also recommended routes between Green Bay, Wis., and Muskegon and Grand Rapids, Mich., and between Escanaba, Traverse City and Saginaw/Bay City/Midland, Mich., plus a route on a nonstop basis between Oshkosh, Wis., and Chicago. These routes also would be awarded for a three-year period.

If North Central wins these new routes, they will represent a second major route expansion for the local carrier. The airline added 17 new cities to its system in the Seven States Area Case. North Central operates a mixed fleet of DC-3s and Convair 340s.

Allegheny Extensions

Along with the new routes for North Central and Lake Central, the examiner recommended that Allegheny Airlines' route structure be extended beyond Huntington, W. Va., to Louisville, Ky. Flights operating between Pittsburgh and Louisville would have to make two intermediate stops. He also suggested that Piedmont Airlines' certificate be amended to redesignate Louisville as Louisville/Frankfort, Ky., and he said Ozark Airlines' application for an extension from Louisville to Cincinnati should be deferred for one year.

Suspension Recommended

Fredericks recommended suspension of trunklines at several points while the cities are served by local carriers. These include American Airlines at Elkins and Marietta/Parkersburg, Trans World Airlines at Wheeling and Capital Airlines at Clarksburg/Fairmont, Morgantown, Wheeling, Erie, Cheboygan, Traverse City and Sault Ste. Marie. He also would cancel American's authority to serve Clarksburg/Fairmont and TWA's authority to serve Morgantown.

The examiner said he did not find it necessary to recommend suspension of Delta Air Lines at Toledo or TWA at Terre Haute, Ind. His report said consideration of service between Detroit and Cincinnati via Toledo, Columbus and Dayton should be deferred for consideration with the Cincinnati-Detroit Investigation.

Braniff Electra Crash Investigated by CAB

Dallas—Civil Aeronautics Board began an investigation last week into the crash of a Braniff Airways Lockheed Electra turboprop transport near Buffalo, Tex., with early evidence pointing to a midair explosion of the aircraft during a scheduled flight from Houston to Dallas.

The crash, which took the lives of 26 revenue passengers, two non-revenue passengers and six crew members, was Braniff's first accident in which all passengers aboard an aircraft were killed. It also marked the second fatal accident in which the Electra has been involved since it entered airline service in January.

The aircraft involved was the fifth of nine Electras Braniff has on order.

According to eyewitness accounts from layman observers, the airplane apparently caught fire and then exploded. R. V. Carleton, Braniff vice president-operations, reported from the scene of the accident, however, that there was no concrete evidence to show whether the Electra exploded in the air or when it hit the ground.

Carleton and a CAB investigator both pointed out that a pressurized aircraft cabin can be scattered widely by ground contact.

The Electra was following an IFR flight plan from Houston to Dallas at an assigned altitude of 15,000 ft. Last Federal Aviation Agency communication with the crew positioned the plane about 40-mi. east of Waco and at 15,000-ft.

Indicated and true air speed was 337 mph. Ground speed was 330 mph. Accident occurred at 11:13 p.m., eight minutes after its report to the San Antonio air route traffic control center at a point four miles east of Buffalo and about half-way between Houston and Dallas.

Crew report was routine and the pilot, Capt. W. E. Stone, reported no unusual weather or malfunctions. Other crewmembers included First Officer Dan Hallowell, Second Officer Roland Longhill and Stewardesses Betty Rush, Alvilyn Harrison and Leona Mary Winkler.

Civil Aeronautics Bureau of Safety sent five investigators headed by John Zrocki to the scene of the accident.

The plane was operating as Flight 542 from Houston to Dallas, Washington and New York.

West Coast Route Asked by National

Washington—Elimination of its interchange routing to the West Coast was cited by National Airlines last week as a necessity if it is to effectively compete with Trans World Airline's onestop jet service between the West Coast and Florida.

Testifying at a Civil Aeronautics Board hearing in the Southern Transcontinental Case, witnesses for the carrier urged the Board to extend National's route system beyond Houston and Dallas to California in order to provide the first one-carrier service to the coast along the southern route.

Authorization of TWA to enter Florida from St. Louis in the St. Louis-Southwest Case has resulted in a one-stop jet service by the airline between Miami and Los Angeles via St. Louis, with an elapsed flight time nearly 4 hr. less than National can offer on its interchange service, spokesmen for the airline said.

The spokesmen said extension of National's route system to the Pacific Coast would provide a direct southern transcontinental service that would be more than 300 mi. shorter than the TWA route in addition to providing direct service to the West Coast to many points which TWA does not serve.

Soviet Runway Hazards

Moscow—Ability of Soviet jet and turboprop transports to use grass fields and dirt runways (AW July 27, p. 44) is striking a sour note with Aeroflot's maintenance personnel.

Aeroflot reports concede that the service period of gas turbine engines is substantially reduced by unpaved landing strips, taxiways, "pretakeoff" areas and parking ramps.

Some engines, they admit, have "clogged up and failed" from the flying dust and grit.

Aeroflot says that, even at paved airports, the hot, high-velocity gases from the Tu-104 turbojet and Il-18 and An-10 turboprop engines create flying dirt problems by tearing up the adjacent turf and exposing the bare ground. As a result, Soviet engineers have recommended wide concrete shoulders with an additional outer strip of soil cement for taxiways, parking and pretakeoff areas used by jet and turboprop transports.



First Boeing 720 in Final Production Stages

First of 46 Boeing 720 medium range jet airliners now on order is in final production stages at Boeing Airplane Co.'s Renton, Wash., plant. The aircraft is one of 18 which will go into service for United Air Lines. Boeing 720 is powered by Pratt & Whitney JT3C-7 turbojet engines, which develop 12,000 lb. thrust each. Plane will carry from 90 to 150 passengers; gross weight will be 202,000 lb. Rollout is scheduled for late October and United will take delivery in April, 1960, after Federal Aviation Agency tests.

Examiner Approves Air Forwarder

Washington — Civil Aeronautics Board examiner recommended last week that American Express Co. be granted a five-year operating authority as an air freight forwarder as it has requested (AW June 15, p. 39).

Examiner Herbert K. Bryan said his decision was primarily based upon advantages the company could offer its customers and rejected claims by objecting forwarders that the firm's international banking and shipping interests could give the company a monopoly in its new enterprise.

Bryan held that prohibiting plans by American Express to offer "one package" bank and transportation facilities might protect competing forwarders but would do so at the expense of an improved service to the customer. He added that the company also is unlikely to grant rebates to customers by offering lower commission rates on letters of credit, as the forwarders charge, because of the low profit margin involved.

707-420 Nonstop Flight

First Boeing 707-420 has flown 4,815 mi. nonstop from Seattle to Tokyo in 10 hr. 55 min. The Rolls-Royce Conway-powered jet transport, in British Overseas Airways Corp. markings, took off from Boeing Field at 302,000 lb. gross weight. Average speed on the transpacific flight was reported at 441 mph. against headwinds averaging 85 mph.

Average cruising altitude of the plane was 29,000 ft.

The airplane now is in the final phases of its certification testing. BOAC has ordered 15 of the Boeing Intercontinentals with Conway powerplants.



FRENCH FLYING ACE ESTABLISHES FIRST TRANS-AFRICA AIR ROUTE BETWEEN FRANCE–MADAGASCAR!

COMMANDER JEAN DAGNAUX LINKS PARIS, TANANARIVE

Jean Dagnaux

Tananarive, Madagascar, Feb. 10, 1927 – Commander Jean Dagnaux, famous World War flying ace, arrived here today after a daring series of flights from Paris. He piloted his Breguet 19 through Spain, over the Mediterranean, across the Sahara, and down the length of Africa to realize his lifelong ambition – the completion of an overland air route connecting

FIRST IN INTERNATIONAL AIR TRAVEL! The exploits of brave French airmen like Blériot, Bossoutrot, Noguès, Mermoz and Dagnaux have made aviation history since the very beginning of international flight. Air France still follows this great French tradition of leadership in aviation. Today Air France offers the most non-stop flights between New York and Paris and the fastest jet service in Europe and the Middle East aboard sleek, swift Caravelle Jets. Next year Air France plans to cover the world's most extensive route network with one of the world's largest pure-jet fleets, featuring the world's largest, fastest, most luxurious airliner–Air France 707 Intercontinental Jet.

40TH ANNIVERSARY OF INTERNATIONAL FLIGHT

AIR FRANCE

WORLD'S LARGEST AIRLINE/WORLD'S FIRST INTERNATIONAL AIR SERVICE

Allegheny Details Convair 540 Operation

By L. L. Doty

Washington—First summary of operating costs and performance of the converted Convair 540 turboprop transport in regularly scheduled local-service operations was revealed last week by Allegheny Airlines.

The single aircraft, operating since July 1 on a seven-day-week schedule over Allegheny's Pittsburgh-Atlantic City-Washington route, has been flown by the airline under the terms of a three month lease with Napier Engines, Inc., which has been renewed for a similar period beginning last week. The airline wants more experience with the aircraft before it makes a final decision whether to add a number of the turboprops to its present fleet.

Operating statistics of the airplane, however, indicate that Allegheny will settle on the 540 as the backbone of its future turbine-powered fleet. The statistics released by Allegheny on the airplane cover the period from July 1 through Aug. 31 but, since the aircraft was pulled from service for a two-week period because of now-corrected engine bearing problems, a true performance record is reflected only in the August period when the aircraft showed an operating performance of 96.51%.

The aircraft earned $83,759 in revenues for the carrier during August, which amounts to $1.92 per revenue mile as compared with $1.27 for the Douglas DC-3 and $1.77 for the Martin 202 fleets now operated by Allegheny.

Direct operating expenses for the Convair 540 during August were 97.47 cents per revenue mile, slightly higher than the 93.45 cents direct operating expense per revenue mile shown for the Martin 202. DC-3 direct operating expenses for the period were 64.40 cents.

Expense Factors

Chief factors contributing to the direct expenses of the Convair 540 were insurance costs and airframe depreciation. However, Allegheny is conservatively basing its depreciation costs on the $1.4 million value of a new Canadair 540 aircraft plus $125,000 for a spare engine.

Allegheny is operating a Convair 440 which has been converted by Napier to turboprop power with its Eland engines. Therefore, Allegheny actually can base its depreciation on the total evaluation of a conversion model which is about $850,000. This amount, coupled with proportionately lower insurance premium costs, would reduce total direct operating costs to about 85 cents per revenue mile.

Using a 56-seat configuration, which is top capacity for the airplane, direct operating costs of the Convair 540 will fall as low as 1.5 cents per seat mile. Allegheny is operating its Convair with a 44-seat configuration.

Average stage length of the Convair during August was 199.8 mi. as compared with an Allegheny fleet average of 84.7 mi. Total miles flown for the entire July-August period were 80,924.

Average daily utilization for the turboprop plane in August was 6 hr. 10 min. Martin 202s during this period showed a 5 hr. 7 min. daily utilization, while the DC-3 average was 5 hr. 16 min. Scheduled miles flown for the 540 were 262.5 mi. per hour as compared with 176.5 for the Martin 202s and



New Lighting for Hong Kong Airport

Kai Tak Airport at Hong Kong has gone into 24 hr. service following installation of approach and runway lighting by British General Electric Co., Ltd. View above is of Runway 13 to Kowloon Bay. Unusual feature is that aircraft follow a 3,150 ft. long curved line of approach lights because nearby hills preclude a direct approach. Southeast approach to Runway 13 has approach lights mounted on piles driven into the bay bed. Radio and radar aids leading to all-weather operations now are being installed.

138.1 for the DC-3s. Available seat miles on regularly scheduled flights were 1.9 million for the single Convair 540 compared with 12.7 million for the carrier's 13 Martins and 6.1 million for the 11 DC-3s.

August load factor for the 540 was comparatively low: 49.8%. However, most Allegheny officials attribute the decline from the 50.9% realized in July to the affects of the prolonged steel strike on traffic in and out of Pittsburgh, main terminal of the 540's present route. Average revenue passenger load on the Convair was 21.50.

Although Allegheny has firmly settled on the turboprop engine as the powerplant it wants and on the converted Convair as the airframe best suited to its needs, it is still evaluating the Allison turboprop engine in its studies, as well as the Napier Eland.

Napier Eland engines, however, have been operated on 404 regular flights from July 31 through Sept. 24 at an availability rate of 99.51%. All maintenance and overhaul of the engine is being handled by Napier personnel at Allegheny's main base at Washington's National Airport. Current overhaul time of the engine is 400 hr.

TWA Complaint

Meanwhile, Trans World Airlines has raised an objection to Allegheny's plan to offer the turboprop service on its route between Philadelphia and Pittsburgh at reduced rates which were scheduled to become effective on Oct. 4. In its complaint to the Civil Aeronautics Board, TWA charged that Allegheny's proposed services were "first class" and that the reduced rates are therefore "unreasonably low and discriminatory."

The carrier also said in its complaint that promotion alone is not sufficient to justify a fare that would otherwise be unjustly discriminatory.

Allegheny's tariff would give purchasers of a 10-trip booklet of tickets a 15% discount from the present $18.45 one-way fare and establish a new low commuter fare of $11.82 for passengers boarding without a reservation.

All passengers, whether they pay the full tariff or take advantage of the proposed reduced fares, would receive the same services aloft. On this point, Allegheny President Leslie O. Barnes, said in the company's petition to dismiss the TWA complaint:

". . . the fact that passengers paying different fares may sit next to one another on the same (first-class) flight does not constitute discrimination."

Barnes emphasized that the reduced fares were possible, not necessarily through economies in flight operations, but through savings in ground handling facilities. He added:

"If the passenger requires a reservation, the tariff covers the handling costs of such a procedure. If a passenger purchases a 10-trip booklet of tickets, substantial economies are realized on ground handling which are passed on to the customer."

Barnes charged that reduced fares, which are based on a reduction of ground handling costs, are not more discriminatory than reduced "air coach rates" based on a less comfortable seat and some reduction in in-flight services. Barnes summarized his whole philosophy of local service operations when he concluded:

"The real issue at stake here is whether or not this new concept in air travel designed to develop new markets through simplified procedures and appropriate fares merits a trial such as that proposed by Allegheny Airlines."

Excessive Heat Buckles DC-8 Windshield

Chicago—Excessive windshield temperatures resulting in delamination of the outer layer windshield of a United Air Lines Douglas DC-8 caused a recent unscheduled landing of the jet transport in Salt Lake City, according to United spokesmen.

Incident occurred while the aircraft was at 29,000 ft. over Milford, Utah, en route to San Francisco from New York on one of its early passenger flights. A small spot appeared on the windshield and continued to expand until it obstructed the pilot's view. Descent to 18,000 ft. was made under instrument flight rules and a normal landing was made by the copilot, because of better visibility from his position, United spokesmen reported.

Damaged windshield has been replaced and the aircraft is now back in service.

Federal Aviation Agency has not made an official ruling on the cause of the damage, but agency spokesmen say they regard the incident as "typical teething pains" of a new aircraft and that a similar, but smaller, delamination occurred recently on an American Airlines Boeing 707.

Douglas Aircraft Co. engineers attributed the problem to sensitivity of the glass to sudden thermal changes and the difficulty in controlling heating element temperatures within the three laminated glass and plastic sections of the outer windshield.

While the DC-8 windshield heat regulating system is operational on other United aircraft, the airline says it will develop and install an improved regulator for the windshield.

Damage to the United windshield had no effect on cabin pressurization, the airline said, since only a portion of the outer layer of the two piece windshield was involved. The inner windshield remained untouched and was adequately stressed to retain cabin pressure.

The two-part windshield consists of sandwich laminated panels separated by an airspace, with each panel stressed to hold eight times the cabin pressure, according to Douglas. Outer panel is composed of an outside sheet of $\frac{7}{16}$-in.-thick glass, a $\frac{3}{8}$-in.-thick vinyl and an inner pane of $\frac{1}{2}$ in. temperated glass. Combination provides strength, while placing of the heating element in the outer panel prevents the vinyl from becoming brittle at low temperature and provides for windshield deicing.

The windshield underwent stress testing identical to that of other DC-8 structural members, including hydrostatic testing of the entire forward fuselage to simulate pressure and load conditions for 140,000 cycles, the manufacturer said. In addition, it was tested for resistance to impact of a 4-lb. bird at appropriate temperature and pressure conditions and further tested under instrumented conditions during 291 hr. of flight.

BOAC, Middle East Try for Agreement

London—British Overseas Airways Corp. and Middle East Airlines of Lebanon are negotiating a new financial agreement to replace an existing pact which gives the British airline a 49% holding in Middle East.

Each airline already has rejected initial plans submitted by the other, according to a joint statement by Middle East Chairman Sheikh Najib Alamuddin and Sir George Cribbett, deputy chairman of BOAC.

In return, Middle East gets loans from BOAC—at 6% interest—and backing of the British airline's sales operations. Commenting on the agreement, the Sheikh says BOAC's holding is worth about $1 million. He also pointed out that his airline had spent $15.4 million with the British aircraft industry and intended spending more.

BOAC has rejected Middle East's offer, totaling about $5.7 million for its holding in Middle East and repayment of all outstanding loans. About half would be in cash and the remainder payable over a three year period. Neither airline will reveal BOAC's counter offer.

In a separate statement, the Middle East chairman replied to recent criticisms of his airline. He said it was "incorrect and grossly unfair to speak of Middle East Airlines as one big sieve through which British public money has been poured, or to the grave losses of BOAC in Middle East.

"In fact, up to now the British operator hasn't paid any losses in Middle East Airlines," he added.

Engineers Urged to 'Fit Jets to Airports'

Los Angeles—Noise, blast, size and fuel requirements have caused most of the airport operator's problems in handling jet transports, according to Thomas M. Sullivan, deputy director of aviation for the Port of New York Authority.

Sullivan reviewed the first year of jet operations at New York International Airport in a report scheduled for delivery to Society of Automotive Engineers members at their national aeronautic meeting here this week.

The Port Authority, he said, has stretched its facilities tremendously to accommodate the new aircraft. But he asked engineers who design the planes to note the "urgent need for making the aircraft fit the airport with performance characteristics which are compatible with the interests of the neighboring communities."

Since the start of scheduled jet operations at Idlewild last October, Sullivan said, the Port Authority has experienced these major problems:

• **Noise.** Through July, there were 3,286 jet takeoffs at Idlewild, of which 73% conformed to the Port Authority's noise abatement procedures, and half of them were made over water. Noise suppressors on the aircraft "have spelled the difference between success and failure" of the anti-noise program, but suppressors cannot do the whole job. Partly for this reason, runway extensions have been made at the airport. The Port Authority was able to get official information on required jet runway lengths only 35 days before the first scheduled takeoff. Since then, Runway 23 has been extended to 10,000 ft., Runway 13R-31L to 11,248 ft., and the latter runway will be extended to 14,600 ft.

• **Jet blast.** Initial experience with jets taxiing to and from gates under their own power showed this procedure unacceptable. Examples: one starting blast picked up a 550-lb. baggage cart, blew it 75 ft. over and beyond the blast fence; another time full power was applied to free tires frozen to the pavement and the blast damaged a passenger loading stand, two panel trucks, an air conditioner, a tug and several glass panels in the terminal building. A jet making a full power runup in the hangar area blasted out a 30 by 50 ft. area of asphalt pavement. The Port Authority now requires towing away from the gates.

• **Aircraft size.** To accommodate bigger and heavier planes, airport operators must lengthen and sometimes strengthen runways, provide additional apron space, and enlarge hangars. At Idlewild, last-minute addition of tail gates to hangars was necessary to accommodate the big jets. To keep up with the demand for space, aircraft at Idlewild now are parked on the temporary terminal apron with as little as 5 ft. of clearance between wing tips. Also, time is a factor in size. It appears that the jet requires about 50% longer for servicing than the largest piston transports.

• **Fuel.** Idlewild's fuel storage capacity was increased about 50% during the past year to keep up with demand for jet fuel. Capacity now is 9.8 million gal., of which almost half is jet and turboprop fuel. Jet fuel requirement forecast for 1965 is 700 million gal. The Port Authority is studying a hydrant fueling system for the central terminal area, and a preliminary report on the project is being reviewed by the airlines. Introduction of kerosene fuel has brought an exhaust odor problem which reaches "serious proportions" on humid summer days, when the odor permeates the airport area.

In another aspect of jet operations at Idlewild, the Port Authority is working to establish location and design of portable noise suppressors for ground engine runups, Sullivan said.

In another report scheduled for presentation to SAE, the ducted fan engine was described as a means of efficiently tailoring a basic gas generator to a number of specific aircraft missions.

Neil Burgess and A. P. Fioretti of General Electric Co.'s Commercial Engine Operation, Flight Propulsion Division, said specific fuel consumption of the turbofan engine today is in the area of .78, compared with an optimum for the straight turbojet of .9 to .85 at Mach .85 at 35,000 ft. Optimum of the turbofan should reach the vicinity of .7 in the subsonic transport regime.

Other applications of the ducted fan for future use, according to the General Electric officials, provide means of tailoring a basic gas generator to a number of different aircraft missions including VTOL and supersonic transport.

In one suggested vertical takeoff design, fans are mounted in the horizontal wing surface with their axis in a vertical plane. The fans are driven by gas generators mounted in the horizontal plane, either mechanically or through use of independent turbine blades mounted at the tips of the fan blades which are turned by gas generator exhaust. When sufficient horizontal speed is attained, all of the gas generator energy is used for forward propulsion.

Also scheduled for the SAE meeting was a discussion of the development and operation of the Lockheed Electra turboprop transport. Among the points covered in the report by R. W. Partridge, V. S. Upton and J. T. Power of Lockheed were:

• **Modification in the field** of all Electras requiring nacelle tilt to correct a noise and vibration problem will be completed by Oct. 23. Tilting the thrust line up 3 deg. reduces propeller blade stresses and propeller shaft bending moments and reduces both noise and vibration levels (AW May 4, p. 47).

• **Breakeven load factor** of the Electra has been placed between 47% and 48% by Eastern Air Lines, according to the Lockheed engineers. Ansett-ANA sets its Electra breakeven load factor over its particular routes at 55.3%, compared with 69.9% and 75.7% for other equipment now in operation, according to Lockheed.

• **Speed of the plane** is greater than predicted and engine power is 104% to 105% of nominal values. External noise level is about 10 db. less than that of piston aircraft. In Eastern's operation, Federal Aviation Agency has approved 1,000 hr. between overhaul of the Allison engines and 1,250 hr. between Aeroproducts propeller overhauls.

• **Bugs have included** trouble with the starting system, particularly combustor, high pressure regulator, low pressure regulator, air turbine starters, air compressors, and the like. Other problems have appeared in the freon system and in the electrical systems.

Pan American Pilot Suspended by FAA

Washington—Federal Aviation Agency has imposed a 60-day license suspension on a Pan American World Airways pilot for allegedly napping at the controls of a Douglas DC-6B.

Charges of failing to remain at the control of the aircraft at all times and failing to be alert to his duties were filed last March by FAA inspectors against Capt. Carl A. Skiles, pilot in command of Pan American's New York-to-Bermuda flight.

One hour after departure from Bermuda, according to FAA, the pilot was seen reclining in his seat with his eyes closed and "left foot extended up on top of the radar scope for a period of about 30 min."

Agency spokesmen said FAA originally had planned to suspend Skiles' license for a 90-day period and to issue him a commercial license in order to permit his employment as a copilot during the period. Pan American, however, said its scheduling would not permit it to assign Skiles to a copilot status for at least 60 days of the suspension period.



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Heliport Success Based on Convenience

Los Angeles, Calif.—Economic, legal and construction problems to be faced in the development of heliport and helistop networks were outlined here for more than 200 businessmen, government officials and helicopter industry representatives in what has been billed as the nation's first Symposium on Planning and Designing of Urban Helicopter Facilities.

James C. Buckley industrial and transportation consultant, said that early predictions on the growth of helicopter markets have been borne out as far as the order in which markets would develop but magnitude of development has been far less than anticipated. Present indications are that helicopter passengers in the New York area in 1960 will number barely 10% of the load forecast for that year in 1952.

Primary Market

He said that helicopter and VTOL aircraft are not likely to create new travel "desire-lines." Rather, they will find their primary market by diversion of some traffic from existing carriers serving established travel-desire lines and by generating additional traffic along the same travel-desire lines. Therefore, heliports must serve centers of travel demand large enough to support the facilities.

Community officials must find locations for substantial and sizable installations convenient to the community's business and hotel centers, these being primary generators of the types of travel for which helicopter is most useful.

Experience has shown that in large cities a market does exist for helicopter service between the community's central business district and its airports. Demand in this market is controlled by fares.

While it has grown rapidly, it is still small compared with the number of passengers using fixed-wing aircraft.

Low Penetration

In 1958, passengers using scheduled helicopter carriers at Chicago, Los Angeles and New York only amounted to about 2% of the number of passengers traveling on fixed-wing aircraft in those cities. This indicates low penetration of service into the market provided by passengers moving intercity on fixed wing aircraft. Mere existence of this demand makes it a primary obligation upon the community to make adequate provision at each airline airport for the handling of helicopters and helicopter passengers.

Heavy, high performance equipment such as the Fairey Rotodyne VTOL now on order by New York Airways will call for more elaborate facilities in downtown heliports and requires communities to make provision for later expansion of their early facilities. Rotodyne VTOL has a cruise speed of 200 to 250 mph., accommodations for nearly 50 passengers, and an indicated cost per seat mile comparing favorably with that for fixed-wing aircraft operating in the short haul, intercity market. Heavy volume of intercity traffic moving at competitive fares may absorb most fixed wing and surface traffic in markets such as New York-Philadelphia, as well as generating substantial new traffic. This would make the central heliport a key point in the community's entire air transportation system.

Buckley said he believes helicopters and related vehicles will always be slow and expensive in the suburban market. For example, a helicopter cruising at 120 mph. makes a trip-speed of only 53 mph. with an average of 5 mi. between stops and 85 mph. with 15 mi. between stops. These speeds are scarcely better than a commuter train and considerably more costly. He also pointed out that such transportation is paid for out of personal funds rather than being a business expense. Only transportation on business justifies payment of a premium fare because of the profit shown on the time saved.

Since the market and benefits of the heliport will extend far beyond the boundaries of the community in which it is located, responsibility for planning, financing, developing, and operating outlying heliports should be accepted by political units supported by a large geographic area, such as counties or regional authorities. If this is not done, the advent of outlying heliports is likely to be blocked by the inability of small communities to finance and operate facilities which would be best located in their territory.

Safety Considerations

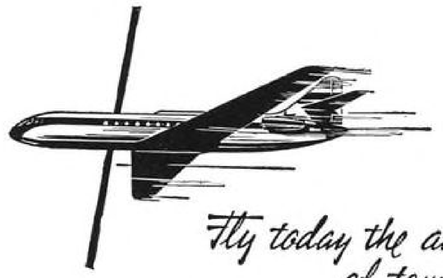
Safety considerations in heliport or helistop design were discussed by John G. Degenkolb, battalion chief, Los Angeles Fire Department. Degenkolb said he believes it is, at present, impractical to build a heliport atop a building. Problems of underground gasoline storage, fire resistant separation of office areas and medical facilities from the hazards of overhaul and refueling operations make the rooftop heliport a subject for future planning, he contended.

Los Angeles Fire Department once thought that helicopter engines should be shut off and rotor blades stopped before passengers were allowed to embark



Japanese Dedicate Tokyo Heliport

Northwestern Tokyo heliport, atop the Seibu Department Store, is dedicated at ceremonies sponsored by Seibu Railway Co., which operates the store. Sikorsky S-58 helicopters are part of Japanese Marine Corps fleet; Bell 47s in foreground are owned by the newspaper Asahi, which has a heliport atop its building in Osaka. Seibu heliport is 116 ft. off the ground; cost of the 11,880 sq. ft. facility was $420,000. Freight will be hauled pending passenger certification, which is expected by next March. The unit has a control tower.



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ETHIOPIAN AIRLINES

THE WONDERLAND ROUTE

or disembark at a helistop. Current thinking is that repeated starting and stopping may be a greater hazard than rotating blades. Helicopter pilots have advised the department that the helistop touchdown pad should be accessible by only one path of travel and this should be within view of the pilot at all times.

Degenkolb laid out this safety checklist for design of rooftop helicopter landing facilities:

- **Helistops should be located** in an area offering two clear approaches with 8 to 1 ratio glide slopes. Approach course lines should be separated by at least 90 deg.
- **Touchdown pads** should be elevated above the level of the rooftop to provide head clearance between rotor blades and personnel and means should be provided to collect gasoline spillage. Pads should be surrounded on all sides by a cleared area of roof averaging 15 ft. in width and with no side less than 5 ft. wide.
- **If there is no parapet wall,** a strong fence should be built around the edge of the roof and rooftop should have at least two safe exits located remotely from each other.
- **At least one wet standpipe** should be installed and equipment provided to lay down a fire extinguishing fog pattern. Two dry powder fire extinguishers of at least 20 lb. capacity should be placed upon the roof at locations distant from each other, and a fire alarm box or non-pay telephone must be placed on the rooftop.

Surface Strength

E. J. Nesbitt, of Sikorsky Aircraft, said that strength of the surface or structure on which a helicopter lands should be considerably greater than that of the helicopter landing gear so that it will not break, even in a landing hard enough to damage helicopter landing gear. Nesbitt observed that if the gross weight of a helicopter is spread over the roof area swept by its rotor blades, loading is only 6.3 lb. per sq. ft. even for the heavy Sikorsky S-61.

This is less than one-sixth of snow-loading design requirements, which are 40 to 50 lb. per sq. ft. In smaller two- and four-place helicopters, rotor area loading never exceeds 3 lb. per sq. ft., or about the same as ⅛ in. of rainwater. Even if the total weight were distributed over the small area enclosed by the helicopter's landing gear, loading would only be 42 lb. per sq. ft. Impact loads upon a landing surface are considerably less than deceleration loads measured in the helicopter. This is because a force equal to 60 or 80% of the gross weight is being exerted upward upon the helicopter by the main rotor blades.

SHORTLINES

► **Air France** reports it carried over 2.5 million passengers with a load factor of 65% during 1958. Total revenues for the year were $178 million, up 17.4% over 1957. The French airline made initial payments of $17.9 million on its fleet of 17 Boeing 707-328s and 24 Sud Aviation Caravelles during 1958.

► **Eastern Air Lines** has carried a total of 94,205 passengers to and from Mexico City during the last two years. The airline flew 23,213 passengers from New York to Mexico City, 23,239 from New Orleans to Mexico City, 22,890 from Mexico City to New York and 24,683 to New Orleans.

► **Japan Air Lines** carried 4.3% more passengers in Fiscal 1958 than it carried the previous year. The carrier flew 5,716,696 mi. on international routes, logging 225,560,940 passenger miles and 4,908,202 cargo ton-miles. Compared with Fiscal 1957, Fiscal 1958 traffic was up about 30%. JAL had a net profit of $1.4 million on domestic flights, an increase of $600,000.

► **Northwest Airlines** has almost completed the first stage of construction on its $18 million general office and overhaul base at Minneapolis/St. Paul International Airport.

► **REAL Airlines of Brazil** plans to begin service between Los Angeles and Rio de Janeiro via Mexico City, Bogota and Manaus on Nov. 20. The carrier will use Lockheed Super-Hs.

► **Sabena Belgian World Airlines** carried its 250,000th helicopter passenger in Europe during September.

► **Transocean Air Lines,** a supplemental air carrier, is scheduling a San Francisco-New York nonstop flight operating every Tuesday and a nonstop San Francisco-Chicago flight operating on Thursday. Boeing 377 Stratocruisers will be used on the services.

► **Trans World Airlines** was scheduled to begin four weekly round trip international all-cargo flights and three daily domestic round trip all-cargo flights Oct. 1. Combined domestic and international capacity of 6,157,000 ton miles will be available in six Lockheed Super-H Constellation aircraft.

► **Western Air Lines** reports total operating revenues of $6.5 million for August. For the same period, the carrier reported net income of $2,407,000, or $2.36 a share, and total operating revenues of $33,473,000.

AIRLINE OBSERVER

► Airline common stocks are reacting to the recent general market recovery on the New York Stock Exchange and are again showing strength. During the week of Sept. 14, however, when over-all prices fell sharply, airline stocks had declined further from their 1959 highs than the general listing averages had from the peak reached in early August. Average decline of airline stocks listed on the New York Stock Exchange was 27% as compared with 12% quoted on stocks used by one organization in establishing averages. Large military aircraft producers suffered even more—declining an approximate average of 35%.

► **Hawaiian Airlines will lease the initial DC-8 turbojet transport built by Douglas Aircraft Co. from the manufacturer after the plane has been re-equipped with Pratt & Whitney JT-3D turbofan engines. Modification to Hawaiian specifications will begin in the summer of 1961 after the number-one DC-8 has finished its part in the turbofan test program now being conducted by Douglas. Aircraft is now equipped with Pratt & Whitney JT3C-6 turbojets.**

► Average daily utilization of all Boeing 707 turbojet transports since the beginning of airline service last October has been seven and one-half hours, according to the manufacturer. The jet transports, Boeing says, have flown twice the daily mileage piston-engined aircraft could have accomplished with the same utilization. Continental Air Lines has reached a peak 12 hr. daily utilization with its fleet of four Boeing 707s.

► **Air India International and British Overseas Airways Corp. will discuss possibilities next month of a traffic pooling arrangement on the London-India route. The talks will be closely tied-in with current British plans to create an organization of international air lines operated by Commonwealth countries to combat the competitive threat arising from the four-member Air Union airline in Europe.**

► Requirement for a fleet of 36 to 40-passenger VTOL transports in the next 10-12 years is foreseen by Central Airlines President Keith Kahle as a means of overcoming private automobile competition on short hauls which is now aggravated by long distances from the center of town to many of the airports the carrier serves. Kahle also says that Central will purchase turboprop equipment, probably the Fairchild F-27, within the next two years.

► **Domestic airline traffic continued to climb during the month of September. Although final figures will show a larger increase in available seat miles than in previous months of this year, load factors should remain fairly steady due to the traffic increases. Many officials, however, are now wondering how much longer it will be before the rise in available seat-miles resulting from the introduction of jets will outstrip traffic climbs and begin to depress load factor levels.**

► Sabena Belgian Airlines will key its European schedule pattern to its turbojet operation scheduled to begin Feb. 15 with Boeing 707-320 intercontinental transports. European schedules will be revamped to permit close connections at Brussels with jet schedules which will be introduced simultaneously on the Brussels-New York, Brussels-Montreal and Brussels-Rome-Johannesburg routes.

► **KLM Royal Dutch Airlines is scheduled to begin Lockheed Electra turboprop service from Amsterdam to Moscow early next year. The airline took delivery of the first of its fleet of 12 Electras last week. Initial service with the Electra will begin in December on the carrier's Amsterdam-Cairo-Damascus route.**

► Chicago Helicopter Airways on Sept. 18, handled a total of 1,003 passengers which, the airline says, is a company record for a single day. August total was 21,414 passengers. The helicopter line estimates that 40% of the passengers it is currently carrying are connecting passengers with jet aircraft serving Chicago's O'Hare International Airport.

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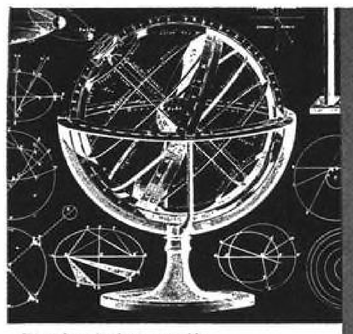
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TWA, Flying Tiger Report Record Gains

New York—Trans World Airlines earned a net of $6,097,000 before taxes in August, highest comparable total in the company's history for a single month. The August, 1958 net income was $4,156,000 before taxes.

Results for August, 1959, were attributed by the airline to strict cost control procedures and record passenger volumes.

TWA's fleet of Boeing 707-120 jet transports accounted for 38% of the August, 1959, domestic revenue passenger miles. Jet load factors averaged 90.6% from start of service Mar. 20 through Aug. 31.

System totals for all equipment during August reached 619,041,000 revenue passenger miles. Jet plane miles for the month totaled 1,826,000.

In another report, Flying Tig Line said its net income from operations for the fiscal year ended June 30 totaled $2,806,389, more than double the figure for the previous fiscal year and the highest net in the company's history. Net after debt expense and taxes was $1,391,366.

The cargo carrier's net earnings of $1.23 were based on an average of 1,095,331 common shares outstanding, compared with a Fiscal 1958 net of $1.28 based on 983,635 shares outstanding. The increase in shares resulted from conversion of 5½% debentures into 314,318 shares of common stock. The debentures were redeemed at the end of the fiscal year as part of the financing of new equipment.

Flying Tiger's total gross revenues for Fiscal 1959 were $34,579,936, up from $33,860,549 the previous year, while operating expenses decreased by $687,429 to $31,773,547. Air freight revenues gained 39% to $13,315,698, while charter and service sales revenues were down from $24,265,475 to $21,264,238. Shift in fleet concentration to common carriage and away from military contract and group tourist business was the reason for this decline, according to the airline.

Air France, Lufthansa Plan Polar Service

Los Angeles—Air France and Lufthansa West German Airlines plan to begin polar flights between Europe and the West Coast early next year under the auspices of the European Air Union.

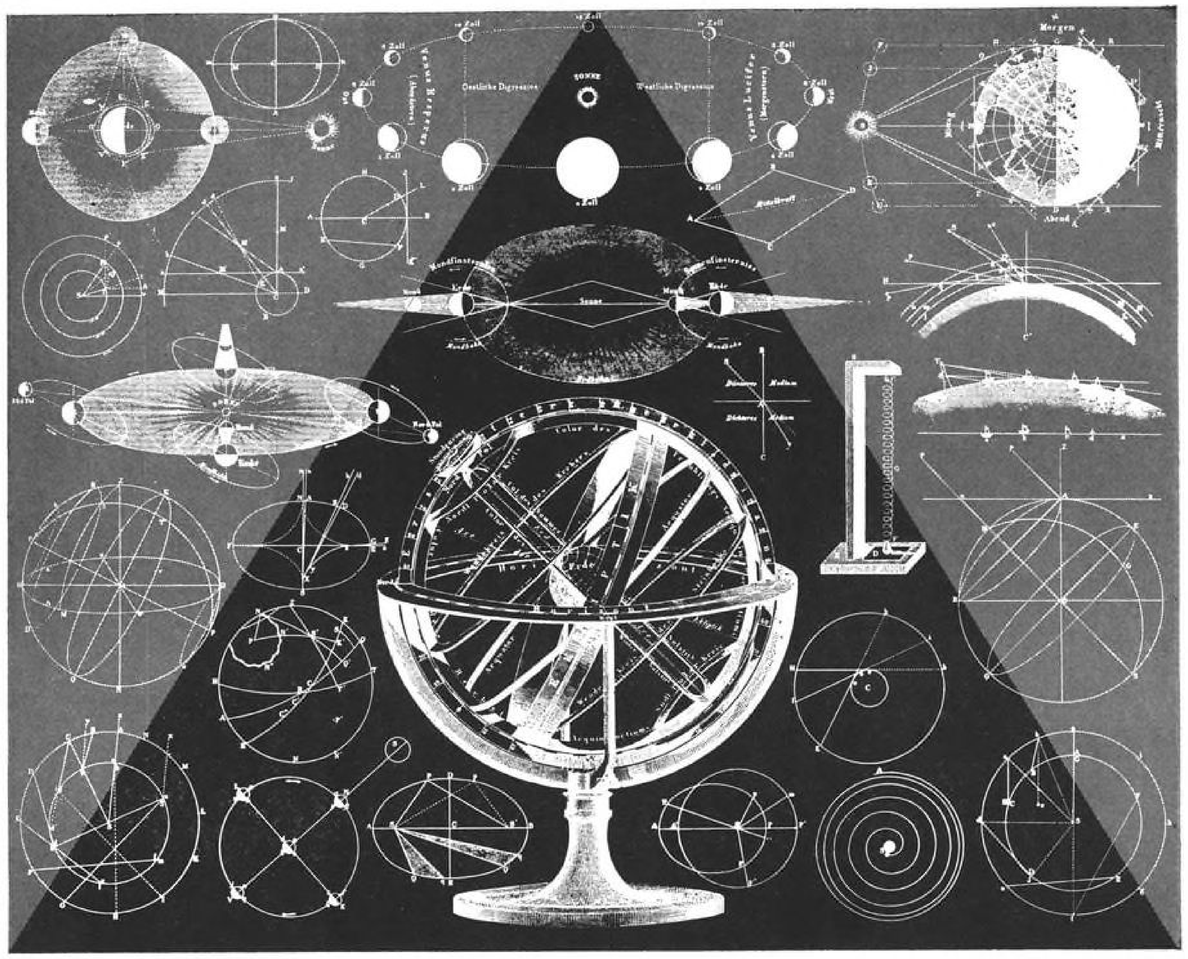
The two airlines will pool services and equipment, probably using Lockheed 1649 aircraft. Air France will operate three flights between San Francisco/Los Angeles and Paris each week; Lufthansa three flights between these cities and Frankfurt.

The other two members of the Air Union—Sabena Belgian World Airlines and Alitalia—do not have routes to the U. S. West Coast but will be represented by Air France and Lufthansa.



Vickers Vanguard Cockpit Layout

Vickers Vanguard turboprop transport cockpit includes temporary fuel jettison panel fitted at center windshield for test purposes. Airplane incorporates a Collins Flight System. Third crew member sits between and behind pilot-copilot seats (AW Sept. 14, p. 56).



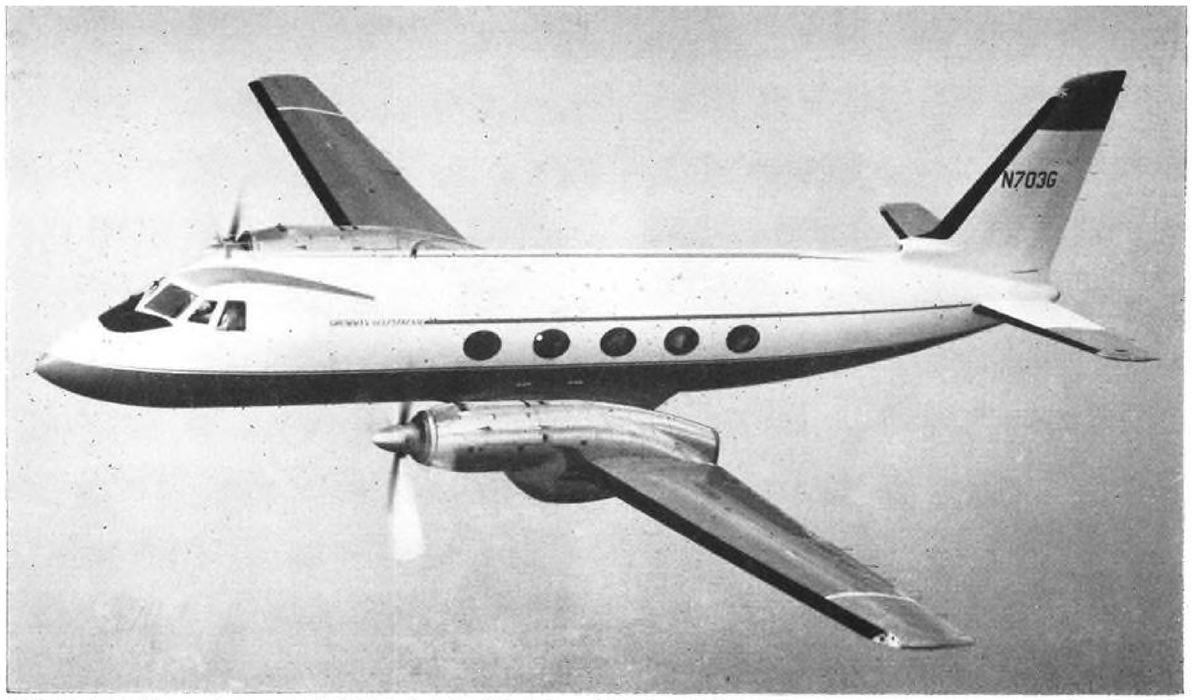
Guided tour of the solar system



The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT



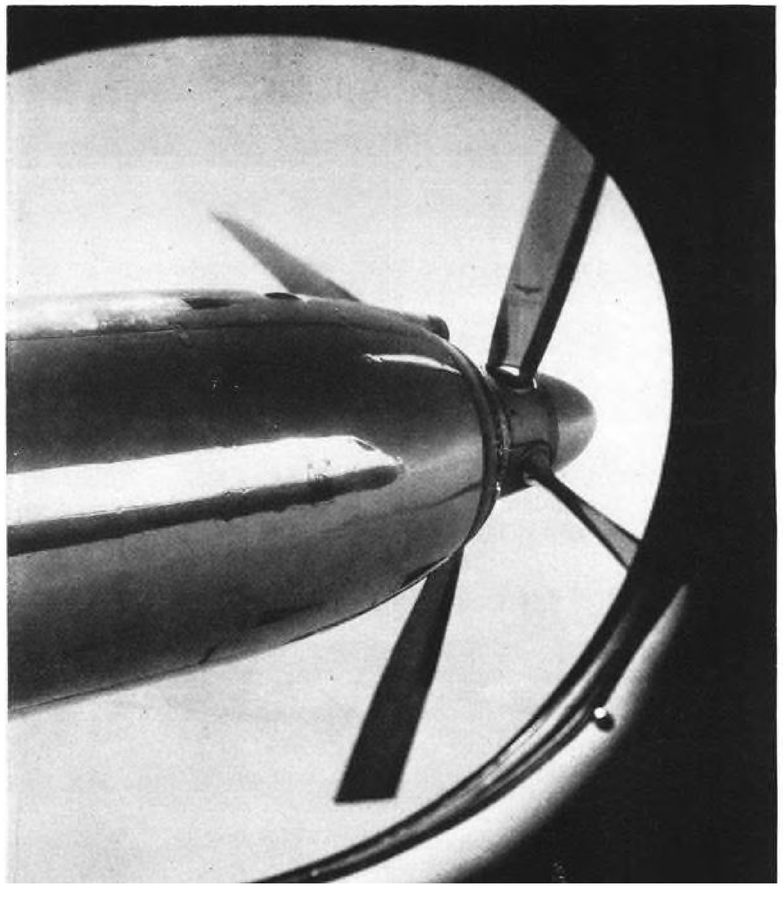
GRUMMAN Gulfstream has a span of 78.33 ft., length of 63.69 ft. and height of 22.84 ft. Maximum gross weight is 33,600 lb.

Aviation Week Pilot Report:

Gulfstream Is Easy to Handle, Rugged

WITH port engine feathered at 20,000 ft., Gulfstream indicated 170 kt. for 278 mph. TAS.

By Robert I. Stanfield



Bethpage, N. Y.—Grumman has worked the ruggedness of its military line into its pressurized, 350-mph., twin-turboprop corporate Gulfstream which, at 25,000 ft., has a range of 2,530 stat. mi. with 45 min. fuel reserve. It should pose few transition problems for pilots of executive piston-engine aircraft.

The 10-12 place executive airplane—in high-density configuration it will carry 19 passengers—is marked by a fast rate of climb, good single-engine and slow-flight characteristics, and low pattern speeds which combine with its ability to utilize 4,000-ft. runways at maximum weights.

Power is supplied by two Rolls-Royce Dart R.Da. 7/2 (Mark 529) turboprops, each generating 2,190 eshp. and 15,000 rpm. at takeoff. Propellers are four-bladed Rotols of 11 ft. 6 in. diameter. Engine-propeller gear ratio is .093. Grumman estimates current overhaul life at 1,000 hr. per engine, which is expected to be progressively increased to a par with the Rolls-Royce-6 engines which now run 1,800-2,000 hr. between overhauls.

Gulfstream operating weight (plus a crew of two) is 21,600 lb. Maximum gross weight is 33,600 lb. Landing gross weight is 32,000 lb. Basic cost of the air-conditioned, tricycle-geared aircraft is $896,000. Completed cost, including distributor installation of avionic equipment, instrumentation, interior layout according to buyer's needs and tastes, etc., runs about $1,046,000.

BUSINESS FLYING

Flight Capabilities

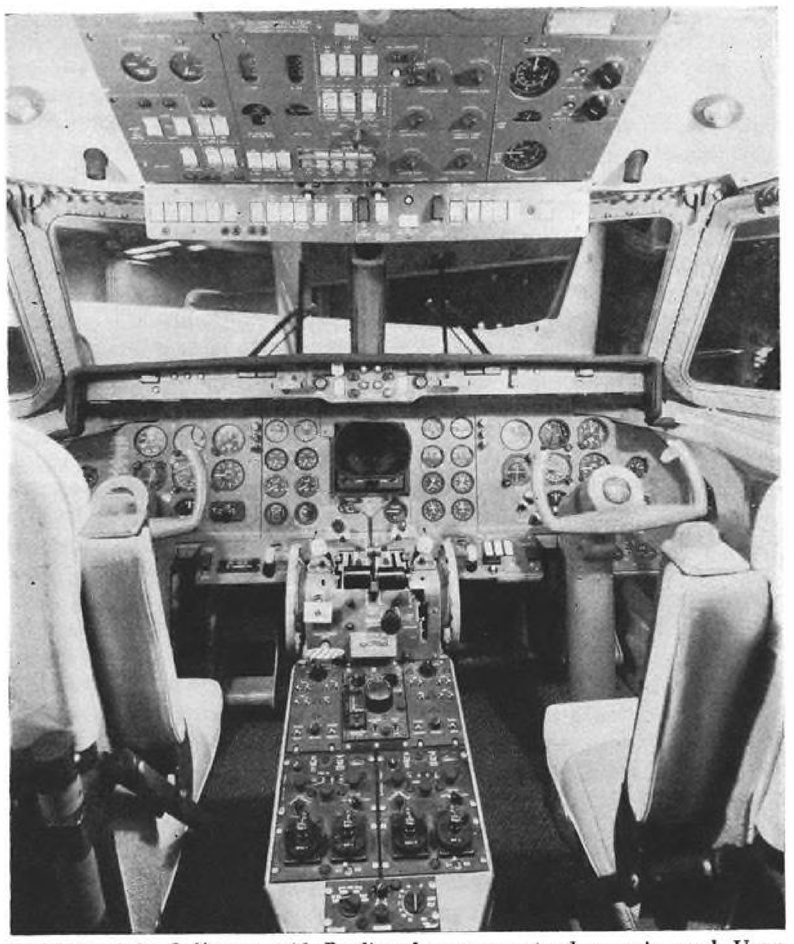
Airplane was first flown on Aug. 14, 1958. Federal Aviation Agency certification was received on May 25, 1959. Features evidenced during flight evaluation by AVIATION WEEK included:

• **Takeoff-landing distance.** Weighing 30,000 lb., with outside air temperature 21C and with a 10-kt. 90-deg. crosswind, the Gulfstream was airborne from Grumman-Bethpage after a run of 16 sec., covering about 1,500 ft. Additional takeoffs at Grumman-Peconic (Calverton, N. Y.), at lower weights into the 10-kt. wind, were made in as little as 1,200 ft. Landings resulted in easy turnoffs at the first intersection, 2,200 ft. from the end of the active runway. Landing rolls averaged 1,800 ft.

• **Rate of climb.** Initial rates of climb, with engines turning 15,000 rpm. and initial climb speed of 110 kt., ran from 2,500 to 4,000 fpm., varying with climb angle. Following first takeoff the Gulfstream crossed the end of Bethpage's Runway 15, 6,700 ft. long, at about 1,200 ft. altitude indicating 160 kt. Airplane ascended to 20,000 ft. in 16 min. for an average climb rate of 1,250 fpm.

• **Speed runs.** At 20,000 ft., normal cruise, engines were turning 14,000 rpm. Outside air temperature was minus 5C. Gulfstream indicated 210 kt. for a true airspeed of 300 kt. or 346 mph. At standard temperature, the latter figure would have exceeded 350 mph. Holding configuration at 12,500 ft., engines generating 11,200 rpm., outside air temperature 5C, produced an indicated speed of 125 kt. for a true reading of 151 kt. or 174 mph. Fuel flow into both engines was only 900 lb./hr.

• **Single-engine performance.** With the left engine feathered at 20,000 ft., the right engine to maximum continuous power of 15,000 rpm., the airplane stabilized clean at 170 kt. indicated for a true airspeed of 242 kt. or 278 mph. Stall in this configuration was preceded by warning (stick shaker) at about 105 kt. indicated, then buffeting. Docile, level break came at 90 kt. Simulated single-engine takeoff was later made, during which left power lever was pulled back following acceleration to rotation speed (V_r) of 98 kt. Airplane initially climbed at 115 kt. and



COCKPIT of the Gulfstream, with Bendix radar screen centered on main panel. Upper overhead panel contains switches and controls for pneumatic boots, deicing and electrical equipment, pressurization, APU. Center quadrant seats radio controls.



INTERIOR of demonstrator contains five seats which can be swiveled about, each adjacent to a window. Cabin is pressurized, as is rear baggage compartment.

1,000 fpm.; ascended through 1,500 ft. at 130 kt. and 1,200 fpm.

• **Rapid descent.** Initial descent from 20,000 ft., clean, with engines turning 11,000 rpm., was at an indicated speed of 260 kt., rate of descent 2,000 fpm. Dropping main gear (not nosewheel), which acts as speed brake, decreased descent speed to 225 kt. indicated and increased rate of descent to 3,500 fpm. Gulfstream later descended from 12,500 ft. at 6,000 fpm. In an emergency the airplane can descend 14,000 fpm. without exceeding V_{ne} (never exceed speed—310 kt. CAS below 15,000 ft.).

In appearance, the Gulfstream is a sleek and beautiful airplane. First design details of the airplane, Grumman design No. G-159, first appeared in AVIATION WEEK last year (AW Sept. 22, 1958, p. 82). The fuselage is circular with an outside diameter of 94 in. and inside diameter of 88 in. Cabin headroom is 73 in. without obstructions. Pressurized portion of the fuselage is 41.5 ft. long and includes the cockpit, passenger area and baggage compartment. Pressurization is 6.5 psi., maintaining sea level pressure at 15,000 ft. Five elliptical-type windows run along each side of the passenger area, each 17.5 in by 25.5 in. with the exception of two 19 in. by 26 in. windows which can be used for emergency exit over the wings. Emergency roof exit, 20 in. by 36 in., is located just aft of pilot's compartment.

Airplane structure in general is fabricated from aluminum alloy, with alloy steels, stainless steels and titanium used where advantageous. All metal, full cantilevered wing is of two-spar box beam makeup, continuous across the airplane's center line. Integral fuel tank area utilizes sealing system identical to that on the Grumman F11F-1F Tiger supersonic fighter. Tank area between the wing beams is approximately 22.5 ft. long on each side of the airplane.

Fuel is carried in two inner wing panels containing a total of 10,400 lb. of JP-1 in the integral tanks (775 gal. per tank). Two outer panels contain bladder cells for 300 lb. of water/methanol.

Fuel System

Fuel system utilizes four pumps, two in each tank at the inboard sections. All four are operated on takeoff; in flight one pump on each side is operated. Cross-flow system permits either tank to feed either engine. There is no fuel transfer system from tank to tank and no fuel dumping is provided.

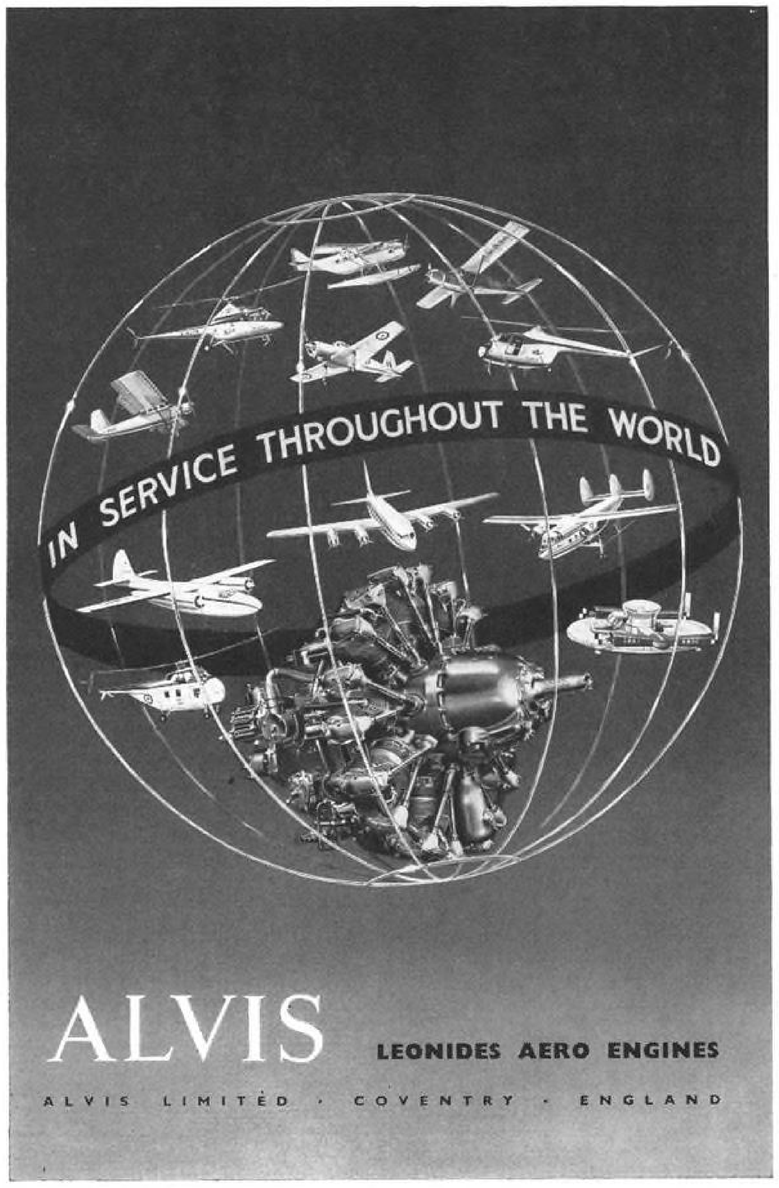
Fowler-type flaps occupy 57% of the span and 30% of the chord. Flap action moves surfaces rearward from 71% of wing chord to 95% of chord. Full control movement of flaps is 33 deg. Gulfstream's Rolls-Royce engines and components are interchangeable with those on the Vickers Viscount airliner. Jet pipe and tail cone of both engines are identical and interchangeable.

Gulfstream flown by this AVIATION WEEK pilot was production airplane No. 3, N-703G. Airplane was entered through its integral, self-contained stairway, which folds down from forward, port side of fuselage. This main passenger door is activated hydraulically via electric motor, though it will free-fall down.

Interior of N-703G was tastefully furnished, with five rows of two-abreast seats, each adjacent to a window. Each seat can be swiveled. Furnishings included two desks, one on each side forward of seat rows, enclosed lavatory, forward galley, 28 cu. ft. of luggage space in forward cabin and pressurized rear baggage compartment of 100 cu. ft.

Cockpit, Instrumentation

Cockpit of the Gulfstream is comfortable and roomy. Crew seats, with hinged arm rests, are adjustable fore and aft. Forward windshield is of bird-and-splinter proof construction, electrically heated. Sliding direct vision panels, one inch thick, can be used for emergency escape. Side windows, of three-ply construction (two glass and



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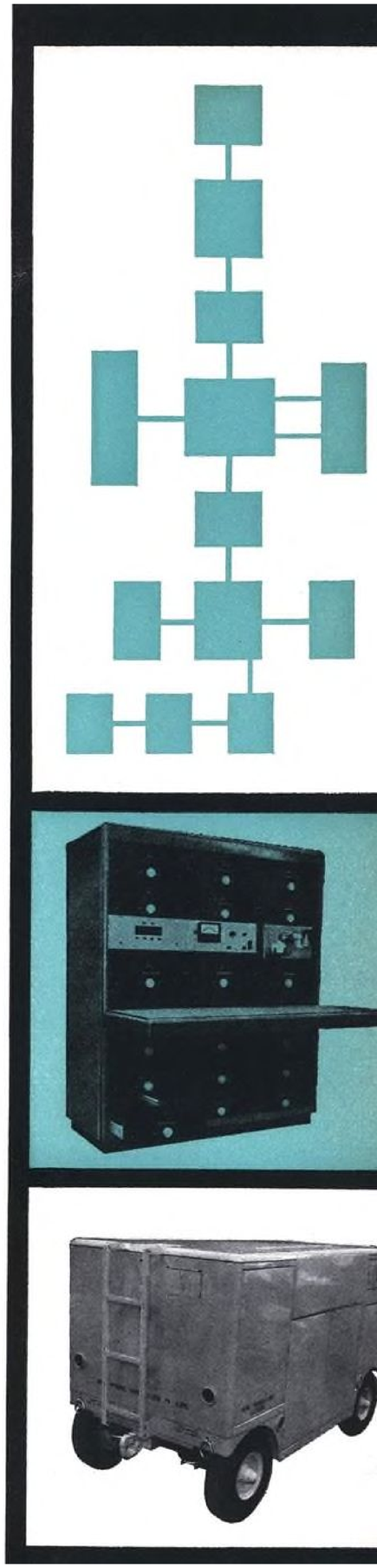
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See and order the Collins 618F-1 at the NBAA show in October.



GULFSTREAMS on the line at Grumman's Bethpage, L. I. plant. To date 15 aircraft have been produced, at the rate of three a month.

one vinyl) can have defogging installed as optional equipment.

Dual controls are provided. Flight instruments are arranged in "Basic T" form with duplicate flight panels facing each pilot and engine instruments are centered. Auxiliary eyebrow panel runs across the top of the main instrument panel. Upper overhead panel seats switches and controls for pneumatic boots, deicing and electrical equipment, auxiliary power unit, pressurization and cockpit lights. Lower overhead panel contains switches-controls for lights, landing lights, windshield heat, boost pumps, engine starts, fuel crossfeed. Circuit breakers are located behind both pilots.

Master caution light display panel sits forward and adjacent to both pilot and copilot. Radio controls are mounted on center quadrant. Power levers are mounted on center control console, along with high-pressure fuel cocks, flap control, fuel trim switches, rudder and aileron trim wheels. Elevator trim wheels for each pilot are located to each side of the center console. Demonstrator gear handle was mounted forward-right of the center quadrant, on main panel, but could be (and was) easily activated from the pilot's side.

Mechanical gust-locks, controlled from cockpit, are geared to 60-kt. gusts and provided for elevators, ailerons and rudders. Interlock prevents both engines from being simultaneously run up with gust locks activated, preventing accidental takeoff with locks in place.

Airplane also is equipped with auxiliary power unit (an AiResearch gas turbine compressor) located in tail, which can be used as an alternate source of air and during ground operation. APU runs off main fuel supply and may be utilized for ground heating or cooling at extreme temperatures, and for ground operation of radios, lights, emergency inflight pressurization, battery charging, etc.

Along with AVIATION WEEK pilot during this evaluation was John R. Jefferies, of Grumman's commercial sales department, and three passengers. With 6,000 lb. of fuel aboard, weight of the airplane approximated 30,000 lb. Wind

Grumman Gulfstream Range, Engine Data

Range With 45 min. Fuel Reserve

CRUISE ALT.	Maximum Cruise Speed			Maximum Range Speed		
	Range (Stat. mi.)	Speed (TAS)	Fuel Flow (lb./hr./engine)	Range (Stat. mi.)	Speed (TAS)	Fuel Flow (lb./hr./engine)
10,000 ft.	1,640	345 mph.	1,020	1,865	260 mph.	640
15,000 ft.	1,900	350 mph.	890	2,080	270 mph.	600
20,000 ft.	2,070	353 mph.	790	2,320	285 mph.	580
25,000 ft.	2,320	357 mph.	680	2,530	300 mph.	540

Rolls-Royce Dart R.Da. 7/2 Ratings (Standard Day)

	Horsepower	Rpm.	Jet Thrust	Specific Fuel Consumption
Takeoff	2,190 eshp.	15,000	510	.721 lb./hp./hr.
Normal Cruise (25,000 ft., 304 kt. TAS)	1,082 shp.	14,000	87	.616 lb./hp./hr.

general characteristics

	valve pressure drop 1000 psi	3000 psi
Maximum rated flow		
Series 31	4 gpm	7 gpm
Series 32	8 gpm	14 gpm
Operating supply pressure	50 psi to 4000 psi	
Electrical signal power	40 milliwatts minimum	
Temperature range (fluid and ambient)	—65°F to 350°F standard, to 450°F or 600°F on special order	
Resolution	<½%	
Hysteresis	<3%	
Null shift		
temperature —65°F to 450°F	<4%	
acceleration to 50g	<5%	
supply pressure 80% to 100%	<2%	
quiescent current 50% to 200% rated current	<2%	
back pressure 0% to 20% of supply	<2%	
Weight (approximate)	0.75 pounds	

series 31 and 32

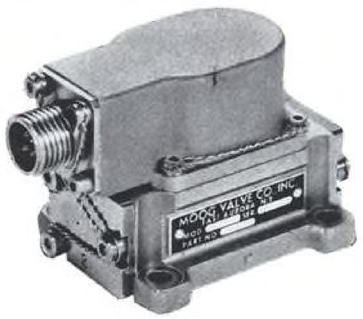
flow control

servovalves

with mechanical feedback

from

MOOG:



Series 31 and 32 servovalves are miniaturized two-stage flow-control valves which utilize internal mechanical feedback. Features of the new design include high performance, simplification and compactness, together with a wide temperature capability. Specific valve characteristics can be achieved other than the ones listed above.

Write for catalog 310 and individual model data sheets that illustrate typical performance variations.

MOOG SERVOCONTROLS, INC. PRONER AIRPORT, EAST AURORA, N. Y.

LEADING INNOVATOR AND PRODUCER OF ADVANCED ELECTROHYDRAULIC SERVOVALVES

at takeoff varied from 230-260 deg. at 10 kt. Sea level pressure was 30.27. Outside air temperature was 21C. Field elevation at Grumman-Bethpage is 119 ft.

As with most turbines, engines were quickly started and the Gulfstream taxied smoothly at 11,000 rpm. to Runway 15, for a crosswind takeoff. Temperature was checked against fuel datum indicator, takeoff flaps were lowered, and on taking the runway airplane was held with brakes while full power (15,000 rpm.) was applied and all instruments checked.

With brakes released the Gulfstream accelerated fast, rudder taking hold from nosewheel steering at about 40 kt. Airplane quickly passed through V_1 (critical engine failure speed; in this case 92 kt.) and rotation speed of 98 kt., where light back pressure had the Gulfstream airborne after a ground run of about 1,500 ft., in 16 sec. With gear up, followed by flaps, and with power reduced to 14,000 rpm., the Gulfstream climbed at 160 kt. indicated, passing over the end of the 6,700-ft. runway at about 1,200 ft.

Climb Rate

Climbing through 8,000 ft., still indicating 160 kt., rate of climb was 2,000 fpm. Torque pressure was 290 lb. per engine. Turbine gas temperature was 740C. Fuel flow was 950 lb./hr. per engine. Visibility was good, climb angle being fairly shallow, and noise level was not excessive—we didn't have to raise our voices during conversation. During climb, the airplane trimmed out neatly for hands-off flight.

Going through 12,000 ft. the indicated speed had dropped to 150 kt. and rate of climb was 1,500 fpm. Fuel flow was 850 lb./hr. per engine. Still climbing at 17,500 ft., indicated speed now at 135 kt., the rate of climb was 1,000 fpm. Fuel flow was 750 lb./hr. per engine. Torque pressure was 225 lb. (for each powerplant) and turbine gas temperature 740C. Rate of climb held to 20,000 ft., where airplane was leveled off, 16 min. after takeoff, for an average climb rate of 1,250 fpm.

At normal cruise, engines turning 14,000 rpm., the airplane was quite comfortable; there was a minimum of noise, and temperature level was good. Cabin altitude was 2,500 ft. Visibility was good, and we had a full view of the engines from the cockpit. Turbine gas temperature held to 740C, engine torque ran about 220 lb., and fuel flow was 700 lb./hr. per engine. With outside air temperature —5C, airplane indicated 210 kt. for a true airspeed of 300 kt. or 346 mph.

Gulfstream was quite stable and responsive at all speeds and in all configurations during this evaluation. Only light control forces are necessary, and



U. S. Air Force Academy mascot "Mach I" inspects nose dome—part of Texas Instruments infrared optics that lead falcon missile to impact.

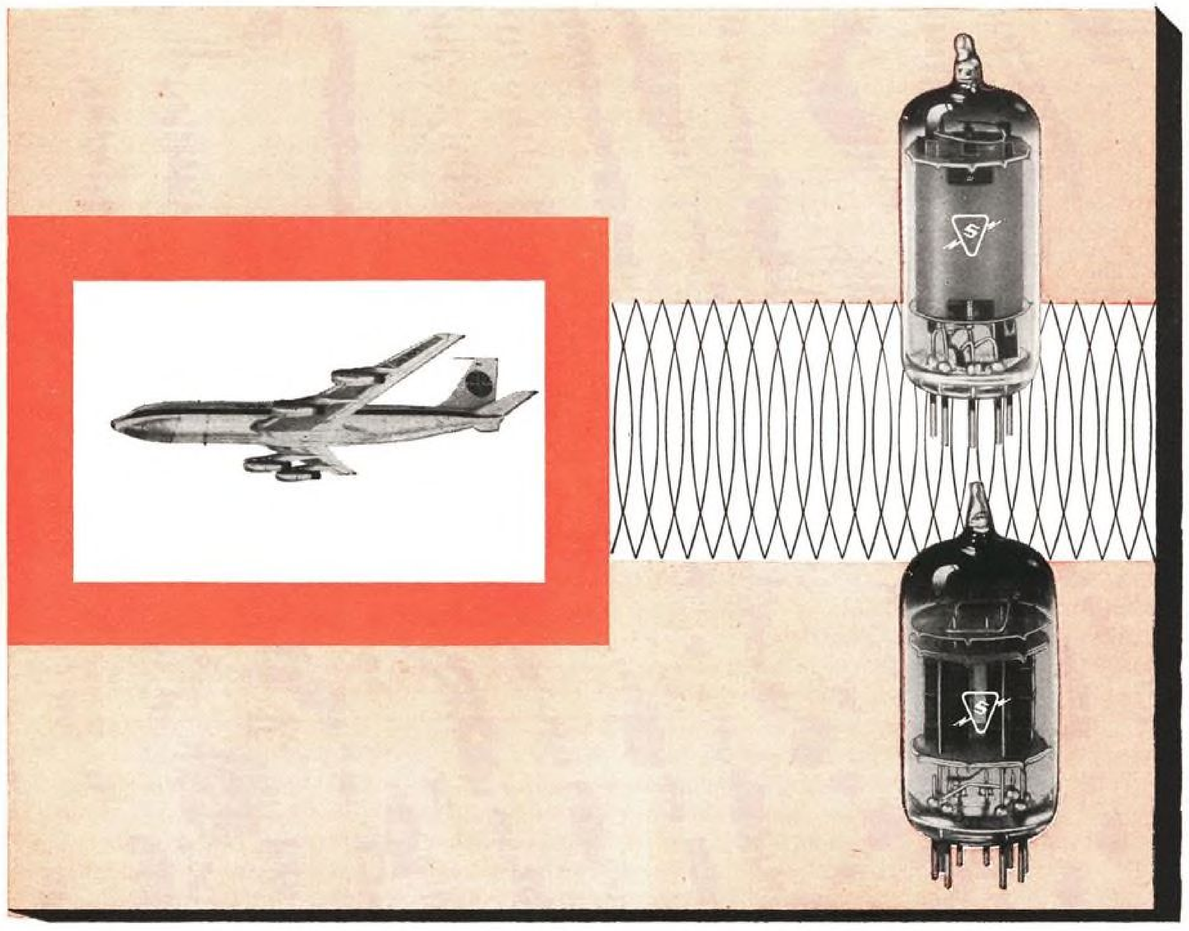
INFRARED SPECS FOR THE FALCON

Falcon Missile— as deadly as its feathered namesake — is guided to the kill by Texas Instruments infrared optics. Unlike nature's Falcon, this Air Force missile has only the combative instinct, attack accuracy, and destructive impact that are built into it at the design and manufacturing levels.

Imparting these instincts to inanimate systems is the business of TI optics engineers and craftsmen. Leading designers and producers of silicon, germanium, quartz, and other optics for infrared applications, the TI optics team has fingertip familiarity with unusual materials suited to specific portions of the spectrum. In one of the nation's best equipped facilities, TI optics specialists grind, polish and coat components with accuracy that exacts the most from even the weakest infrared signal. This experience can work for you. Whatever your needs . . . prisms, lenses, windows . . . TI's full-time engineering service, modern computers, and complete optics facility can meet your requirements from design to delivery. For detailed information on any phase of precision optics technology, contact SERVICE ENGINEERING.

TEXAS INSTRUMENTS INCORPORATED
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SYLVANIA GOLD BRAND TUBES...



and the new standard for the jet age

Today, every major airline uses Sylvania Gold Brand tubes. And in the new jet airliners, where the demand for top performance and reliability is more than ever a critical necessity, Sylvania Gold Brand types are becoming the leading choice. On Pan American's Boeing Jet 707 Airliners over 27 Sylvania types are in daily use.

Sylvania has developed a line of 47 Gold Brand tubes specifically designed for commercial and industrial applications. They are identified with a GB prefix and have become one of the fastest growing tube lines in the electronics industry. They are manufactured to special Gold Brand specifications that tailor the highest military standards to the individualized requirements of commercial and industrial equipment.

For premium quality and performance in any electronic application, use the tubes with the Gold Brand, from Sylvania.

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SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
P. O. Box 1190, Station "O," Montreal 9

Grumman Gulfstream Specifications

Span	78.33 ft.
Length	63.69 ft.
Height	22.84 ft.
Passenger capacity (plus crew of two):	
Executive	10 to 12
High density	19
Empty weight	18,500 lb.
Operating weight (plus crew of two)	21,600 lb.
Zero fuel weight	26,170 lb.
Maximum gross weight	33,600 lb.
Landing gross weight	32,000 lb.
Positive maneuver limit load factor (33,600 lb.)	2.5
Wings:	
Root chord	134 in.
Tip chord	53 in.
Mean geometric chord	99.35 in.
Incidence at tip	0 deg.
Incidence at root	plus 3 deg.
Leading edge sweepback	4 deg. 15 min.
Dihedral	6 deg. 30 min.
Aspect ratio	10
Wing loading	54.5 lb./sq. ft.
Power loading	7.66 lb./eshp.
Ailerons:	
Span	153 in.
Chord (average, aft of hinge line)	25.5%
High lift device:	
Flap type	single slotted
Span (per cent wing span)	57%
Chord (average per cent wing chord)	29%
Horizontal tail:	
Span	306 in.
Chord (MGC)	64.25
Dihedral	6 deg. 30 min.
Aspect ratio	4.81
Total area	136 sq. ft.
Stabilizer area	98.76 sq. ft.
Elevators (aft of hinge line)	17.5 sq. ft.
Vertical tail:	
Total area	117.1 sq. ft.
Fin	88.4 sq. ft.
Rudder (aft of hinge line)	28.7 sq. ft.
Fuel capacity	1,550 gal.
Pressurization	6.5 psi.
Propeller ground clearance	18.5 in.
Propeller fuselage clearance	30 in.
Main wheel tread	290 in.
Main wheels (dual)	7.50 by 14
Nose wheels (dual)	6.50 by 8

Engines: Two Rolls-Royce Dart R.Da. 7/2 (Mk. 529) generating 2,190 eshp. and 15,000 rpm. at takeoff.

Propellers: Two Rotol four-bladed, of 11 ft. 6 in. diameter.

it takes only a minute or so for a pilot to get the "feel" of this airplane. Left engine was feathered while we kept our feet on the floor, and only slight aileron application was necessary to hold directional control. Only about two deg. of rudder trim was applied.

Speed Brake

Stall at this altitude, airplane in clean configuration with the left engine feathered, and descent to 12,500 ft. with engines turning 11,000 rpm., were as described earlier in this article. With speed brake (which in Gulfstream is the main gear, but not nosewheel) descents ranging from 4,000 fpm. to 6,000 fpm. are normal for operational practices.

At 12,500 ft., engines turning 11,200 rpm., airplane was flown in holding configuration and indicated 125 kt. With outside air temperature 5C, true airspeed was 151 kt. or 174 mph. Torque was 100 psi. Turbine gas temperature was 560C and fuel flow was 450 lb./hr. per engine.

Gulfstream again was stalled, both clean and "dirty" (gear and full flaps extended). In clean configuration, power held to 90 lb. torque, the stall warning—a stick shaker—came at about 100 kt. and buffet, then stall, at 92 kt. indicated. In landing configuration, same power setting, stall warning came at 80 kt. and full stall at 68 kt. indicated.

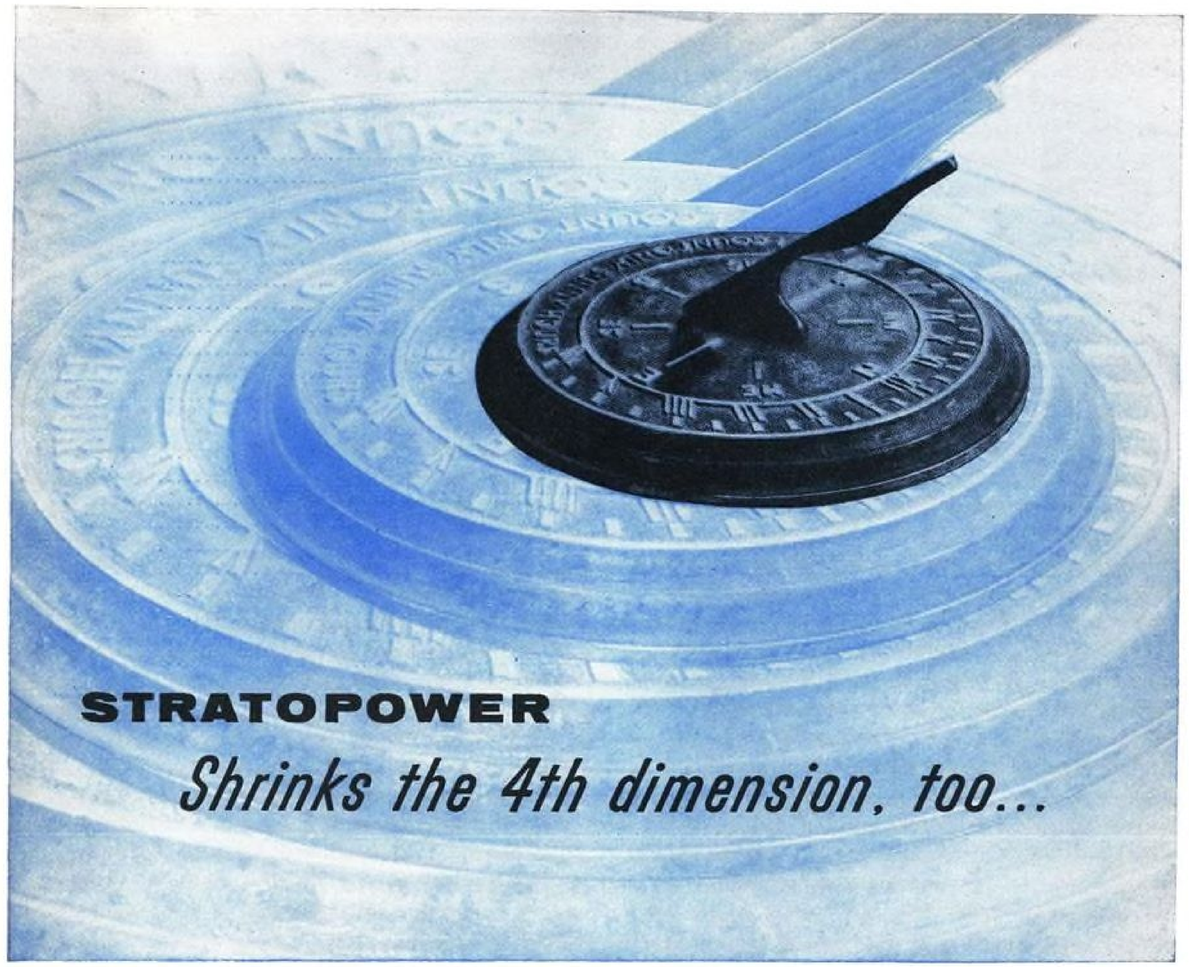
In both instances recovery was quick: there were no abnormal tendencies, rather a straight-away break in which normal recovery procedures brought an altitude loss of no more than 200 to 300 ft. In fact, following recoveries by AVIATION WEEK pilot, Jefferies worked through a stall in landing configuration, effecting recovery in less than 100 ft. of altitude loss. No dishonest features or characteristics were apparent in this airplane.

Dropping down to 3,000 ft., a simulated single-engine go-around was made. Gear was lowered, and right engine reduced to 400 lb. fuel flow to simulate feathering. Takeoff flaps were initially

Grumman Gulfstream Performance

(Standard day, max. gross weight, unless stated otherwise)

Maximum gross weight	33,600 lb.
Takeoff distance (over 35 ft.)	2,800 ft.
Takeoff distance, engine lost V_1 (over 35 ft.)	4,360 ft.
Takeoff distance, 32,500 lb., engine lost V_1 (over 35 ft.)	4,000 ft.
Critical engine failure speed (V_1)	96 kt. IAS
Rotation speed (V_r)	100 kt. IAS
Takeoff safety climb speed (V_2)	110 kt. IAS
Minimum control speed (V_{mc} decreasing 1 kt. per 1,000 ft.)	100 kt. IAS
Stall speed, takeoff	84 kt. CAS
Stall speed, landing (28,000 lb.)	78 kt. CAS
Approach speed (28,000 lb.)	101 kt. CAS
Normal operating speed (V_{no} below 15,000 ft.)	290 kt. CAS
Never exceed speed (V_{ne} below 15,000 ft.)	310 kt. CAS
Design diving speed:	
V_d below 15,000 ft.	342 kt. CAS
M_d above 15,000 ft.	Mach .675
Landing distance (28,000 lb., over 50 ft., engine feathered)	2,180 ft.
Service ceiling (28,000 lb.)	36,900 ft.
Service ceiling (28,000 lb., engine feathered)	20,250 ft.
Rate of climb (28,000 lb., sea level)	3,010 fpm.
Rate of climb (28,000 lb., sea level, single-engine)	1,030 fpm.



STRATOPOWER

Shrinks the 4th dimension, too...

Cuts the time and cost lag between

development and production

With each new design STRATOPOWER packs more and more performance into less and less space. This is evident in the equipment itself.

Less evident but no less true is the fact that each year STRATOPOWER is delivering more and more development results and production items in less and less *time*. This is because, at STRATOPOWER, contracted development is balanced with STRATOPOWER's own development effort to yield a continuous, well-rounded program of creative research in aircraft hydraulics.

No problem in hydraulics, however difficult, is ever completely dissimilar to projects already underway. The skill, tooling and materials are always at hand, whether the need is for testing at 1200°F (1200°F facilities were installed at STRATOPOWER early in 1958), production of a simple constant delivery pump (shipped by the thousands by STRATOPOWER), or development of a compact, complex hydraulic power package (such as the one shown in the accompanying illustration).

Talk to your STRATOPOWER representative. You may be surprised to hear him telling you what your hydraulic problems will be a year or two years from now. He knows, because STRATOPOWER is already there, anticipating the needs of the aircraft industry. It's no secret how STRATOPOWER licks the time lag to shrink the 4th dimension.

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lowered, then approach flaps—about 20 deg. On the go-around, gear was raised, flaps retracted to "takeoff" position, and full power—15,000 rpm.—applied to left engine. Climb at V_2 (takeoff safety climb speed) was made at 110 kt.; initial climb rate was 900 fpm. (This without full power, or water methanol.)

With flaps fully retracted, the airplane briefly accelerated in forward flight, climb speed increasing to 130 kt. indicated and rate of climb to 1,000 fpm. A similar simulated single-engine climbout was later made from takeoff, during which the airplane was airborne in about 1,200 ft. and the engine cut back (to 400 lb. fuel flow) simultaneously. Initial climb in this case was at 115 kt. at 1,000 fpm. Flaps were retracted at 800 ft., airplane accelerated to 130 kt., and, with water methanol off, the airplane climbed through 1,500 ft. at 1,200 fpm.

Extension and retraction speeds for flaps are 140 kt. CAS to landing position; 220 kt. CAS to takeoff position. Limit speed for main and nose gear is 200 kt. CAS. For the speed brakes (main gear), maximum speed is V_d (design diving) which amounts to 342 kt. CAS below 15,000 ft. and Mach .675 above.

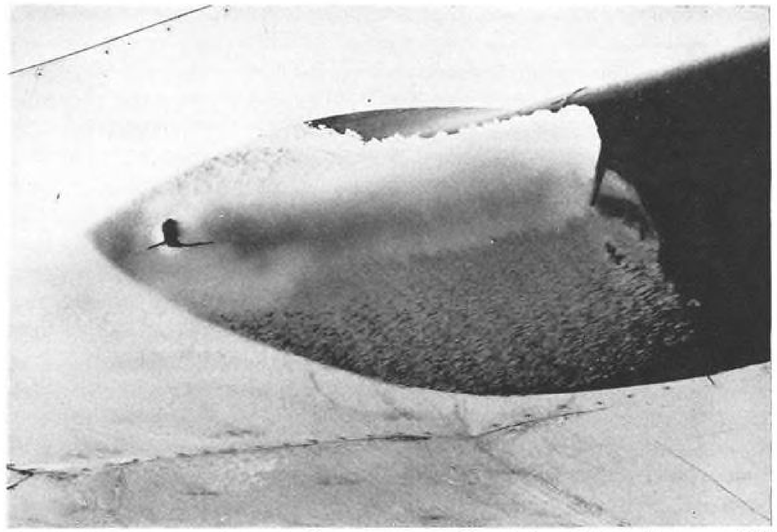
Prior to shooting landings, a simulated ILS approach was made with engines initially turning 11,000 rpm., gear lowered and takeoff flaps dropped. With approach flaps dumped over the outer marker, and engines holding about 100 psi. of torque, smooth rate of descent was set up—500 fpm. at 120 kt. indicated. This is not a hard airplane to fly at any speed, and approach and pattern speeds are not excessive for this fast turboprop.

Landing Pattern

Gulfstream is normally flown about 125 kt. on downwind, 115 kt. on base and 105 to 110 kt. on approach. We followed this pattern during landings at Grumman-Peconic in Calverton, N. Y. (elevation 75 ft.), using Runway 23 into a wind of 10 kt. In each instance takeoff flaps were lowered on downwind, approach flaps turning onto final, then landing flaps.

Power applied during downwind run averaged about 12,000 rpm. On reductions below 11,000 rpm. about 90 to 100 lb. of torque gave the necessary power for lowering of approach flaps. Touchdown was made in all instances at about 90 kt. and airplane immediately slowed down as props were reduced to ground-fine pitch. All turnoffs were made at the first intersection, 2,200 ft. from the approach end of the runway. Landing rolls averaged about 1,800 ft.

Should an engine malfunction have occurred during takeoff, or at any altitude, automatic feathering would occur



IN-FLIGHT icing tests of the Gulfstream were conducted from Wright-Patterson AFB, Ohio, in Feb. Accumulations up to 3 in. were made.

provided the throttle was advanced beyond the 11,400 rpm. position and torque pressure dropped below 50 lb. Once one engine feathers automatically, system cuts out, preventing both engines from being feathered at the same time.

Fifteen Gulfstreams have been produced to date, at the rate of three a month. The rate can be increased, depending on orders. Grumman currently has orders for 40 airplanes, and feels that the break-even point will be 125 to 150 aircraft. Company estimates that about 500 corporations are capable of financially owning an airplane in this category.

Delivery from Grumman to its distributors can follow initial customer order by five to six months. Distributors include Atlantic Aviation, Wilmington, Del.; Southwest Airmotive, Dallas, Tex.; Pacific Airmotive, Burbank, Calif., and Timmins Aviation, Montreal, Can. Of the 15 aircraft produced to date, the first prototype is being utilized by Grumman as a test airplane, the second has been leased to the Federal Aviation Agency (with option to buy), the third is a demonstrator, and the fourth has been delivered to Sinclair Oil Co.

Grumman emphasizes that worldwide service is available for Gulfstream purchasers. In addition to its distributors, the company has 250 service personnel scattered throughout the United States and overseas. Customer pilots and technicians are being checked out at the company's Bethpage school, which will have put 131 persons through four three-week courses as of Sept. 30. Average pilot checkout, for rating, runs about 8 hr. Company also recommends attendance at the Rolls-Royce school in Montreal.

Gulfstream hydraulics are activated by a 1,500 psi. system, with pressure supplied by two variable volume, engine driven pumps. Hydraulically operated units include wing flaps, landing gear, wheel brakes, door and stairway, windshield wipers, nose-wheel steering, propeller brake.

Electrical system furnished both a.c. and d.c. power, and is composed of four components: (1) primary system, energized by two d.c. generators, one in each engine, connected in parallel (either will carry load in event of engine failure); (2) secondary system is a.c. power system composed of two 1,500 v. inverters powered by the d.c. generators; (3) standby system consists of battery power; (4) auxiliary system consists of two a.c. alternators driven by the engine accessory gearbox.

Engine-driven supercharger acts as a source of pressurized air. Auxiliary power unit acts as a second source. Pressure controls enable pilot to vary his isobaric range from sea level to 8,000 ft. and rate of cabin altitude change from 50 fpm. to 2,000 fpm. Should cabin altitude exceed 10,000 ft., warning light will so indicate.

Cooling is provided by a bootstrap air cycle system employing water separation to reduce humidity. In event of equipment failure, airplane may be ventilated with ram air. Heating is accomplished by heat of compression supplied by the pressure sources.

Wing and tail are deiced via high-pressure Goodrich pneumatic boots. Front windshield is electrically heated. Control cable systems are conventional, manually operated type, utilizing pulleys, bellcranks, pushrods, with antifriction bearings used throughout the system.



BELL 47J helicopter arrives at North American Aviation's Field Propulsion Laboratory, where rocket engines are tested.

Inter-Plant Helicopter Saves Time

Los Angeles—North American Aviation, Inc., finds that use of a company-owned light helicopter is saving many costly executive and engineering hours in connecting its general offices with outlying plants and also serves in emergencies for rushing high-priority parts shipment from its plants to outbound airplanes.

In the 12-month period from August, 1958, when it put its Bell 47J Ranger helicopter in operation, through July, 1959, the four-place Ranger has logged close to 600 flight hours, made more than, 1,770 trips and carried approximately 1,800 passengers.

Company considered the time-saving feature of the rotary-wing courier aircraft important enough to build a heliport atop the roof of its general offices building across from Los Angeles International Airport.

North American Pilot Melvin C. Nowack flies no set schedule, is on alert for service as needed. Since the start of operations from the general offices rooftop heliport last March, Nowack has been averaging between 60 and 70 hr. a month carrying approximately 200 passengers on a like number of trips. North American estimates that since it got the Ranger it has saved key company and government personnel more than 1,200 working hours. Approximately 45 min. are saved using the aircraft from the heliport to visit North American's Canoga Park Rocketdyne facility or Autonetic or Missile Divisions at Downey. Trip can take approximately an hour by car through heavy traffic areas.

Once, when Nowack was en route from Canoga Park to his home base, he received a call that an urgently needed part for a ballistic missile had to make a Douglas DC-6 bound for Cape Canaveral leaving the International Airport in a few minutes. Only 15 min. after a call to Rocketdyne to have the material ready, it was airborne in the Ranger and heading for the airport.

Cutting hours from transporting vital interplant mail is another important function of the helicopter's courier duties.

Nowack reports that there have been few times that weather has kept the helicopter grounded and that except for a 300-hr. overhaul it has never been down for unscheduled maintenance. He also notes that he has not yet made an unscheduled autorotation landing.

Douglas, Northrop and Hughes also are among the West Coast aviation companies using helicopters for courier duty and as air-rescue standby vehicles when they have aircraft on flight test over water areas.

U.S. Business & Utility Aircraft Shipments

JULY, 1959

Manufacturer & Model	No. of Units	Net Billings
Aero Design 500	7	$1,293,000
560E	4	
680E	8	
720	1	
Beech 18S	8	$2,970,000
Bonanza	43	
Mentor	...	
Twin Bonanza	6	
95 Travel Air	13	
Call Air Model A5	7	$49,000
Model A6	...	
Cessna L-19	...	$3,056,000
150	43	
172	43	
175	28	
180	25	
182	63	
310B, C	19	
Colonial C-2 Skimmer IV	12	$247,000
Champion Model 7EC	6	$128,000
Model 7FC	7	
Model 7GC	10	
Helio H 391B Courier	N.A.	N.A.
H395 Super-Courier	N.A.	
Mooney Mk. 20	22	$254,000
Piper Super Cub	25	$2,836,000
Tri Pacer	61	
Apache	33	
Comanche	80	
Pawnee	5	
Total	567	$10,586,000

N.A.—Not Available.

PRIVATE LINES

Export sales of $7,295,116 during 11 months of Fiscal 1959 by Beech Aircraft Corp., Wichita, Kans., represents a 69% increase over the same period a year ago. Totals include delivery of 91 Beech Mentor trainers.

License for Douglas DC-3 modernization program has been granted to Southwest Airmotive Corp., Love Field, Dallas, by originator of the modifications, Pan American World Airways' Brownsville, Tex., customer service base. Under the agreement the licensee will handle the improvements in its own shops, manufacture and sell replacement parts. Southwest Airmotive opened a shop to assemble all types and sizes of Aeroquip hoses and fittings at its Fairfax (Kansas City, Kans.) Municipal Airport parts distribution base.

Aeroflot agricultural aircraft will seed, dust and spray 44.5 million acres of state and collective farms in the Soviet Union this year, an estimated 5 million more acres than in 1958.

Czechoslovakia's Motorlet Aircraft Works, Jinonice, plans a 56% increase in production of lightplane engines this year. Types will include Walter Minor four and six cylinder engines for twin-engine Super Aero 45 and Morava L-200 air taxis, also for L-40-D, Meta Sokol and Trener-226 club and training aircraft. Plant recently developed a four-cylinder 140-hp. Minor 332 engine.

Quantity deliveries of Tactair T-3 autopilot for Cessna 310 installation will begin this month from the company's Bridgeport, Pa., plant. Three-directional T-3 for the 310 costs $3,285.

Merger of Agricultural Aviation Engineering Co., Inc., and Pickell & Associates has been completed. Former firm is a agricultural and industrial aviation engineering research and design specialist—other is a manufacturing concern. Operations will be expanded and consolidated in Santa Clara, Calif., near San Jose Airport. Company's latest product is a 150-gal. reinforced Fiberglas spray tank system for Hiller UH-12E helicopter. System can be used with boom-type dry chemical dispersal units, now under development.

Cie Gyrafrique Nord plans to expand rescue and resort flight operations in French Alps by adding three Bell 47G-2s to present single helicopter operating in this region now. Company, which currently has a fleet of 21 helicopters, specializes in North African operations, primarily geological prospecting for petroleum firms. It has logged more than 30,000 hr. in this region.

Contact Airways Corp., Sioux Falls, S. D., is new distributor for Cessna airplanes in the Dakotas, making the 39th Cessna distributorship in U. S. and Canada.

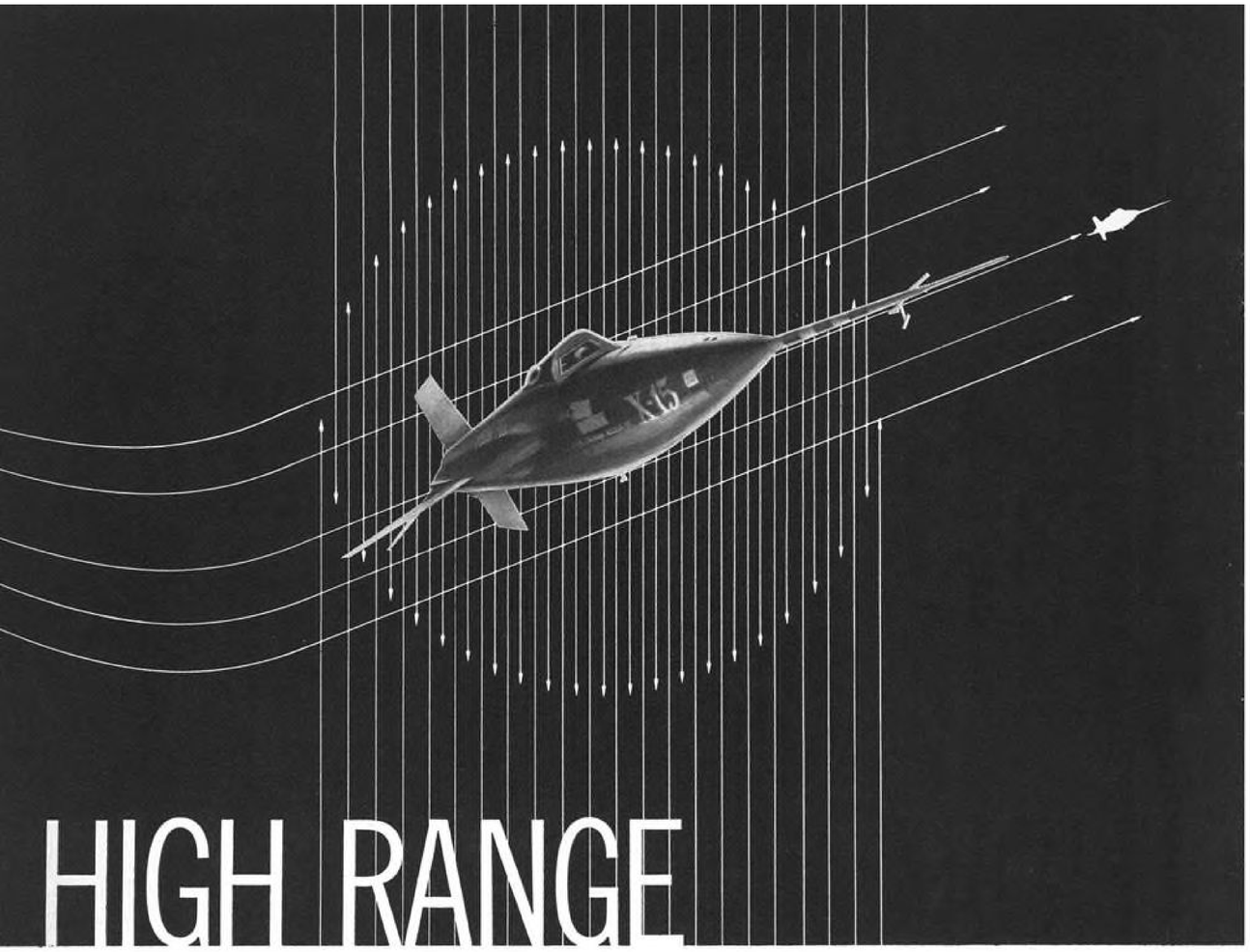
A 360-channel VHF transceiver weighing 12.6 lb. for light and medium business aircraft has been developed by Collins Radio Co., Cedar Rapids, Ia. New 618F-1 will provide minimum of six watts output, covers the 118-135.95 mc. band with 50 kc. spacing, uses digital tuning and features single and double channel simplex. Unit measures 3¾-in. x 5¾-in. x 9$\frac{7}{32}$-in. including cable connectors.

Sunny South Aircraft Service has opened its new $325,000 facility at Broward County International Airport, Fort Lauderdale, Fla. New facilities include three major buildings just south of the new Broward terminal. Area includes 15 T-hangars. Robert Uricho, Jr., president, said new hangar will be added next year.



One Design Sailplane Regatta

Nineteen Schweizer 1-26 sailplanes competed recently in the 5th annual 1-26 National Championship meet at Elmira, N. Y. Otto Zauner of Vineland, N. J., won the new Schweizer Perpetual 1-26 Trophy. Majority of the sailplanes were built from kits.



HIGH RANGE

Radar and telemetry equipment capable of spearing a speck in space records historic flights of X-15 across three-state test range

Built by Electronic Engineering Company of California

When the Air Force, National Aeronautics and Space Administration and U. S. Navy authorized a 485-mile "inner" spaceway, 50 miles wide, for testing North American's new X-15, they sought a company with enough space-age background to design and build everything from radar digital data systems to access roads.

Awarded the prime contract was Electronic Engineering Company of California, a research and development firm with more than a decade of electronic missile range instrumentation experience gained at Cape Canaveral and Point Mugu.

Along the range between Wendover, Utah, and Edwards Air Force Base, California, EECo engineers established two radar and telemetry monitoring stations on mountain tops near Ely and Beatty, Nevada; a third, the master control station, was set up at the NASA High Speed Flight Station, Edwards Air Force Base. Each station incorporates a space positioning system, a precision data recording system and a constant-contact air-ground communications system.

When the X-15 drops from the B-52 mother ship and soars into space, this electronic complex goes into action, providing flight test engineers with a continuous stream of vital information. A flight surgeon, for example, will watch a radiocardiograph of the pilot's heart action, as well as a dynamic graph of his body temperatures; three engineers will give the pilot an assist by watching and reporting certain critical pressures and temperatures; every event in space will be faithfully recorded.

From the data telemetered to the ground and recorded within the X-15 will come the knowledge required for man's next step into space.

A detailed report on HIGH RANGE is contained in EECo's latest R&D Review. For your copy, write the Technical Literature Department.

Several important career opportunities have just opened up in EECo's engineering department. For further information, call or write Merl Perkins.

Electronic Engineering Company *of California*

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Business Flying Shows Strength

New York—Business plane manufacturers—Beech Aircraft Corp., Cessna Aircraft and Piper Aircraft—have tended to suffer less than the predominantly military producers in the stock market decline and market analysts still look with favor on the group.

Of the three, Piper has weathered the change in climate a shade better, perhaps because its business last year was 98% commercial.

Before the recent rally its stock had dropped 21% in price from its high of 42 for the year, compared with Cessna's 22% from a high of 89 and Beech's 25% from a high of 40. Similar decline averaged 36% for 10 large military aircraft companies.

A report by the investment firm of L. F. Rothschild & Co. reflects the attitude of the financial community to two basic facets of general aviation:

• **Business flying** growth has contradicted its skeptics first by its continuation in the face of removal of the excess profits tax in 1954 and despite the recession in 1957-58 (AW Mar. 9, p. 249).

• **Necessity of an extensive** distributor dealer network.

The first point is regarded as testimony that business flying is here to stay—that it has demonstrated its utility and economic value to company managements and is not a boom time frill.

The latter point is implicit in the report's observation that Beech might be the most sophisticated purchase of the three. In part, this is because Beech has risen less in price than the other two, leaving more room for improvement.

But a major reason why Beech might become more attractive to shareholders, the report says, is because of addition of its new Model 33, a four place airplane in the $20,000 price category, to give it an entry to the middle price market where Cessna has shown great strength heretofore. Beech also will unveil a larger airplane, the Model 65 (AW Sept. 28, p. 23).

Aviation Week has learned that Beech plans to expand its dealer-distributor organization in addition to expanding its model line, indicating Beech will increase its competitive force with Cessna and Piper.

Cessna still is a big favorite with the analysts—some going as far as to call it the best of the aircraft company stocks. Reasons cited for this, besides its success in the business flying field:

•.**Product diversification** into such areas as avionics—through merger with Aircraft Radio Corp.—helicopters and military jet trainers.

• **Management ability** as indicated by its large earnings growth—estimated to reach $7 a share in 1959.

• **Strength to withstand reverses,** as in the write-offs on 620 four-engine project which did not go into production.

• **Expansion** into non-aviation area such as hydraulic pumps and valves for agriculture for which 1959 sales so far have risen 77%.

Piper, besides its strong commercial bent, is well regarded for its secure position in the low priced aircraft market.

The Rothschild report comments that its product development program is the most aggressive in the industry, its costs low, its profit margins wide.

Wall Street may be under one misapprehension, however. The Rothschild report refers to the secure position in the field of the "big three" and to them as a "friendly oligopoly."

Cessna regards the next five years as an era when it will be most vulnerable to competition, when a new, small company might find it easiest to make a rapid penetration of the market. Cessna has realigned its management to prepare for the broad policy decisions it feels it will have to face.

Intensifying competition as indicated by the Beech moves will require increasing management flexibility. Market and business analyses will come strongly into play in addition to the familiar problems of design and production.

Financial Briefs

Perkin-Elmer Corp. reported preliminary sales and earnings figures of $17,500,000 and $900,780 respectively for the year ended July 31, 1959. Sales represented a 16% increase over last year's total of $15,062,055 and earnings 20% over the $751,158 reported in 1958. These figures do not include $2 million in sales and $120,000 in earnings of the company's foreign subsidiaries in England and West Germany, the latter of which was just awarded a $30 million prime contract to build Sidewinder air-to-air missiles for NATO.

Six months figures were reported by:

Cohu Electronics, Inc.

	Sales	Earnings	Per Share
1959..	$4,432,803	$535,103	$.53

No 1958 figures were listed because they are not comparable as the result of acquisitions by the San Diego, Calif., electronics company.

Atlantic Research Corp.

	Sales	Earnings	Per Share
1959..	$3,429,010	$195,895	$.26
1958..	1,563,441	95,462	.15

The company, in the rocket and space development field, delivered 600 Arcas sounding rockets during the period for use in Atlas and Thor ballistic missile programs and in the Pioneer, Explorer and other space programs. It also is developing the Iris high-altitude sounding rocket and an advanced design sustainer for the Terrier surface-to-air shipboard missile.

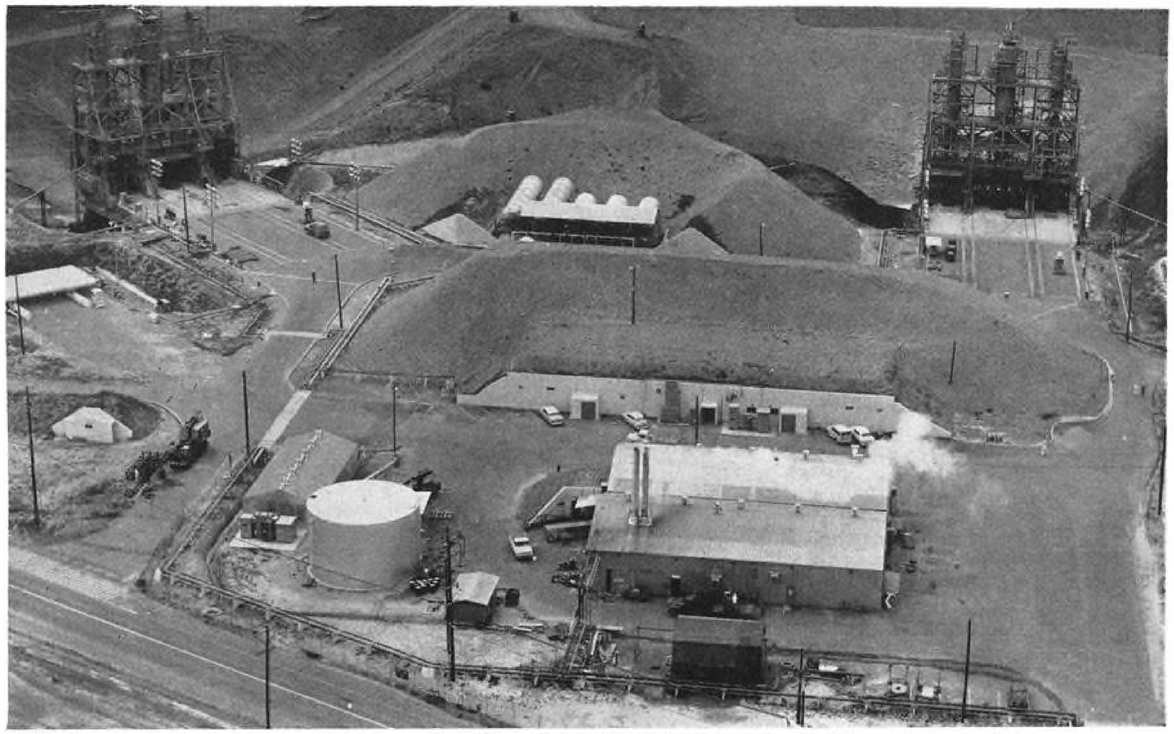
Hawaiian Airlines

	Revenues	Net Loss
1959....	$2,703,998	$207,659
1958....	2,160,702	213,551

Horkey-Moore Associates, which builds components and test equipment, tripled its net income in the fiscal year ended June 30—from $49,601 to $3.57 a share to $156,447 or $6 a share. Revenues rose to $1,979,006 from $841,228 the previous year. The return on stockholders investment rose from 30 to 60%, the company reported, and backlog at year-end totaled $1.5 million.

Britain's Vickers Group first half net profits were down to $4.98 million from the corresponding 1958 figure of $8.04 million. Net profit for the full year of 1958 was $18.45 million. Second-half profits will be at about the same level this year as the first half, the group expects. Blamed for the decline are declining sales of aircraft, slackness in some sections of the group's English Steel Corp., lack of recovery in Canadian heavy manufacturing and shipbuilding, and provision for development costs of new aircraft ($5.6 million the first half this year, against $7 million dollars in all of 1958). Group sales were $204.5 million the first half of this year, compared to $250.5 million.

• **Litton Industries** sales and earnings for fiscal 1959 increased over 50%. Sales, which totaled approximately $125 million as of July 31 compared with $83,155,473 for the previous year, were running at a $145 million annual rate at year-end. Earnings, including a $1 million special income credit, were approximately $6 million, compared with $3,702,203 last year. Approximate 1959 per share earnings were $3.24; last year they were $2.06. Litton recently split its stock 2 for 1.



TOWERS at top left and right can aim three positions for rocket engine static tests; center blockhouse houses control rooms.

Aerojet Broadens Activities in Move to Diversify

By Russell Hawkes

Azusa, Calif.—Recent Aerojet-General Corp. purchase of Rheem Mfg. Co. Defense and Technical Products Division at Downey, Calif. brings Aerojet into the fields of drone aircraft, flight simulators, large aircraft fuselage section fabrication and new areas in explosive ordnance—typifying its efforts in diversification.

Aerojet trend toward diversity has been impelled by a demand for speedy progress in missiles and space flight and, in the early days, and the need to overcome lack of experienced component suppliers. The rapidly growing rocket makers found they were obliged to make themselves competent in new fields to win contracts using their original capabilities, Aerojet officials report.

As Aerojet President Dan A. Kimball told AVIATION WEEK, "we never deliberately diversified our business for the sake of economic security. Aerojet is a rocket propulsion company. We went into infrared in 1947 because there were no experienced suppliers of infrared equipment to support us. Now we have the largest infrared facility in the country and are finding uses for our capability which are further afield. The rest of our diversification has followed the same pattern."

Since its founding in 1944 by Dr. Theodore von Karman, Aerojet has grown from a small manufacturer of solid propellant JATO bottles to a corporation doing a $300 million a year business, and employing over 17,000 people on projects ranging from skin-diving equipment to advanced nuclear reactors, though rocket engines are still by far the most important part of its business.

A list of its functional divisions gives an idea of the versatility that has grown into the company. It includes:

- **Solid rocket plant.**
- **Liquid rocket plant.**
- **Aerojet Nucleonics.**
- **Avionics division.**
- **Explosive ordnance division.**
- **Anti-submarine warfare division.**
- **Chemical division.**
- **Architect and engineering division.**
- **Structural plastics division.**
- **Turbomachinery division.**
- **Space technology division.**
- **Systems division.**

Facilities are located at Azusa, Downey, Riverside, Chino Hills, Sacramento and San Ramon, Calif.; Atomic Energy Commission reactor test station, Idaho Falls, Idaho, and Frederick, Md.

Company officials predict that Aerojet's diversification will continue to be on the basis of opportunity rather than planning. The company has entered some new fields because business logic dictated merger or purchase of organizations with capabilities that Aerojet lacked. Notable among these moves were the purchase of Rheem's Defense and Technical Products Division plant at Downey, Calif., in June and the acquisition of Aerojet-General Nucleonics at San Ramon, Calif., as a subsidiary in 1956.

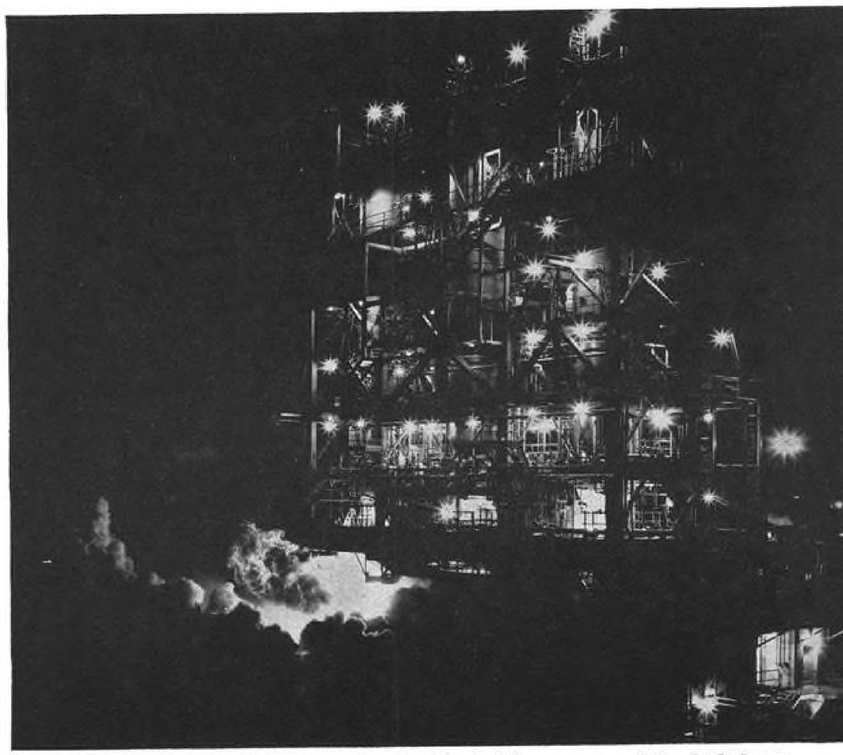
Aerojet took over the Rheem property mainly because it is tooled and staffed "to build large round objects," which could include rocket cases and tanks, and because the price was attractive. The plant has 600,000 sq. ft. of floor space. Also turned over to Aerojet was an explosive loading facility at Riverside, Calif., used in Rheem's ordnance jobs. Rheem ordnance personnel will not be mixed in with Aerojet Explosive Ordnance Division because their projects do not duplicate Aerojet work. Rheem Electronics Division will be combined with Aerojet Avionics Division and moved to Azusa.

The ex-Rheem plant is now manufacturing large aircraft fuselage sections under subcontracts, but Kimball says Aerojet will not attempt to renew these contracts when they expire. Production and further development of the Rheem-designed Army SD-2 surveillance drone will be continued. Company interest in surveillance drone development is due at least partly to the fact that it is a natural extension of Aerojet Avionics Division's work with infrared battlefield surveillance gear. The ex-Rheem plant has also built aircraft gunnery simulators and Aerojet will seek to expand this capability.

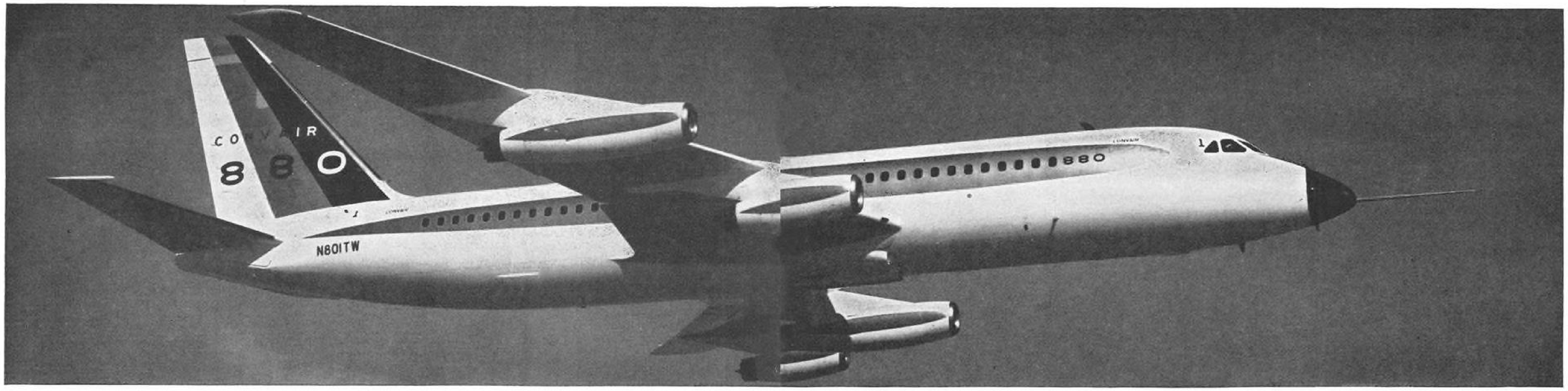
Company officials say this rapid multiplication of product lines, combined with Aerojet's explosive rate of growth since 1955, makes it difficult to get good, uniform administration. The problem is to expand the supervisory staff fast enough to keep pace with growth and diversification without sacrificing quality of supervision. Top management reports no trouble at all in finding high caliber talent for the new jobs, but in many cases new supervisors have so little time with the company that Aerojet procedures and attitudes are not well inculcated. Despite this stumbling block, most divisions seem to maintain about a 15% ratio of



AERIAL view shows Aerojet's Sacramento, Calif., facility for testing liquid propellant rocket engines at 24 positions.



NIGHT firing of Aerojet LR-91 engine for the Martin Titan on one of the high-thrust liquid rocket test stands at Sacramento. Air Force procurement policy now requires two 20-sec. acceptance test runs with thrust vectoring demonstrated on one.



Republic High-Performance Metals for the 880



STAINLESS STEEL IS USED IN LEADING EDGES of the 880's vertical fin and horizontal stabilizer where anti-icing is accomplished through electrical heating of the metal. Use of Republic ENDURO Stainless Steel increases strength and heat-resistance, permits thinner, lighter gages. Types 301 and 302 are readily formed into desired shapes by cold-forming, drawing, and bending operations. Mail coupon for complete details.

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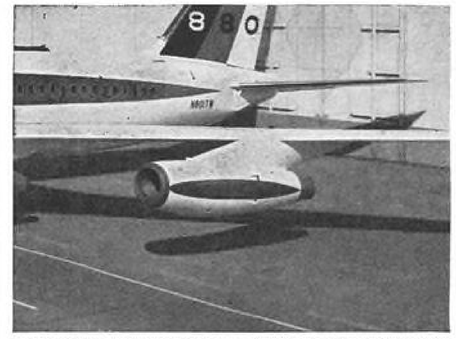
Let us help you find the most advantageous uses of these metals in *your* project. Return the coupon for complete information without obligation. Please indicate if you would like a Republic Metallurgical Specialist to call.



IN EACH 880 POD-PYLON, rear engine mount "horseshoe" frame — of nickel-plated, chrome-alloy steel—grips the powerful General Electric CJ-805-3 engine. Republic Alloy Steels offer exceptionally high strength-to-weight ratios with the highest strength values. Uniform response to heat treatment assures complete deep hardening penetration, plus hard, wear-resistant surfaces. Send for additional information.

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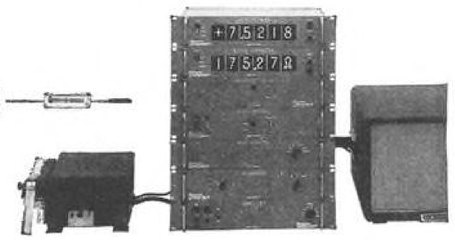
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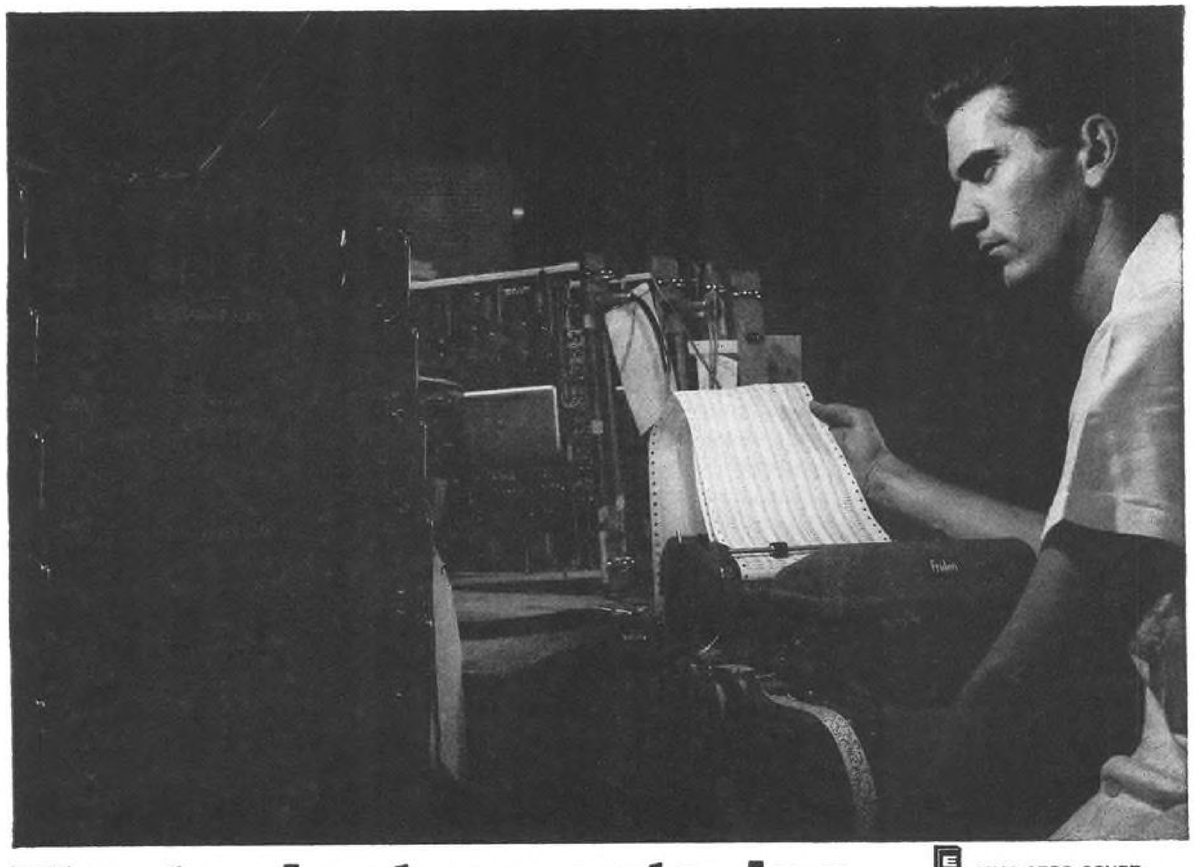
Typical E-I system for evaluating components—includes 100 channel input signal scanner. Can digitize DC voltage, resistance, AC voltage and DC/DC voltage ratio analogs. Digital equivalents are recorded on strip printer for "quick look" data and on punch paper tape for additional data reduction by digital computer.

Small E-I automatic digital systems provide many advantages. First, they cost less. This is primarily the result of large-quantity manufacture of modules which make up the E-I system. Cost is almost a linear function of performance capabilities desired in the system.

Second, they are exceptionally versatile. The E-I system can be expanded simply by adding appropriate modules. Typical systems presently in use measure resistance, capacitance, DC and AC voltages, DC/DC ratios, AC/DC ratios, AC/AC ratios and combinations of these. Measurements to four or five digits can be visually displayed and printed out at rates up to five readings per second. Operation can be semi- or totally automatic with go/no go comparison of values and programmed readout at periodic intervals. Scanners can be provided for scanning thousands of single and multi-wire input channels. In brief, the E-I system has an extensive scope of operating capability.

Third, E-I systems provide unmatched reliability. Where practicable, circuits are totally transistorized. The use of etched, plug-in circuit boards, and modular internal construction make maintenance checks and in-plant repairs easy.

Lower cost, maximum versatility and greater reliability—if you want these advantages in your component test system, contact your nearest E-I representative. He can give you complete information or answer any specific questions you may have.



Electro Instruments, Inc.

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indirect to direct man-hours, which is quite low no matter how the accounting is done.

Aerojet is now beginning to seek international markets. A sales agreement has been signed under which Mitsui & Co., Ltd., of Tokyo will handle Aerojet products in the Orient.

In England, Aerojet and Bristol Aeroplane Co. are operating a joint company known as Bristol-Aerojet, Ltd., combining the experience of both parent companies in development, propellant formulation and manufacture of solid rockets. Bristol-Aerojet might have a key role in supplying Scout boosters to the British space program under plans to use the National Aeronautics and Space Administration sponsored vehicle announced in the House of Lords by Viscount Hailsham recently. Scout is to be used to launch British-made payloads from the United States. It can put a 150-lb. payload into a 300-mi. orbit (AW Sept. 7, p. 64). Aerojet Senior solid rocket which is first stage of the Chance Vought Scout, was originally designed to meet Navy requirements in the old Army-Navy Jupiter program.

Bristol-Aerojet also distributes all Aerojet-General products in the British Commonwealth and in some European countries. Westinghouse Electric International Co. handles Aerojet-General Nucleonics sales in all countries but the United States and United Kingdom.

Development, production and testing of Aerojet's big rockets is now done almost exclusively at the company's 18,000-acre Sacramento base. Engineers there can already foresee the day when there will not be enough room to build and test the big space boosters that will be needed. The military table of distances from explosives sets the minimum separation between inhabited buildings and potentially explosive concentrations of different sizes. Rocket makers must be guided by this table.

Aerojet tries to maintain at least a one-mile buffer zone around its Sacramento rocket test site, including land leased for the purpose. Despite the isolated location of the plant 18 mi. northeast of Sacramento, neighbors are beginning to crowd the buffer zone. So far the noise of rocket tests has not caused Aerojet any public relations problems but the toxicity hazards and the requirements of the military table of distances are beginning to cramp the operation, particularly that of the solid rocket test site.

Throughout the corporation, Aerojet-General has about 180 test stands of all types. This reflects the importance attached to testing not only for quality control purposes but for feed-back leading to design improvements. The Sacramento test area contains 24 high-thrust liquid-propellant rocket test stands, 27

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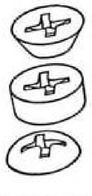
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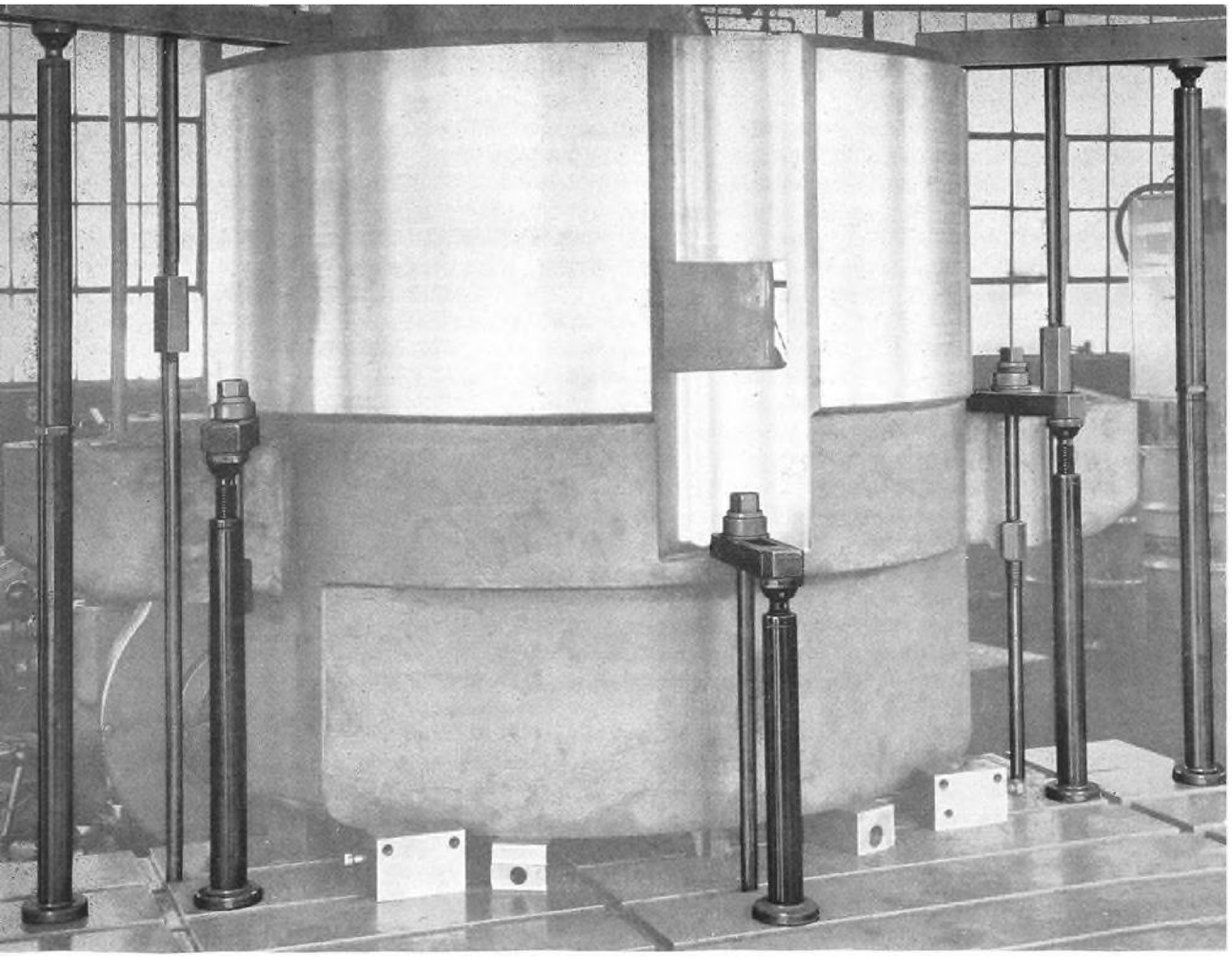
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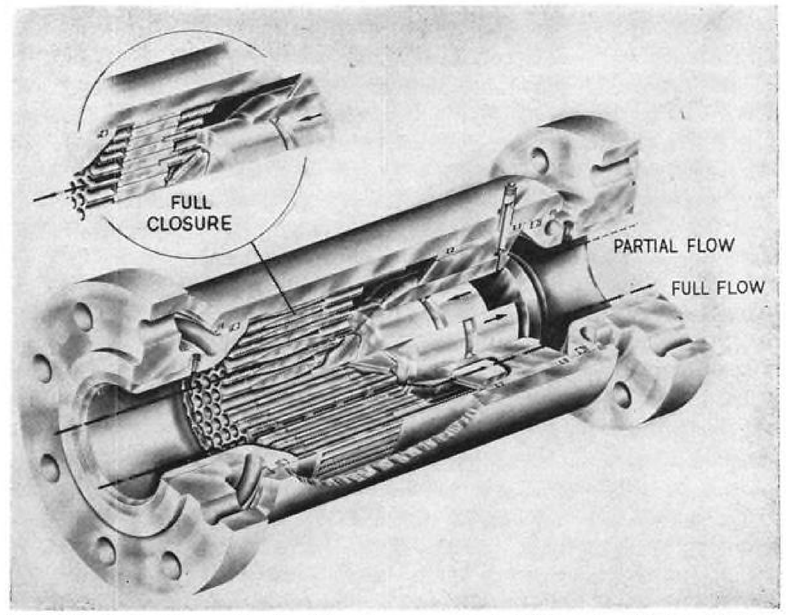
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AEROJET silent valve was developed by the company's Anti-Submarine Warfare Division. Cavitation and aeration of fluids is source of noise easily detected by passive sonar.

component test stands for checkout of gas generator driven subsystems, and seven high-thrust solid propellant rocket test stands. Five more solid rocket test stands are just about to go into operation.

About 1,800 persons are employed in the rocket test areas. Around 1,200 of these work in the liquid rocket test area because testing plays a larger part in the liquid propellant rocket program. This is because liquid rockets are reusable tools and every one is fired as a normal part of the production and delivery sequence. Aerojet LR-87 and LR-91 liquid propellant rockets (AW Aug. 24, p. 27) for Martin Titan are given two 10-sec. and one 40-sec. acceptance test runs with gimbaling systems exercised on the latter. Acceptance test procedures will be changed to require only two 20 sec. runs. Chambers are tested separately from the rest of the system like all other individual components because of the hazard involved in operating an entire system made up of untried units.

Aerojet's liquid rocket test stands at Sacramento are designed on the principle of a C-clamp with deflector plates bearing downward loads and transmitting them into the vertical part of the test stand which also bears upward thrust loads of the rocket engine under test.

In addition to acceptance runs of production engines, liquid rocket stands are being used to test advanced versions of the basic engines. NASA's Saturn space vehicle will use one such further development of the LR-87 first stage engine. In the ICBM, a pair of LR-87 chambers generates about 300,000 lb. thrust. In Saturn the LR-87 should be capable of generating 360,000 lb. thrust per pair. Design of LR-87 and LR-91 80,000 lb. thrust second-stage engine began in 1955.

Standard engines for the military missile burn RP-1 and liquid oxygen. The chambers are of more or less conventional design made up of a bundle of stainless steel longitudinal tubes carrying fuel through the chamber wall to provide regenerative cooling. Cooling is so effective that it is possible to actually touch the chamber immediately after a run without being burned. Expansion ratio of the LR-91 second stage is approximately four times that of the LR-87.

Control System

Control system avoids use of a special hydraulic system for valve sequencing. The simplified hydromechanical system uses fuel pressure to sequence and operate the engines. Thrust chamber valves are held open and closed at the proper time by fuel pressure. This eliminates dependence upon the functioning of an auxiliary helium or hydraulic system, thereby improving the reliability of the over-all system through simplicity. The mechanically linked thrust chamber valves in the liquid oxygen and RP-1 systems are powered by the single-fuel-operated actuator.

Turbopump lubrication system in the Aerojet engines is air pressurized to prevent evaporation of oil from the turbopump gear box and to reduce the



PUMP PRIMERS

ARTHUR A. NICHOLS

GEROTOR aircraft pump can handle several different fluids and functions simultaneously

The unique construction of the Gerotor type pump permits aircraft systems designers to combine *several pumping* functions in a single pump housing mounted on a single pad and driven by a single shaft.

Basically a form of internal gear pump, the Gerotor has only two moving parts: an inner toothed element meshing with an outer toothed element. The inner Gerotor has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the intake to the discharge. (See Fig. 1). The volume of the chamber multiplied by the number of driver teeth and RPM determines the quantity of fluid pumped.

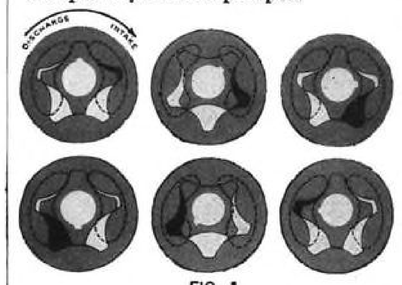


FIG. 1

Both Gerotor elements are mounted eccentric to each other on the same shaft. This structure permits stacking a number of sets of Gerotors along the same shaft, in a common housing. By simply providing each set with a separate compartment and inlet and discharge ports, several fluid systems can be served simultaneously and without interference. (See Fig. 2). Different capacities can be provided for each system despite the common driving shaft speed by varying the diameter or thickness of the Gerotor elements to vary the volume of the tooth chamber.

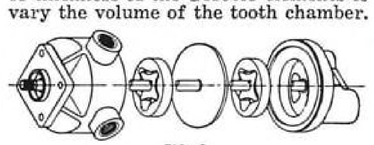


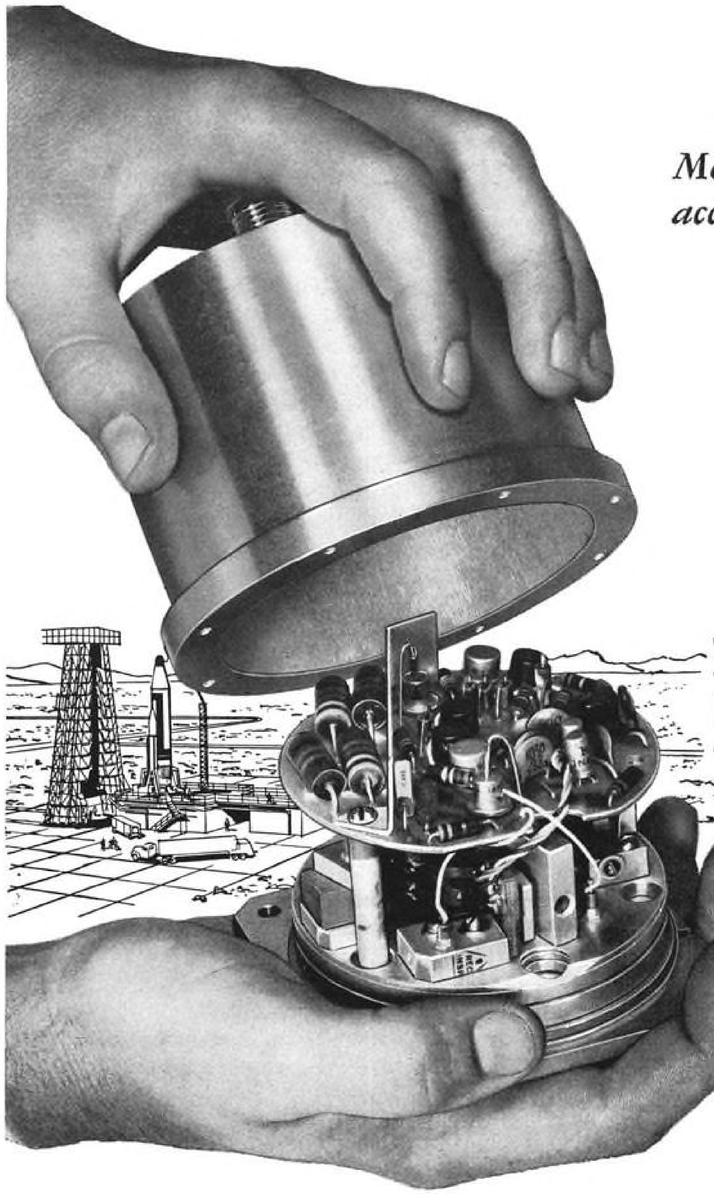
FIG. 2

Diversified systems such as lubrication, scavenging, low pressure hydraulic servo systems and motors up to pressures of about 1000 psi may be centralized in this manner and multiple pump installations avoided.

Advantages – The Gerotor is a positive displacement pump. It is simple and compact, lightweight, valveless, provides high volumetric and mechanical efficiency and offers exceptional performance at high altitudes.

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

W. H. NICHOLS CO.
48 Woerd Avenue, Waltham 54, Massachusetts



PROBLEM:

Measure angular acceleration accurately

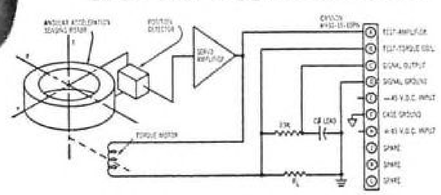
ANSWER:

The New Donner Angular Accelerometer

Light
Compact
High natural frequency

THE FACTS... As you are well aware, designing a good angular accelerometer is a tough technical task. Donner Scientific's new unit is another successful chapter in a record of creative engineering.

Chief applications for this unique force balance angular accelerometer are closing the servo loop on ground launching equipment for missiles and detecting the roll, pitch and yaw accelerations of missiles once they are airborne. In the latter application, the Model 4525 can replace some gyros and supplement others.



Operational diagram of Donner's new Model 4525 Angular Accelerometer.

Donner's rugged new angular accelerometer weighs only 2 pounds.

The Specs

RANGES AVAILABLE
From ±1 radian/sec² to ±50 rad/sec² to any intermediate range.
FREQUENCY RESPONSES
±1 rad/sec² 30 cps natural frequency (90° lag)
±10 rad/sec² 100 cps natural frequency (90° lag)
OUTPUT, FULL SCALE
±20 volts across a 12,500 ohm load
RESOLUTION 0.01% full scale or better
LINEARITY 0.1% full scale
HYSTERESIS Less than 0.01% full scale
DAMPING 0.6 ± 0.1 of critical
SIZE 3.7" diameter x 3.7" high
WEIGHT 2 pounds

The mechanically rugged and electronically rigid Model 4525 is one more basic technical contribution from an engineering team specializing in inertial systems interlocking time, acceleration, velocity, and other dynamic inputs.

MORE DATA AVAILABLE—An illustrated 4 page data file is yours for the asking. Please address Dept. 0510.

DONNER SCIENTIFIC COMPANY
CONCORD, CALIFORNIA

danger of cavitation in the lubrication oil pump.

Other improvements claimed over liquid rockets of earlier design include shorter nozzle expansion cones resulting in lower inertia moment for the thrust vectoring system to overcome. Also, the need for prestart combustion has been avoided. Pressurized nitrogen is used to spin the turbopumps in the starting sequence.

For about a year, Aerojet has been testing an LR-87 thrust chamber burning liquid hydrogen and liquid oxygen. Thrust up to 100,000 lb. has been generated in the program under contract from Wright Air Development Center. Chamber pressures used during the liquid oxygen and hydrogen tests have run from 80 to 500 psi. These pressures are considerably less than those used in the standard military engine burning conventional fuels. Liquid oxygen and hyrdogen tests at normal chamber pressure should yield from 10 to 20% more thrust than the 150,000 lb. per chamber obtained in Titan.

Development work is also being done on a storable propellant version of the Titan engines. Propellants attracting most interest at Sacramento are amine fuels such as hydrazine with nitrogen tetroxide as oxidizer. Aerojet engineers expect greater range in the storable propellant version of Titan because better mass fractions can be expected. Aerojet refuses to discuss performance figures, but industry sources say that a storable Titan should achieve a mass fraction on the order of .915.

Aerojet's solid rocket plant tries to offer an across-the-board, integrated approach to the manufacture of solid propellant rockets. Its activities include research and development, propellant formulation, case manufacture, propellant casting, and nozzle design and manufacture. The plant employs 7,000 persons.

Engineering Staff

Organization of the engineering staff is based on mixed functional and project lines of responsibility. Work upon the Navy-Lockheed Polaris and Minuteman is done by tightly organized project groups. The project type organization has the advantage of being able to move very quickly and the disadvantage that it tends to drift out of touch with advances in the technology, hence Aerojet's use of a mixed hierarchy.

Aerojet solid rockets have been characterized by large use of polyurethane fuels. Richard D. Geckler, vice president in charge of the solid rocket plant, credits polyurethane fuels with moving solid-propellant rockets into the intermediate range and intercontinental range missile field. He attributes much of the pioneering work with polyurethanes to Jet Propulsion Laboratory of California Institute of Technology.

Personnel at the solid rocket plant includes about 1,300 salaried technical and professional employes, including 43 who hold Ph.D.s and 134 with Masters' Degrees. There are 700 salaried administrators.

In 1944, Aerojet began a campaign to sell large solid-propellant rockets to the military services. At first, efforts foundered on the objections that no ability to produce large solid rockets could be demonstrated and no ways were known to vector and terminate thrust. Since the solid propellant rocket cannot be gimbaled, many thought that thrust vectoring would prove to be impossible. They also believed that since there was no way to cut off the supply of propellant to a solid rocket it would prove to be impossible to extinguish burning.

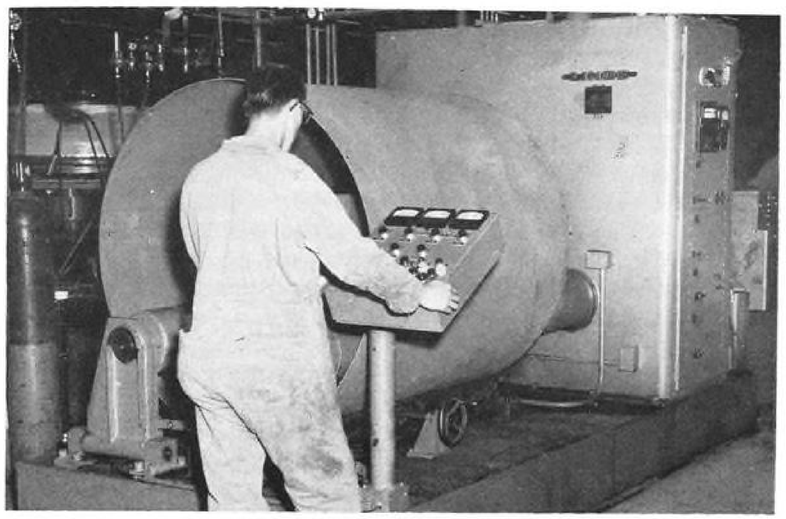
Navy Support

Aerojet officials credit consistent support of Rear Adm. William F. Raborn, head of Navy's fleet ballistic missile program, with bringing the big solids to their present state of development.

Technical obstacles were removed by development of thrust vectoring jetevators at Naval Missile Center, Pt. Mugu, by Willi Fielder and Aerojet development of thrust termination through use of reverse thrust ports to separate warhead from final stage propulsion.

Aerojet is now testing three stages of Minuteman. Inevitably, Minuteman will incorporate many developments and improvements upon techniques used in Polaris. Thrust vectoring will probably be supplied by rotating or swiveling nozzles rather than by jetevators. In some cases these can be made lighter than jetevators while avoiding the drag and severe asymmetrical heating of jetevators. Minuteman will reap performance bonuses from breakthroughs on insulating materials for the case liner. First Minuteman propulsion units off the line will use conventional homogeneous rolled and welded steel cases such as those in Polaris engines. Later operational versions of Minuteman and Polaris will use spiral-laminated steel and plastic cases made by a technique Aerojet calls Aerowrap. While thrust termination on Minuteman is similar in principle to that used on Polaris, the reverse thrust port is opened by a different technique (AW Aug. 31, p. 39). The port is closed during operation by a phenolic plug and O-ring held in place by a slotted steel disk which is removed from a retainer ring on the outside of the case by an explosive actuator triggered by a command from the guidance system. This allows the phenolic plug to escape from the port generating reverse thrust in less than 500 microseconds after the thrust termination command. Release of warhead holddown is synchronized with the reverse thrust pulse, allowing the warhead to separate and coast through the remainder of the trajectory to the target alone.

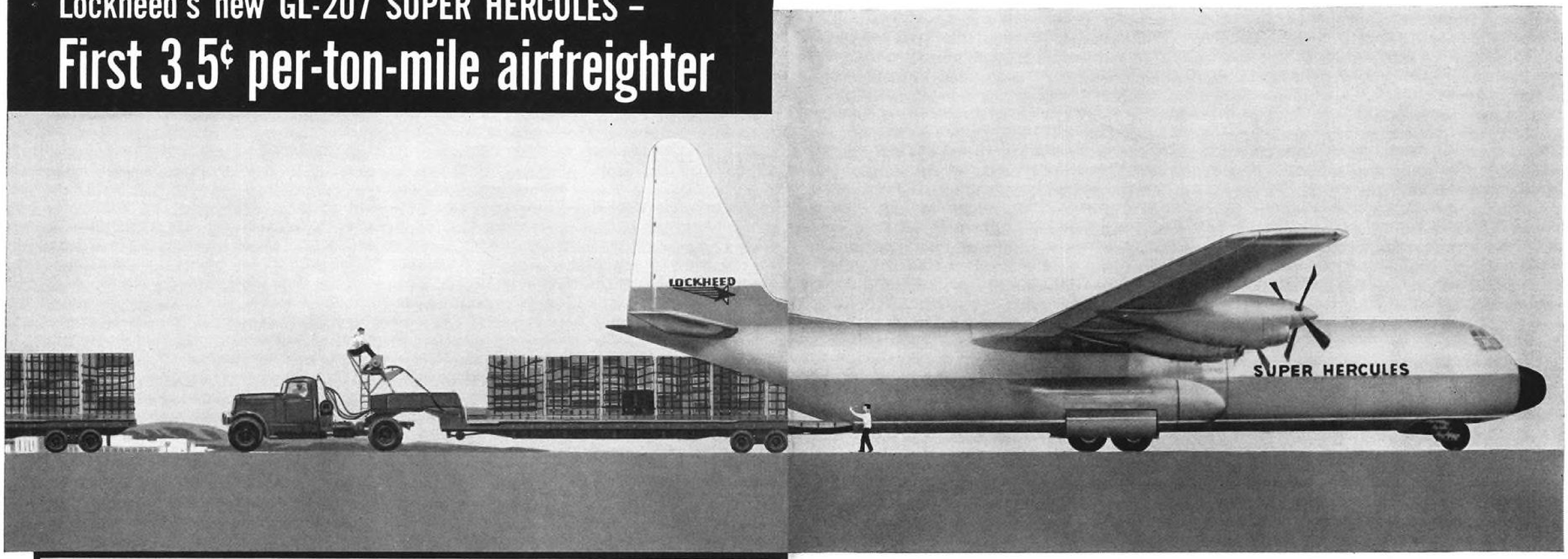
Engineers at the Sacramento solid rocket plant report that propellant formulations better than those now in use are being held back for lack of refractory metals needed to make a nozzle which is capable of withstanding the high temperatures and other conditions which the new propellants will create in the nozzle throat. Scientists in the solid rocket plant are doing research in this field in the hope of incorporating the improved propellants in future



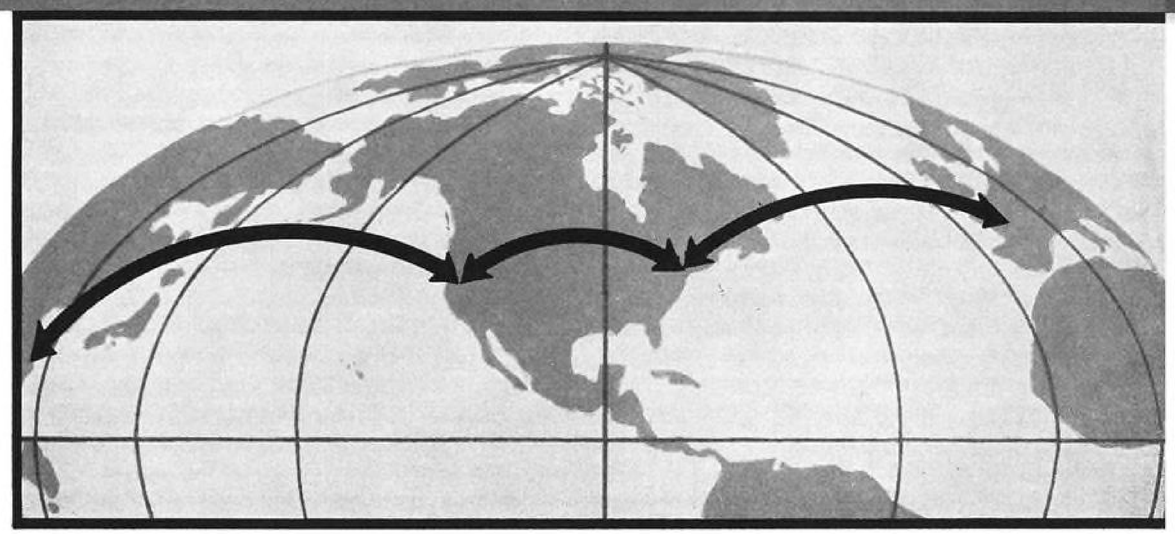
HOMOGENOUS sheet steel solid rocket case for Polaris fleet ballistic missile is seam-welded at Aerojet's solid rocket plant. Highly refined weld rods and close control of welding conditions are needed to make a bead with properties similar to the sheet steel to prevent uneven heating or expansion.

Lockheed's new GL-207 SUPER HERCULES –

First 3.5¢ per-ton-mile airfreighter



Nine lightweight cargo pallets with 77,000-pound payload can be mechanically loaded in or unloaded from the SUPER HERCULES in less than one minute!



SUPER HERCULES non-stop flights: transcontinental, with full 77,000-pound payloads; transatlantic to European cities as far as 4,650 miles, with 60,000-pound cargoes; San Francisco to Tokyo, with 43,500 pounds.

The long-sought goal of air freight carriers—cargo rates competitive with surface transportation—will be achieved when Lockheed's GL-207 SUPER HERCULES starts rolling off production lines in 1961.

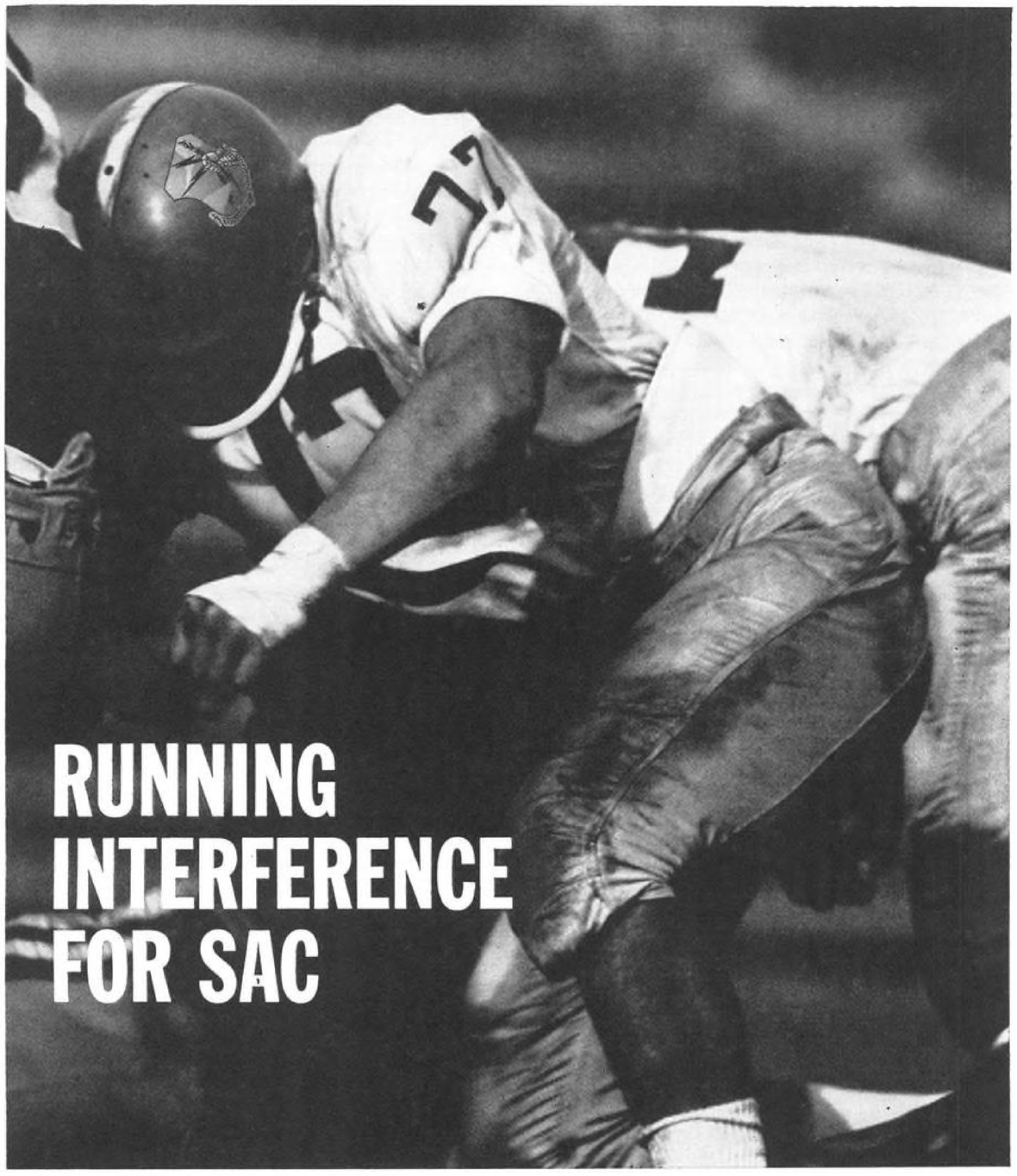
In addition to a direct operating cost of 3.5¢ per-ton-mile, the SUPER HERCULES embodies these profit-making features: straight-in rear loading through huge 9′ x 10′ doors... truck-bed height cargo floor . . . dependable prop-jet power provides flexible operational altitude . . . pressurized and air conditioned cargo compartment, ideal for transporting perishables, animals, and sensitive cargo . . . short-field landings and takeoffs . . . climb rate of 1690 feet per minute . . . over the weather altitude capability . . . cruise speed of 390 miles per hour . . . transcontinental and transoceanic non-stop range.

Using Lockheed's Lightning Loader system, the SUPER HERCULES can unload its entire palletized cargo, reload, refuel and be ready for take off—*in less than 20 minutes!*

Get the complete story on the profits to be made with the Lockheed GL-207 SUPER HERCULES—designed to haul the goods of the world in the Jet Age. Write or telephone: HERCULES Commercial Sales, Lockheed Aircraft Corporation, Georgia Division, Marietta, Georgia.

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RUNNING INTERFERENCE FOR SAC

Now SAC's B-52G has a pair of hard-running teammates... the GAM-77 Hound Dog air-to-surface missiles. They can lunge into action at supersonic speeds to clear a path for the bomber by knocking out ground-defense centers hundreds of miles away. A pair of Hound Dogs carried under the wings of the Boeing B-52 increases the bomber's striking power ... gives it a triple-punch capability. Successful test launches of the jet-powered missiles are being made on schedule over the Atlantic missile range. The system will be deployed by 1960 under the present accelerated development program.

The Missile Division of North American Aviation is weapon system contractor for the GAM-77.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA

Aerojet rockets and in follow-on versions of missiles such as Polaris and Minuteman.

Research is also being carried on in the solid rocket plant on improved production techniques. Presently, Aerojet is still using the same 2,000 lb. mixers for Polaris engines that were used to mix propellant for the much smaller JATO bottles. A batch from a single mixer will turn out propellant for 15 JATO bottles, while several mixer loads are required to prepare the propellant for a single stage of Polaris. Aerojet has no plans to change this procedure. The decision was made on the basis of explosive hazard. For the sake of safety, Aerojet would like to avoid any extremely large concentration of propellant in a single mixer. The Sacramento plant grinds its own oxidizer to particles to sizes of 40-60 microns and formulates its own polyurethane fuel binders.

Continuous Mixing Technique

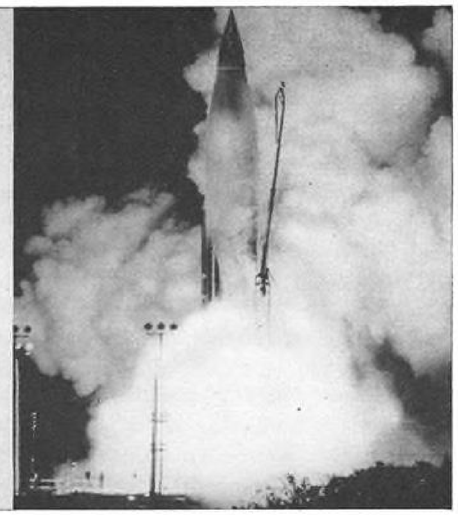
Geckler reports that solid rocket plant researchers are doing highly successful work with a continuous mixing technique for solid propellants. Present process is to mix up a batch of propellant, empty it into portable containers, carry it to the casting pit and shut down the mixers until the next case is ready. Continuous mixing offers the labor cost saving inherent in quantity production by maintaining a steady stream of ingredients into the mixer and regular output of completed propellant. Cost can be cut by as much as one-third or one-half. The technique requires careful adjustment of propellant production flow to case production. It is possible to store mixed propellant for some time without deterioration or curing.

Aerojet experts believe the continuous mixing process may fit in well with proposals for on-site assembly of very large solid propellant rockets. Consider the fact that the shipping container alone for a completed Polaris fleet ballistic missile weighs 35,000 lb.—almost as much as the missile itself. On-site casting of propellant would make logistic support of Minuteman ICBM and large solid rocket space vehicle boosters vastly easier.

Weight of the empty rocket case alone causes no shipping problem. Propellant ingredients would be transported in bulk and the work of mixing could continue en route to the launch site. Aerojet engineers are attempting to design a continuous mixing caravan which would, in effect, be a traveling solid rocket plant. Stumbling block will be the question of safety standards.

For large missile applications, the continuous mixing caravan is attractive for strategic reasons. Its natural mobility would result in a missile manufac-

ON EVERY ATLAS COUNTDOWN RMC-LINDSAY PRESSURE GAUGES ARE CONSULTED

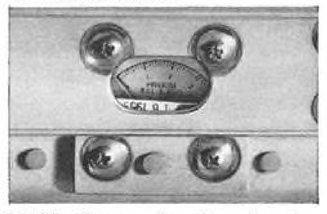


Used for Readout of Gas Pre-Charge in Hydraulic System Accumulators

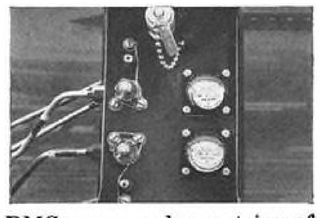
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These gauges must withstand shock tests of 100Gs. They are checked for accuracy in vibration tests ranging from 10 to 2,000cps at 35Gs and at ambient temperatures from −65°F to +275°F. *There is no linkage, no gear train to disintegrate or to cause pointer vibration. The indicating pointer is attached directly to the end of the helical bourdon coil.*

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RMC Gauge for the booster engine hydraulic system accumulator is flush mounted on the booster engine compartment for easy reading from the outside.



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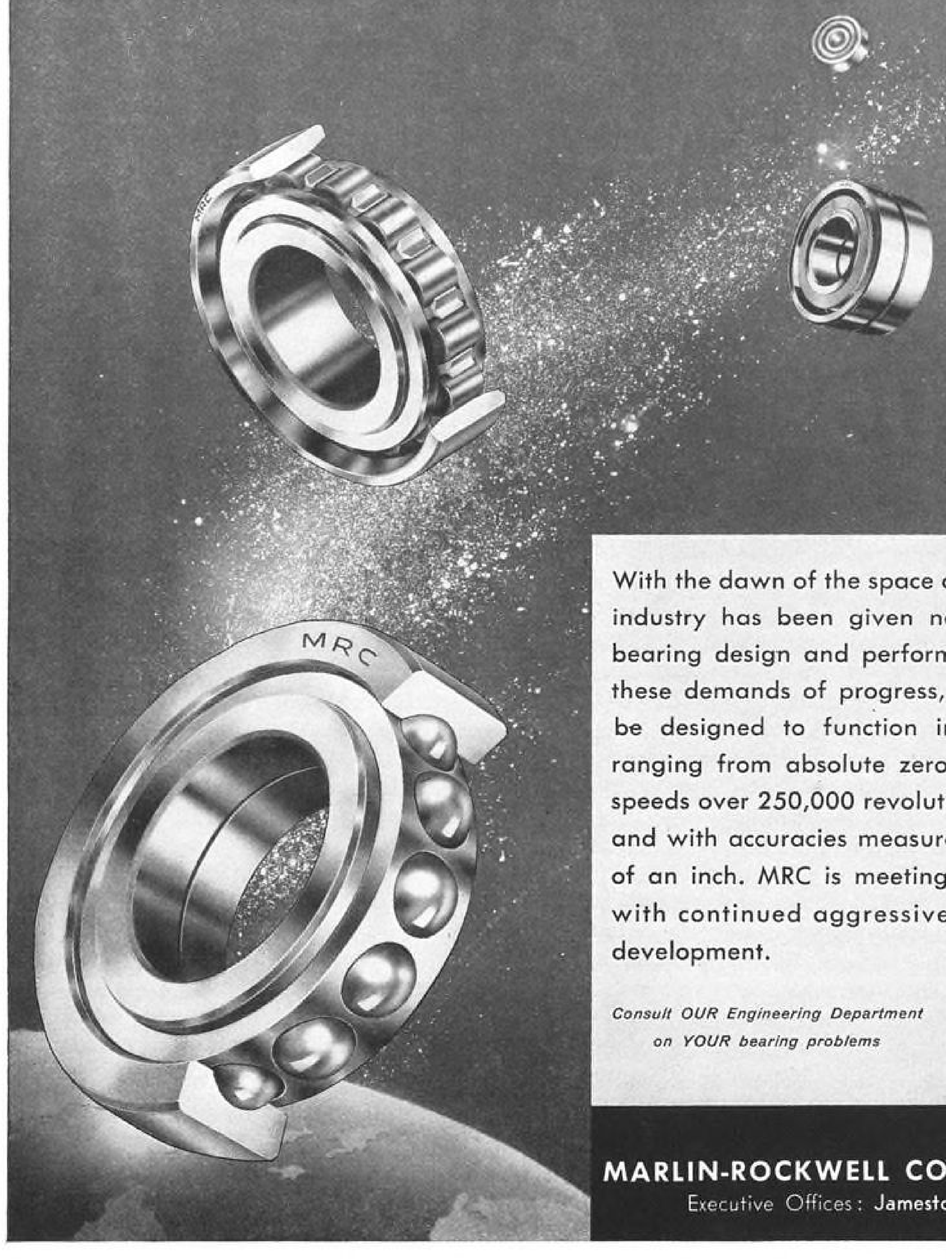
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With the dawn of the space age the bearing industry has been given new frontiers in bearing design and performance. To meet these demands of progress, bearings must be designed to function in temperatures ranging from absolute zero to 2000°F; at speeds over 250,000 revolutions per minute and with accuracies measured in millionths of an inch. MRC is meeting this challenge with continued aggressive research and development.

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turing capability which would be difficult to destroy and could continue to operate for some time without support of vulnerable fixed installations.

The big Aerojet rockets, Polaris, Minuteman and Air Force-Douglas ALBM (air-launched ballistic missile) are cast in a chamber reduced to 29.3 in. of vacuum. With the new lightweight cases, this is necessary to eliminate bubbles from the propellant.

Liquid rocket plant and solid rocket plant have separate high test thrust areas. Nine of the 24 liquid rocket test stands are intended to withstand thrust up to 150,000 lb. Seven are designed for 300,000 lb. thrust, six stands for 700,000 lb. thrust, and 1 million lb. thrust boosters can be tested in two stands. Liquid rocket test area is laid out in such a way that one control room serves two groups of three stands.

Underground tunnels from the control room give access to the test stands. Vacuum chambers have been constructed at the base of two stands for simulated high altitude start tests of sustainer rockets. The chambers are removable to permit conventional tests. One of these high altitude start installations will accommodate a complete engine, but the other is designed to test only the thrust chamber.

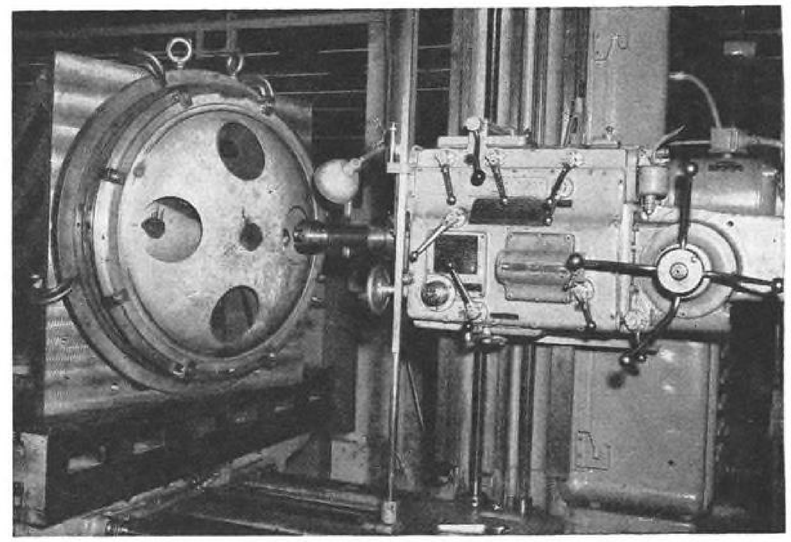
Data can be collected from 432 instrumentation channels. Data reduction equipment is located in the control room and can turn out useful engineering information within 30 min. of a test firing.

Component Tests

Also in the liquid rocket test area is a cold-flow component test facility with 10 fully instrumented bays for testing pumps, turbines, gas generators, etc. The cold-flow facility is equipped with a 3,900 hp. dynamometer and an environmental chamber for turbine torque testing under actual operating conditions. Flow meters are calibrated by a device which is the only one of its kind in the country, and uses water, liquid oxygen or liquid nitrogen. Liquefied gases for tests are supplied by Air Force Plant 71, also located on the Aerojet Sacramento site. Plant 71 can produce several hundred tons of liquefied gas per day.

The solid rocket test area is located on approximately 270 acres of land and includes 12 test bays, including two large vertical bays.

Aerojet also makes the engines for a number of interest smaller solid-propellant rockets. One of these is the solid propellant charge for Navy's Mark 41 torpedo which the Sacramento plant began turning out in 1956. Another interesting Aerojet propulsion unit is the combined solid propellant booster-sustainer engine for Army's Raytheon Hawk anti-aircraft missile. The two



NOZZLE ports are cut in Polaris missile aft tank-head at Aerojet's Sacramento plant. Engineers install the nozzles later.

stages are contained within a single case and fired through a single nozzle. Manufacturing technique is to cast a fast-burning, high-thrust propellant over a mandrel providing the shape of the initial charge port and then cast a slow burning sustainer propellant around the booster grain. Sustainer burning phase is intended to generate only enough thrust to balance aerodynamic drag and prevent the missile from decelerating. Though one nozzle cannot offer maximum efficiency for both booster and sustainer phases, weight saving from combination of two stages within a single case is large enough to more than offset the loss. Aerojet engineers think the Hawk technique may soon be copied in larger missiles. Aerojet-General also manufactures the solid propellant rockets for USAF-Douglas MB-1 Genie, Hughes GAR-9 Falcon, Raytheon Sparrow III and Navy-Convair Tartar.

Aerojet is operating two pilot plants to develop production techniques for the manufacture of solid rocket fuels and high energy fuels for air breathing engines.

The high energy fuel plant is a joint venture between Aerojet and Stauffer Chemical Co. Stauffer is an experienced supplier of borax, boron and the boron derivatives. Operation of the pilot plant is under Aerojet direction. Aerojet officials believe the pilot plant will demonstrate the ability to turn out specific pure alkylated borane derivatives such as HEF-2 at a cost of $1.50 per lb. The Stauffer-Aerojet program is already funded and will continue despite USAF and Navy cancellation of other high energy fuel programs (AW Sept. 28, p. 34).

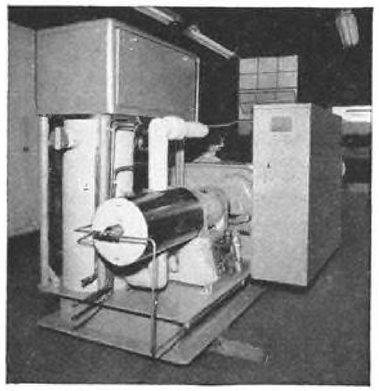
Aerojet engineers call cancellation of the high-energy fuel version of the General Electric J93 a significant setback to the high energy fuel program because the new fuels require special engines designed to cope with rapid flame propagation if maximum advantage is to be derived from them.

Production cost is the main obstacle to large scale use of the high energy fuels and it is this point which the Stauffer-Aerojet joint venture intends to attack. A characteristic which tends to boost cost is that some of the chemical intermediates in the refining process flash on contact with air. One key to the Stauffer-Aerojet low-cost process is the practice of recycling chemical intermediates and byproducts to extract the greatest possible amount of pure fuel from a given amount of raw product.

Costs Rise

Consumption of raw material through the turning out of byproducts inevitably raises costs. The Stauffer-Aerojet venture has about $2 million invested in the Sacramento pilot plant. The high-energy fuel program is operated by a joint project group known as Stauffer-Aerojet Chemical Co. Another pilot plant is being operated at Sacramento under the auspices of Aerojet Chemical Division to try out a method of synthesizing nitropolymer solid rocket fuel. These are not commercially available. Aerojet has not been able to guarantee enough of a market to interest old-line chemical manufacturers in constructing such a chemical plant. The pilot plant culminates 10 years of research in the field by Aerojet and is expected to go on-stream soon. Nitropolymers offer higher specific impulse than current solid

SPECIAL CRYOGENIC EQUIPMENT



High pressure—high capacity liquefied gas pump. Up to 90,000 scfh of liquid oxygen, nitrogen and other gases can be pumped to 15,000 psig, with no contamination. Built-in vaporizing equipment enables delivery of high pressure gas. Efficient and reliable, these units have gained wide acceptance by defense agencies and industry.

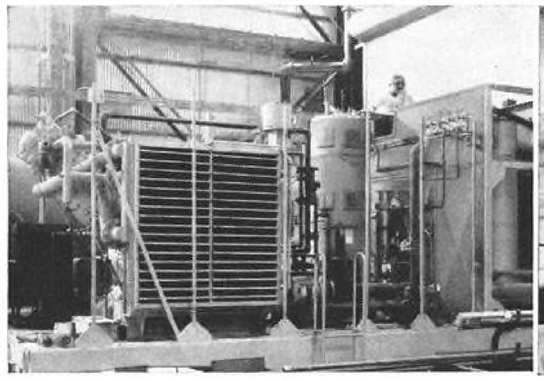
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Air Products puts exceptional experience and skill at your command . . . a background of achievement that includes supplying a major portion of the cryogenic equipment for the defense program and, most recently, the first tonnage liquid hydrogen facility, engineered, installed and operated by Air Products for the U.S. Air Force.

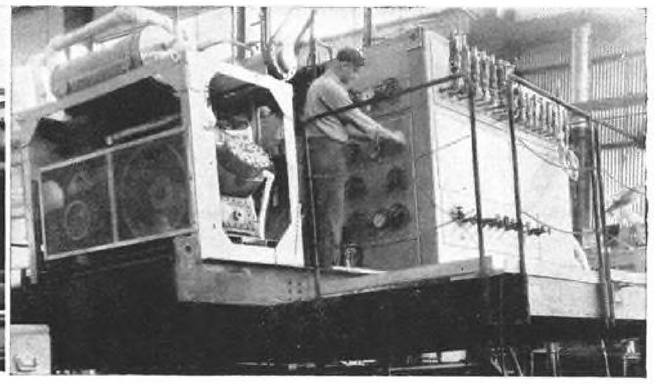
Air Products offers an unequalled range of services . . . including research, engineering, manufacturing and operation . . . and has the organization to service all equipment.

We will be glad to give you details on what we have done, and what we can do. Consult us about your cryogenic requirements, problems and ideas. Air Products, Inc., Allentown, Pa. Phone EXpress 5-3311.

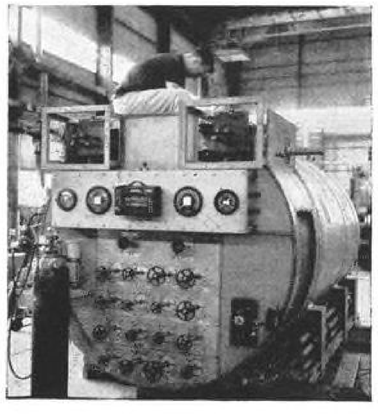
Some special equipment under construction at Air Products



High-capacity helium liquefier. This compact, semi-trailer mounted unit is also capable of liquefying hydrogen. Design of the process . . . requiring the extremely low temperature of minus 452°F . . . and construction of the heat exchangers, expansion engine, transfer lines and specially insulated compartments exemplify Air Products specialized cryogenic skills.



Shipboard liquid oxygen—liquid nitrogen generator. Air Products successful development of units like this was a major technological breakthrough in cryogenic equipment design. More than 40 are now aboard U.S. Navy vessels. This one . . . rated at 1.3 tons per day of high purity oxygen . . . is being tested on a special rig that duplicates the rolling and pitching motion of a ship.



Liquid oxygen—liquid nitrogen storage unit. Two separate tanks within a common outer shell can hold 750 gallons of LOX and 250 gallons of liquid nitrogen, with integral vaporizing equipment. This specially designed and constructed unit can withstand forces of up to 20 g's.

Air Products
...INCORPORATED

rocket fuels and will make usable some new high energy additives. Use of the nitropolymer additive alone will result in a performance boost of about 10%. With the new additives, performance increase will be on the order of 15%.

The Azusa-based chemical division consists of 241 employes, of whom 136 are graduate engineers and scientists and 44 hold doctorate degrees. Nineteen of these persons were recently sent to Sacramento as expert support for the Stauffer-Aerojet operation in the field of rocket propellants. The Chemical Division does Aerojet's initial work with new propellants. Out of its laboratories came the first use of unsymmetrical dimethylhydrazine as a rocket propellant. The Chemical Division has also done work on such projects as sea water-activated batteries to power electrical boosters in underwater cables. It has run one such battery for the equivalent of a two year period at low drain. It is a primary battery and not rechargeable.

Nuclear Reactors

Aerojet Nucleonics at San Ramon, Calif., a wholly-owned subsidiary, is carrying out promising projects on advanced nuclear reactors. The company had an active part in nuclear rocket Project Rover at AEC's Nevada Test Site when the program was under Air Force administration. Aerojet Nucleonics is still maintaining close touch with the project since it has been taken over by NASA.

The company has accumulated a considerable body of experience with gas-cooled reactors and holds a contract from AEC Army Reactors Branch for the development of a gas-cooled air transportable nuclear power generator. A gas turbine in the closed cycle reactor cooling system will drive a turbine generator producing up to two megawatts of power. Designated the ML-1, the nuclear powerplant will be mounted on a trailer bed. Portable reactor is intended for use in combat areas and remote stations where fuel oil supply poses a difficult logistics problem for conventional generators. It is designed to be placed in service within a day after its arrival on site.

Reactor for the nuclear powerplant will go critical for the first time this fall. The gas-cooled reactor-gas turbine combination will use nitrogen as the coolant and power conversion medium. Short half life of activated nitrogen makes it a good fluid for the purpose. Any radioactivity problem will be created by foreign particles picked up by the passage of the gas stream.

Turbine problems are being studied at Ft. Belvoir, Va., by an Aerojet-operated oil-fired gas turbine facility. This, too, is a closed cycle system. Other half of the two-part program is the gas cooled reactor experiment being carried out at the National Reactor Testing Station, Arco, Idaho. A complete ML-1 powerplant is scheduled to go into operation in 1961. About a year later, final design and specifications should be complete. Maintenance and component replacement will undoubtedly be major problems, therefore, Aerojet Nucleonics will attempt to build it as a maintenance-free item.

As direct support to the corporation's solid rocket activity, the San Ramon plant has built a solid rocket inspector using gamma radiation to penetrate the propellant grain and permit non-destructive examination of the interior. The process is analogous to the use of X-ray in other quality control operations.

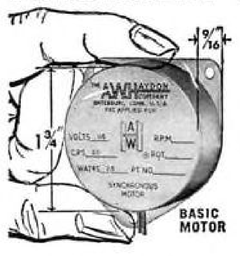
Nuclear secondary power supplies for space flight are being designed with company funds and with some outside support. Such a system was studied for use in Dyna-Soar with direct conversion by thermoelectric or thermionic means specified as preferable. At power levels above a kilowatt, Aerojet Nucleonics found reactor-powered rotating machinery to be a more likely candidate. A big problem in space applications of nuclear power is that of dumping excess heat since there is not atmosphere or other material into which to transfer it by conduction or convection. The only possible way appears to be by radiation which becomes most efficient at very high temperatures, since radiated energy varies as the fourth power of absolute temperature. Such extremely high temperatures are exactly what must be avoided in the reactor. But if energy must be dissipated at low temperatures, size of the radiator becomes excessive due to the effect of the fourth power relationship. Controversy exists over whether the Rankine boiling liquid cycle of the Brayton gas cycle cooling technique is most effective. Problems of using nuclear reactors in space tempt scientists to take a second look at direct conversion schemes. Unfortunately, these usually turn out to require big equipment to get the necessary power level.

Lunar Base

Nucleonics holds a study contract in the SR-192 military strategic lunar base project for a nuclear power supply. Contract is reportedly half way to completion. The company is also studying such a power supply for a non-military lunar observatory.

Provision of nuclear power to drive colloidal or ion propulsion systems is being studied. The power needed for this duty would be on the order of tens of megawatts. Since the ratio of reactor weight to power output decreases along an exponential slope, effi-

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SPECIFICATIONS

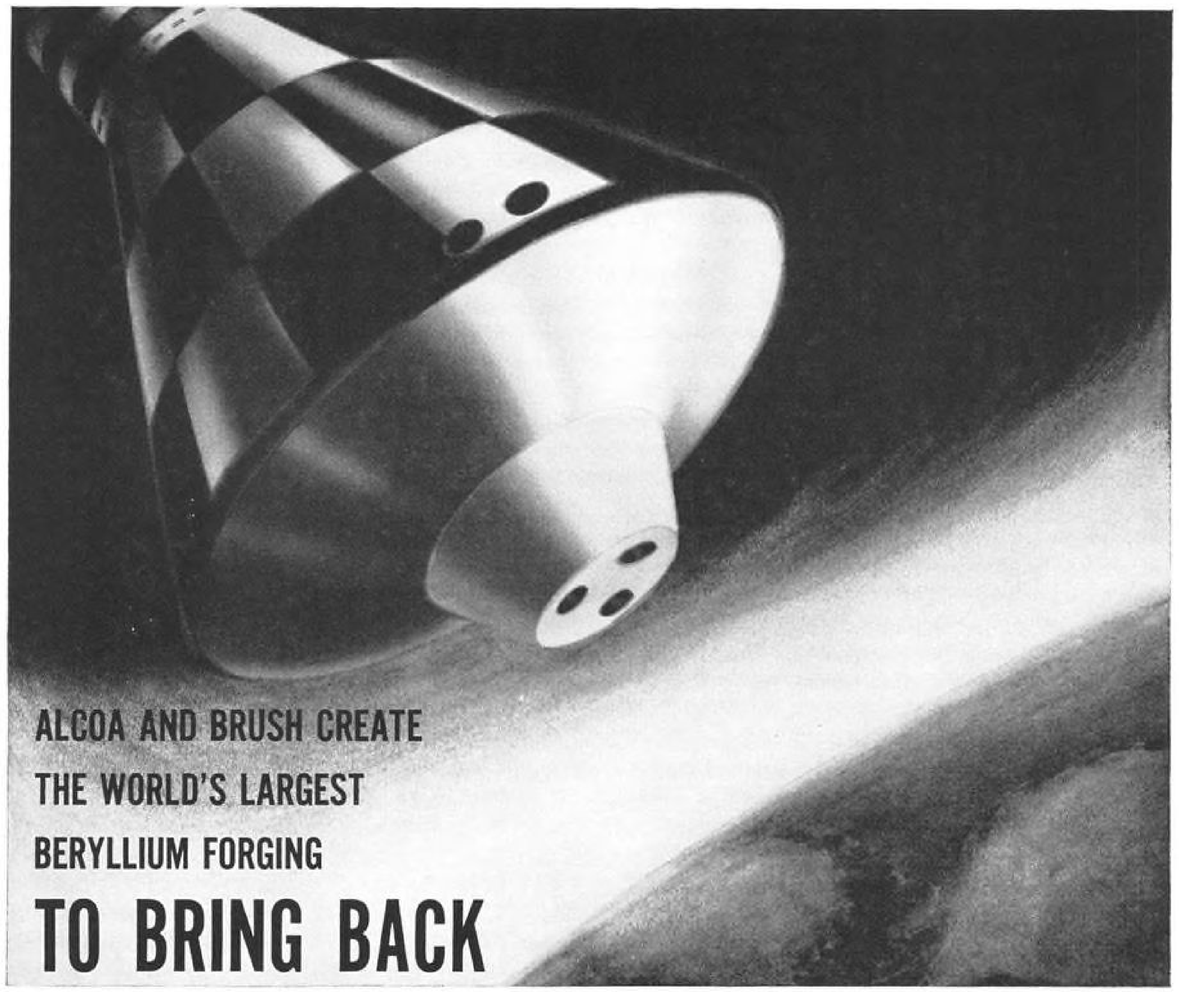
Standard Voltage Ratings: 6, 12, 24, 115, 230 Volts
Frequency: 60 CPS Standard
25, 50 CPS Available
Power Input: 2.5 Watts Maximum (60 CPS)

BASIC MOTOR
Weight: 4 ounces
Speed: 300 RPM
Torque: ¼ oz-in.
Length: 9/16 inch

WITH INTEGRAL GEAR TRAIN
Weight: 5 ounces
Speed: 300 RPM to 1/6 RPH
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AND, SUDDENLY, his life will become the most priceless thing in the black void that rings the earth. To bring him back, living, safe, unharmed—through the buffeting shock waves of the ionosphere; through the fiery heat of re-entry—this, so far, will be man's highest material achievement.

TO BRING him back safely, Alcoa has forged, on the gigantic 50,000-ton Air Force press at our Cleveland Works, the largest beryllium die forging ever turned out for *any* purpose. This forging, produced for The Brush Beryllium Co. from their CMV hot pressed blanks, is a disk-shaped shield with an arc of 80 in. and a chord of 72 in.

THIS BERYLLIUM forging is designed to be the base of a McDonnell Aircraft Corp. "Mercury" capsule. Beryllium is used partly to reduce weight, partly to withstand the shock of re-entry . . . but primarily to absorb, diffuse and dissipate the enormous heat of atmospheric friction—permitting the interior temperature of the space capsule to rise no higher than a safe, maximum 150°F.

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ciency-conscious space ship designers will be happier with large systems.

Fast pulse reactor is being designed for radiation damage study. Pulsing of the energy makes it possible to supply a large dosage for lower cost than with a steady state operation. The word fast comes from the use of fast rather than slow, or thermal neutrons, in the nuclear reaction. Critical mass in a fast reactor is about 40 kg. compared with 2 or 3 kg. of U-235 in a thermal reactor with the right moderator. However, the diameter of fast reactor core is about one foot compared with 2 or 3 ft. for the thermal reactor, because no reactor need be used in the former. Small core means that shadow shield can be smaller and a corresponding amount of weight can be saved.

Aerojet Space Technology Division, located at Azusa, is also working on ion and colloidal propulsion. It reports that colloidal propulsion seems more promising.

Advantages seen in colloidal propulsion are:

- **Less development time** required.
- **Thrust on the order** of 10^{-2} g compared to 10^{-4} g for ion propulsion.
- **Colloidal system** will operate at ambient temperature, whereas ion rocket requires temperatures of around 1,500F to 2,000F.
- **Colloidal particle** has higher mass than ion.
- **Cost of lubricating oil** used as colloidal propellant is 20 to 50 cents per pound compared with a cost of $900 per pound for cesium used in ion propulsion. Main requirements for colloidal propellant medium are low vapor pressure and high dielectric constant.

Space Technology Division is conducting advanced research in plasma and atomic oxygen recombination powerplants as well as specific projects on SR-192, military strategic lunar base, advanced inertial guidance system, and lunar landing techniques as well as general research in the fields of space environment, solid state physics, celestial mechanics and microwave communications. It is developing a thermoelectric solar converter which should have a one kilowatt output and a conversion efficiency of 15% to 17%.

Aerojet's Space Technology Division is newly formed out of other research divisions in the company. Since Aerojet has capability in practically every field of space technology, management decided to create the division as a means of directing research talent throughout the company in a coordinated attack upon space flight problems. Space Technology Division integrates the work of outside contractors in the field as well as that of company divisions.

Aerojet Systems Division has the responsibility of managing and coordinating projects involving several divisions or outside contractors under Aerojet leadership. The division, which developed Titan propulsion, split to form the liquid rocket plant at Sacramento, and the Systems Division. All liquid rocket projects, other than Titan, stayed with the Systems Division.

Systems Division manages the following projects: Able, Ablestar, Aerobee, Astrobee, liquid rocket sleds at Project Snort, Hurricane Mesa, and Holloman AFB, preliminary design of Army tactical support missile under project management of International Telephone & Telegraph, Army large rocket and propellant studies, and hybrid liquid-solid rocket.

Systems Division is boosting Able and Ablestar as complete space vehicles, lacking only payload and guidance. Ablestar is a new rocket roughly twice the size of Able which grew out of Vanguard stage two. Ablestar will use the same chamber but bigger tankage and will have restart capability for late orbit correction. First Ablestar is scheduled for delivery in November.

As its name indicates, Astrobee is a descendant of the well-tried Aerobee series of sounding rockets. It is expected to reach apogees as high as 5,000 mi. Launching of Astrobees are to begin around the end of this year.

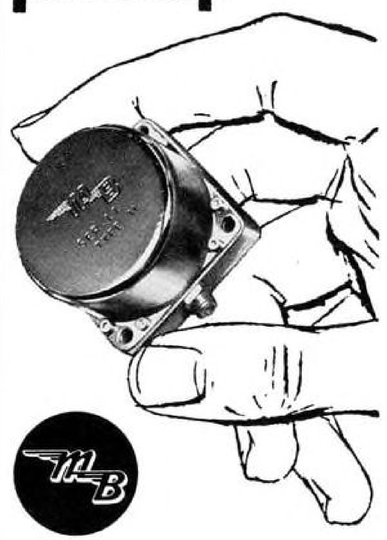
Operations Analysis

Operations analysis of the hybrid rocket by Systems Division indicates that need for such a propulsion system exists. It is expected to find application where maneuverable, precisely throttlable space rockets are required. It offers easy control of burnout velocity. Results of the company funded project lead Systems Division engineers to believe that a second generation fleet ballistic missile may use the hybrid rocket. Tactical lifetime of a submarine is on the order of 20 years, therefore, such a missile must match the geometry of Polaris launchers. A successfully developed hybrid rocket could do this and offer greater range. Chief problem before the designers is how to inject the liquid propellant in such a way as to get uniform burning down the length of the solid propellant grain.

A company-funded project is under way to study the problems of mine field placement location and mapping. The study grew out of a rocket program as did a similar study of night battlefield illumination.

Army tactical support missile being developed under International Telephone & Telegraph project management will probably, but not necessarily, be a solid-propellant rocket. Main objective is low cost. Guidance will be used only if it can be obtained at low enough price. Aerojet has been working on the project for approximately a year. The new missile would carry

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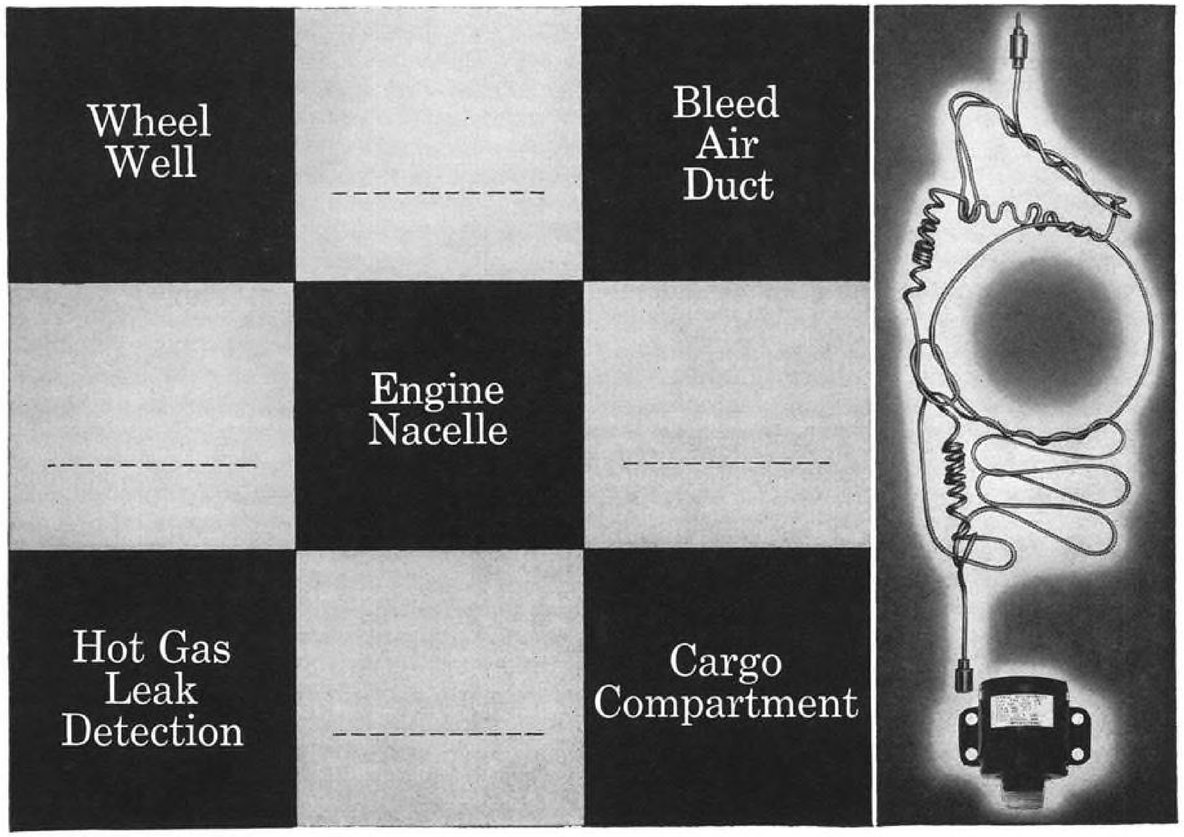
As a starter, we've shown a few of the many proved applications of the Fenwal Continuous Fire and Over-Heat Detector. But you know *your* particular requirements best. So we'll describe this advanced protection system . . . *and you fill in the blanks below!*

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Grumman F11F-1F Carries Bullpups, Sidewinders

Grumman F11F-1F Super Tiger mounts Martin Bullpup ASM-N-7 air-to-ground missiles on inboard pylons, Philco-General Electric Sidewinder AAM-N-7 air-to-air missiles outboard. Super Tiger is a higher-powered version of Grumman's F11F-1 interceptor in service with the Navy. Interceptor is powered by the General Electric YJ79-GE-3 engine rated at over 10,000 lb. thrust. Full span flaps and slats are installed for low speed control; Mach 2 aircraft lands at 120 kt. Large nose houses a 24-in. radar disk. Thin wings each contain 90 gal. of fuel. Japan began flight evaluations of aircraft at Edwards Air Force Base, Calif., for consideration by Japan's Air Self Defense Force.

either a conventional or nuclear warhead.

Another Army-oriented program is an improved technique of vertical envelopment. Proposed Aerojet system would equip paratroops with extremely high sink rate parachutes. Proximity fired retrorockets would provide the final soft landings.

Underwater Propulsion

With 15 years in the field, Aerojet Anti-submarine Warfare Division has developed considerable experience in the fields of hydrodynamics and underwater propulsion. Vehicles propelled by ASW Division-designed engines have achieved speeds of 170 kt. The company first reported producing solid-propellant charges for underwater use in 1956. Charges were used for the Navy Mark 41 torpedo. Notable ASW Division propulsion projects include a hydrorocket boat propelled by a pump-driven jet of water, and a hydroduct underwater ramjet using water-reactive fuel to generate heat and steam.

Now approaching production is a new high-performance anti-submarine torpedo. Aerojet-General holds a $29 million contract from Navy for the weapon. Guidance responsibility is held by Bendix-Pacific Division.

While the ASW Division does no work in the field of submarine detection, it coordinates the activities of all other company divisions and subcontractors in this field. Detection work is done at the company's Atlantic Division in Frederick, Md., and some information comes out of the work of the Azusa-based Avionics Division.

The division is equipped with a high-speed ring channel tow-tank for the development of hydrodynamic shapes and underwater propulsion units. Wave tank owned by Aerojet is for use in mine countermeasure work.

The ASW Division is staffed by 303 persons specializing in the field and is authorized to draw upon all other company divisions for technological support in related fields.

Aerojet scientists are convinced that conventional methods of marine propulsion and submarine detection have reached a plateau in their development curve and are pushing Aerojet ASW work along unconventional lines. They argue that a given expenditure of time and effort is more likely to produce a significant increase in performance if applied to totally new techniques, rather than to an improvement of old techniques.

Direction center techniques are being developed to vector large, widespread anti-submarine forces to the target. Tactical air control centers, combat information centers and SAGE direction centers have long performed this function in air warfare. The Aerojet proposal would apply the same principles to the familiar missions of detection, localization, classification and kill. ASW Division analysts explain that this parallel to air warfare tactics has not been used in the past because submarine capability and mission was so limited as to make it unnecessary. Addition of long-range missile armament, and nuclear power, gives the submarine a new mission which allows it much greater freedom of movement and reduces its vulnerability.

Silent Valve

ASW Division has developed a silent valve to handle large fluid flows without the noise of cavitation and metal-to-metal contact. Close coupling of vessel machinery and water makes submarines and ASW vessels good sound transmitters. Use of silent equipment is a great tactical advantage. Navy will soon begin tests of the silent valve at Annapolis Naval Engineering and Experiment Station. National Aeronautics and Space Administration has already received two for tests at Lewis Laboratory. Since noise is equivalent to inefficiency, NASA is interested in the Aerojet valve as an efficient means of controlling rapid propellant flow in large rockets.

A much publicized product of the ASW Division is Minisub, developed for use of Navy frogmen. Commercial market for Minisub is expected to develop.

Aerojet Avionics Division, which

grew out of a need to make spectroscopic analyses of rocket flame 15 years ago, now claims to have the largest and most complete infrared facility in the country. About 99% of its effort is devoted to work with infrared. Of its 650 employes, 60 are professional technologists. It operates in 120,000 sq. ft. of floor space.

Avionics Division contributions include the infrared half of a combination radar-infrared gunsight now in production for USAF Lockheed F-104. The division has proposed other such systems for Navy's Chance Vought F8U-2 and Air Force's North American F-108. All aspect infrared bomber defense system by Aerojet is now being evaluated at Edwards AFB.

In conjunction with Fairchild Camera and Instrument Co., Aerojet is doing work which should lead to a combination infrared, photo and radar reconnaissance system. Development is privately funded and has reached the mockup stage. Aerojet and Fairchild have been working on the problem for about a year. First breadboard system is expected in about six months.

First step, now being tackled, is to superimpose infrared and photo inputs using a single detector assembly. Aerojet, with responsibility for infrared side, is trying to get resolution three times as good as that offered by present systems.

"Two color" infrared surveillance system is being developed for Project Midas, offspring of the original WS-117L program. Term "two color" is deceptive since use of two detector elements and a filter enables the system to read three parts of the spectrum. Purpose is to enable Midas to study cloud cover or penetrate it to look at the surface of the earth at will.

At Cape Canaveral, Avionics Division staff members have been involved in both Project Gaslight and DAMP (Downrange Anti-Missile Measurement Programs). Gaslight is the original Army-sponsored Jupiter nose cone tracking program. DAMP Program is a regular part of the Atlantic Missile Range operation. Aerojet holds the responsibility for infrared measurements. Ultraviolet measurements are taken by Avco. Infrared equipment has been picking up re-entry at ranges of 1,000 mi.—well in advance of radars.

Aerojet-General is a member of an eight-company team holding a $38.9 million Air Force contract to develop an airborne infrared long-range surveillance system.

Aerojet Avionics Division is working on guidance for Navy Bendix Eagle and is administering flight simulator work inherited with the acquisition of the ex-Rheem facility. The division will seek to put infrared surveillance systems coming out of the joint program with Fairchild on the SD-2 drone acquired from Rheem. Like many companies in rocketry, Aerojet-General has developed a Facilities Engineering Division which has taken part in the development of range instrumentation installations at Naval Missile Facility, Pt. Arguello, Naval Missile Center, Pt. Mugu and Vandenberg AFB. The Aerojet Facilities Engineering Division also designed, fabricated and installed rocket test facilities for Lockheed Aircraft Co.'s Missile and Space Division at Santa Cruz, Calif. It has also worked for Army's Redstone Arsenal, Air Force's Arnold Engineering Development Center at Tullahoma, Tenn., Douglas Aircraft Co. Thor test site on Aerojet land at Sacramento, Calif., Edwards AFB, AEC's Los Alamos scientific laboratory, Martin Titan facility at Denver and the closed cycle gas turbine test facility for the Corps of Engineers at Ft. Belvoir, Va. The division has been active in the design and installation of nuclear equipment, including rod control equipment of six submarines for Westinghouse Electric Corp.; structures, utilities, and external loop of the reactor at the gas cooled reactor experiment in Idaho Falls, Idaho; as well as having designed and constructed about 600,000 sq. ft. of new engineering and manufacturing facilities for Aerojet itself at Sacramento and Azusa.

Major Products

Structural Plastics Division of Aerojet has seven major products:

- **Aerowrap laminated** helical strip steel and plastic, high-strength cylindrical pressure vessels.
- **Aeroply laminated** steel and plastic structural members.
- **Glass-plastic ablation** rate rocket nozzles.
- **Aerorove plastic** bonded wound glass filament pressure vessels.
- **Thermal insulators.**
- **Molded plastic** missile warheads.
- **Aerogard foam** plastic shipping containers.

Aerowrap and Aeroply offer strength to density ratios on the order of 1.2 million to one and will handle tensile loads to about 300,000 psi. Dimensional stability during fabrication is extremely good since no heat treat or stress relief is needed after the fabrication of the basic shape. Steel with a hardness of about Rockwell 97 is used in the processes. Aerowrap will be used for large solid-propellant rocket cases and is now being used for recoilless rifle tubes withstanding pressures of 6,000 psi.

The division fabricates warheads for Nike Hercules and Raytheon Hawk by molding an inner plastic shell, bonding steel fragments to the surface of this and then molding an outer plastic shell over the fragmentation layer. Hercules warhead, designated T-45, is in production and more than 2,000 have been built. XM-5 warhead for Hawk is just about to go into production.

Division engineers working with the Aerogard packaging process are now developing an inter-plant handling package for Minuteman ICBM. An Aerogard warhead package for a 1,600 lb. warhead weighs 180 lb., replacing an aluminum box weighing 800 lb. Cost of Aerogard package is about 70% that of the aluminum box.

Structural Plastics Division employs 700 persons and claims to have the best equipped plastic laboratory in the country. Equipment includes an electron microscope and a plasmatron.

Growing industry fears about explosion of electrical detonators by radar transmissions have led Aerojet's Explosive Ordnance Division to study exploding bridge wire detonators requiring thousands of volts to initiate explosion. Bridge wire is not explosive but is vaporized in an intense flash of heat by heavy current. Low voltage caused by incidental radio frequency fields could not accidentally set off the initiator. Power source for the extremely high voltage device would weigh approximately 4 lb. First use of the system will probably be in missile destruct systems and igniters.

Other important work is being done with two-component liquid explosives. Major component is no more hazardous than kerosene and the minor component can be shipped as a corrosive liquid. When the two are mixed the resulting explosive has an output approximately equivalent to that of standard military explosives but still is reasonably safe to handle. The combination is known as Aerex. Company is keeping secret the two components used.

Major component comprises about 97% of the mixture. Shape-cutting charges made of crescent-shaped steel tubes filled with Aerex are expected to make good destruct charges. Charge need not be sensitized by addition of the minor component until quite late in the missile countdown. Division also is studying use of circular cutting charges as a simple way of creating thrust ports for large solid-propellant rockets.

Turbomachinery Division is designing a fluorine transistor pump for fueling of advanced hydrogen-fluorine rockets. Pump development was company-funded and tests are scheduled for late October. No leakage can be accepted in the fluorine pump because of its high reactivity. For every seal in a conventional cryogenic transfer pump, three are in a fluorine transfer pump. The Aerojet Turbomachinery Division has adopted the practice of using three concentric seals: a conventional bellows seal, a jacket of pressurized nitrogen and an outer metal washer seal.



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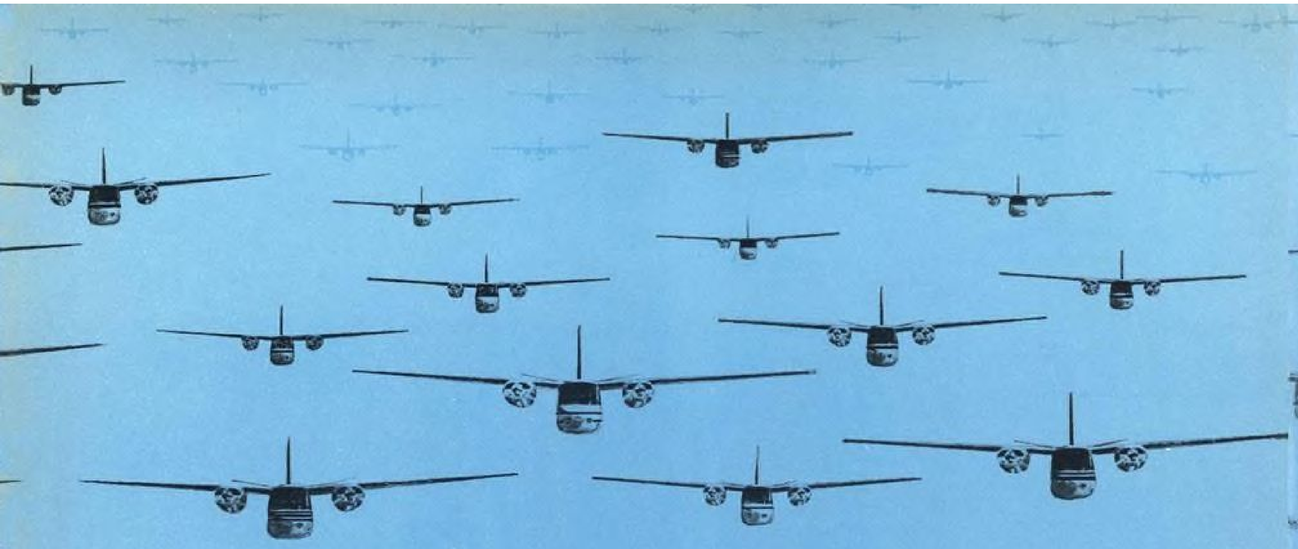
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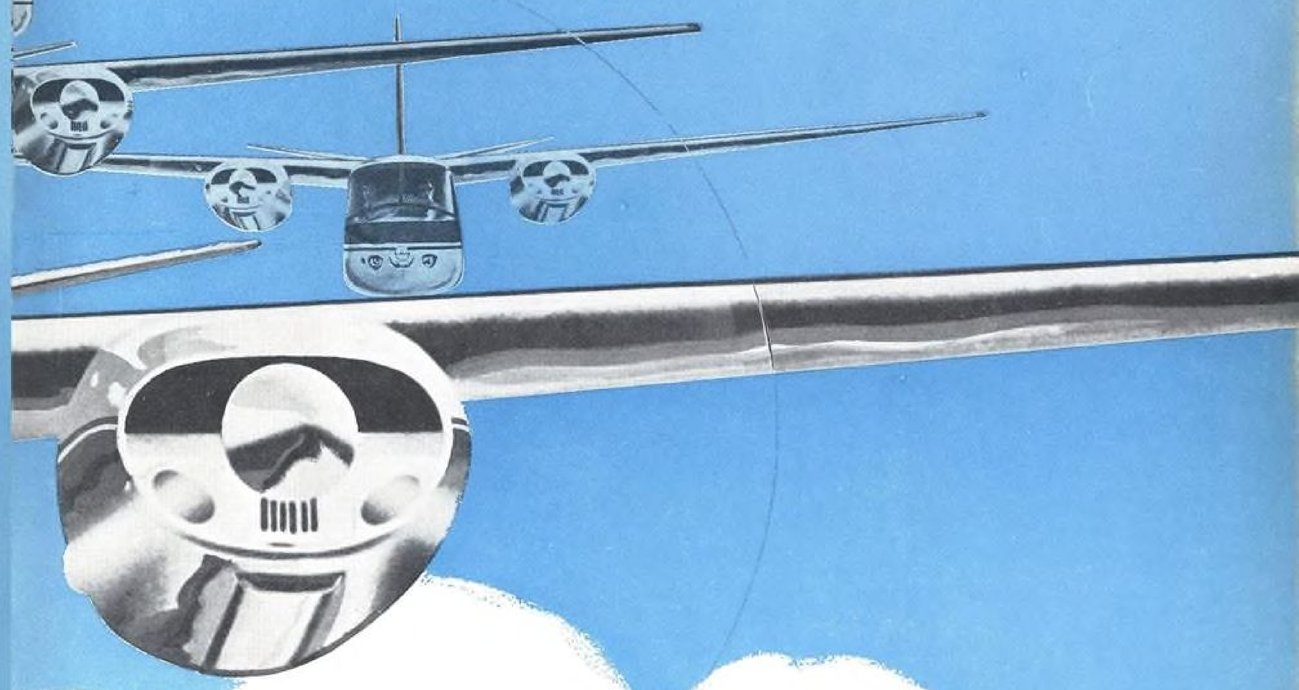
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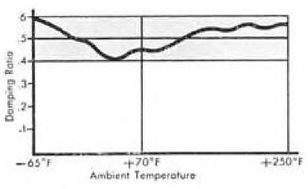


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- Damping: 0.4 to 0.6 from −65°F to +250°F
- Vibration: 20 G to 2000 cps
- Weight: Less than 6.0 ounces



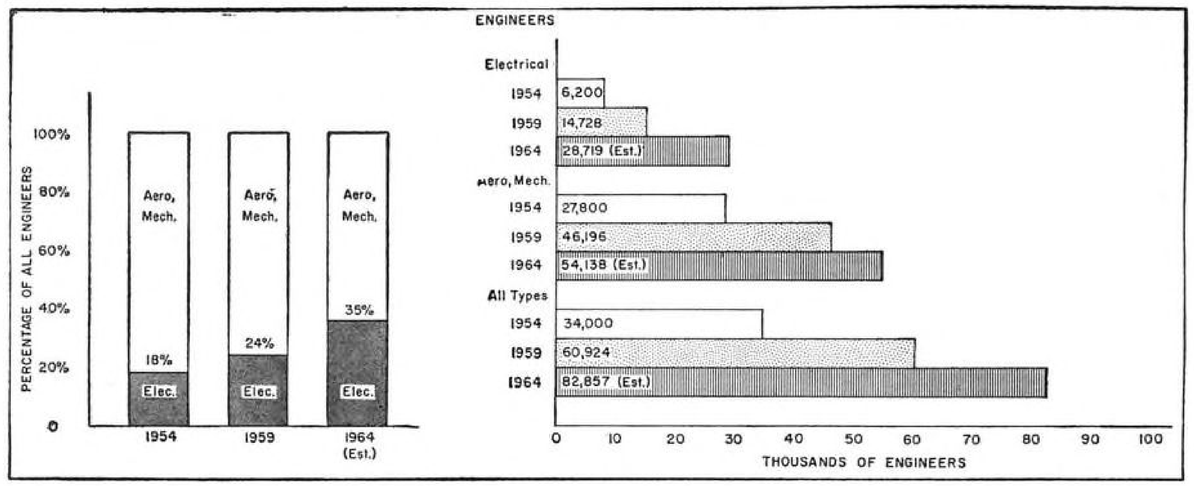
When the chips are down and immediate action is a must, the new Honeywell Miniature Rate Gyros, Type M-100, are always ready. The typical damping of 0.6 at −65°F is obtained *without benefit of heat* from the spin motor, and is held virtually constant up to a temperature of +250°F. The gyro spin motor, requiring only 15 seconds run-up time, will operate on one (split), two, or three phase power, and is isolated from ground.

Other features of the Type M-100 include: unique quadrilever spring construction to produce greater shock and vibration capabilities than a comparable torsion bar gyro; elimination of one gimbal bearing for lower threshold; maintenance of preload throughout severe environmental conditions through exclusive spin motor construction.

Type M-100 is specifically designed for autopilot damping, radar antenna stabilization, and fire control applications. Its small size, high performance, and ruggedness suit it particularly for advanced military aircraft and guided missile applications. Write for Bulletin M-100 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Boston 35, Mass.

Honeywell

Military Products Group



ONE out of four engineers employed by aircraft companies today has electrical-electronic background, and figure is expected to rise to one out of three by 1964, Aviation Week survey shows. In the past five years, number of avionics engineers employed has more than doubled, while employment of other types of engineers has risen by 76%. In next five years, even greater avionic growth is predicted.

Expanding Avionics Engineer Market—Part I:

Avionics Grows in Aircraft Companies

By Philip J. Klass

Washington—One of every four engineers and scientists employed by aircraft manufacturers today is an electrical-electronic engineer and by 1964 the figure is expected to be one out of every three, an Aviation Week survey reveals. Five years ago (1954), an Aviation Week survey showed that approximately one of every six engineers employed by aircraft manufacturers had an electrical-electronic background.

These and other significant figures disclosed by the new survey reflect the changing nature of the aircraft industry, the trend to missiles and space technology and the greatly increased avionic content of piloted aircraft.

Survey Reveals

The survey also reveals that the percentage of aircraft industry avionic engineers engaged in in-house hardware design and development has doubled in the last five years. In 1954, only one-third of the industry's avionic engineers were engaged in in-house design and development, with the balance used to monitor developments by outside avionic contractors, installation engineering and flight test instrumentation. Today, two-thirds are engaged in in-house hardware design and development with only one-third monitoring outside work or performing installation engineering and flight test instrumentation.

This year aircraft manufacturers will produce close to $900 million worth of avionics equipment, for use in their own weapon system projects and for sale to outside companies, the survey indicates. By 1964, manufacturers estimate that they will be manufacturing close to $2 billion in avionics hardware. These figures do not include Hughes Aircraft Co., an aircraft manufacturer in name only, which will turn out close to $600 million in avionics equipment this year.

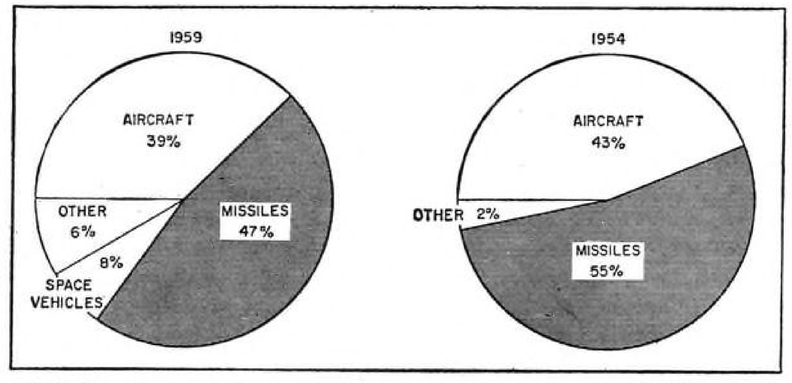
Aircraft companies that participated in the survey include: Beech, Bell, Boeing, Cessna, Chance Vought, Convair, Grumman, Lockheed, Martin, McDonnell, Northrop, North American, Republic, Ryan, and Temco. Douglas and Fairchild declined to participate.

To obtain industry cooperation, and to discourage any inclination to use boastful figures for prestige purposes, Aviation Week assured all participants that no individual company figures would be released.

Industry Percentage

The percentage of the industry's avionics engineers who are working on aircraft has dropped, but the change is not as large as might be expected. This reflects the increased use of more complex avionic equipment in today's manned aircraft.

In 1954, 43% of the industry's avionics engineers were working on aircraft, compared with 39% of the total today. Five years ago, 55% were engaged in



AVIONICS engineers working for aircraft companies divide their efforts (left) between aircraft, missiles, space vehicles, miscellaneous. Breakdown for 1954 is shown at right.

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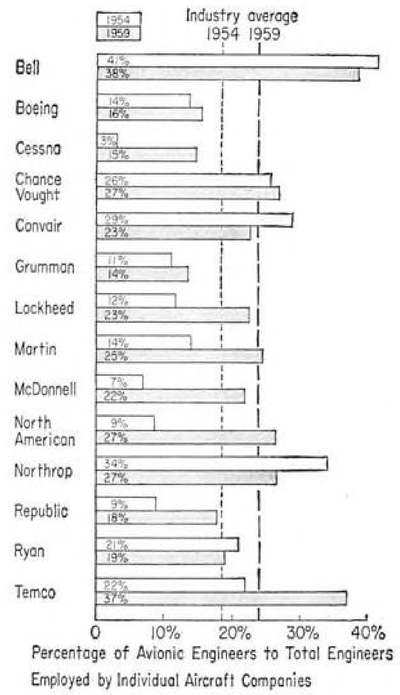
INPUT	100,000 ohms, all ranges, floating and guarded.
OUTPUT	400 ma. full scale, 15 ohms nominal load, ungrounded
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ELECTRICAL-ELECTRONIC engineers employed by individual aircraft companies shown as a percentage of total engineers of all types employed. Figures and industry average is shown for both 1954 and 1959.

missile work, compared with 43% today, with another 8% working on space vehicles, which were not listed in the 1954 survey. Miscellaneous category, which would include such items as Martin's Missile Master, occupies 6% of the industry's total today compared with 2% in 1954, the survey shows.

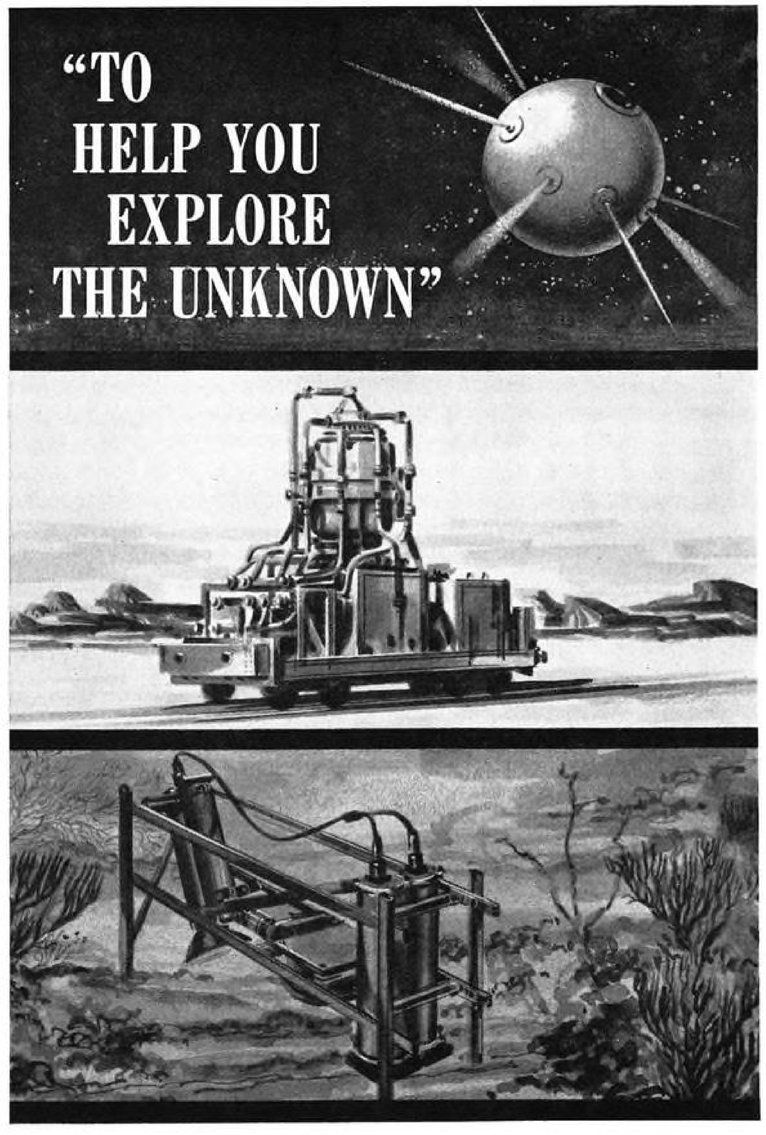
More Than Doubled

Five years ago, AVIATION WEEK's survey of essentially the same aircraft companies disclosed that the industry employed 6,200 avionics engineers. At that time, companies estimated that the total number would nearly double (11,200) by 1959. The new survey reveals that the number has more than doubled and now stands at nearly 15,000.

(Rather than omit Douglas completely from the survey, it was assumed that 8% of all of its engineers, one-third of the industry-wide percentage, are electrical-electronic. This figure was included in the over-all industry total.

In the past five years, the number of avionic engineers employed by aircraft companies has jumped by 137%, compared with an increase of about 76% for aeronautical, mechanical and other non-avionic types. Employment of engineers of all types, including electrical engineers, is nearly 61,000, up 79% over the number five years ago.

The survey emphasized that com-



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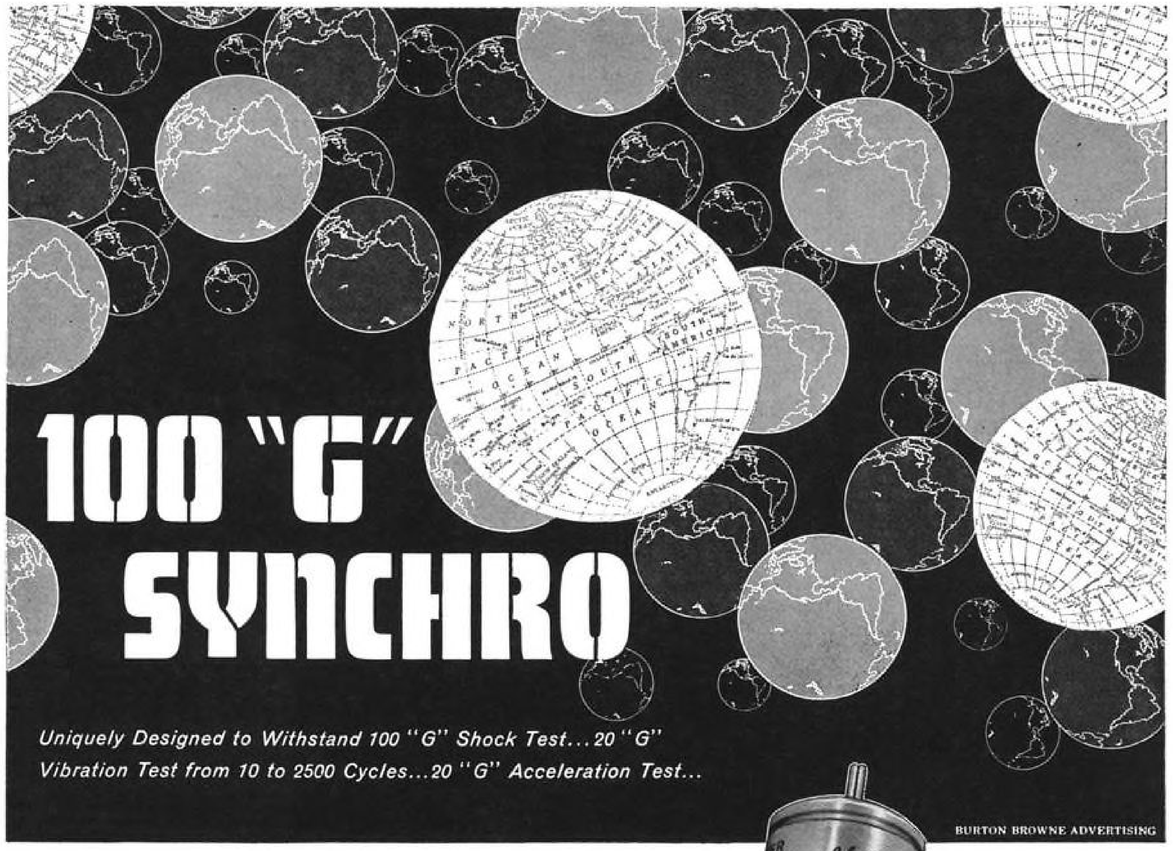
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panies were to list only professional engineers and scientists, not clerical and supporting personnel. The size of a company's engineering department usually is two or three times the size of its professional staff.

Five Years Hence

Aircraft companies were asked to estimate how many avionics engineers and how many engineers of all types they expected to employ five years hence. The industry totals indicate that by 1964, companies expect to have nearly 29,000 avionics engineers on their payrolls, representing a 95% increase over today's figure. The projected total for aeronautical, mechanical and other non-avionic types, is slightly more than 54,000, representing a 17% increase over today's figures.

By 1964, aircraft manufacturers expect to employ a total of nearly 83,000 engineers of all types, representing a 36% increase over today's total. This reflects the increasing engineering content which goes into missiles, space vehicles and advanced weapon systems.

The survey indicates that 24% of all engineers and scientists employed by aircraft manufacturers today have an electrical-electronic training, compared with a figure of 18% five years ago. Because the specific number of engineers employed is considered proprietary information by most companies, survey participants were told that the only figures published for individual companies would be the ratio of the number of avionics engineers to the total engineers of all types.

Such ratios, stated in terms of percentage of all engineers can provide only a rough indication of the extent of a company's avionics effort relative to its total effort and cannot be compared directly with figures for other companies.

Company Comparison

A comparison of the individual company percentages today with those of 1954 shows a marked percentage growth in avionics capability for a number of companies, including Cessna, Lockheed, Martin, McDonnell, North American, Republic and Temco. Several companies show a loss of a few percentage points, but in every case the number of avionics engineers employed today exceeds those on the company's payroll five years ago. Here are the individual company figures, with the 1954 figure shown in parentheses:

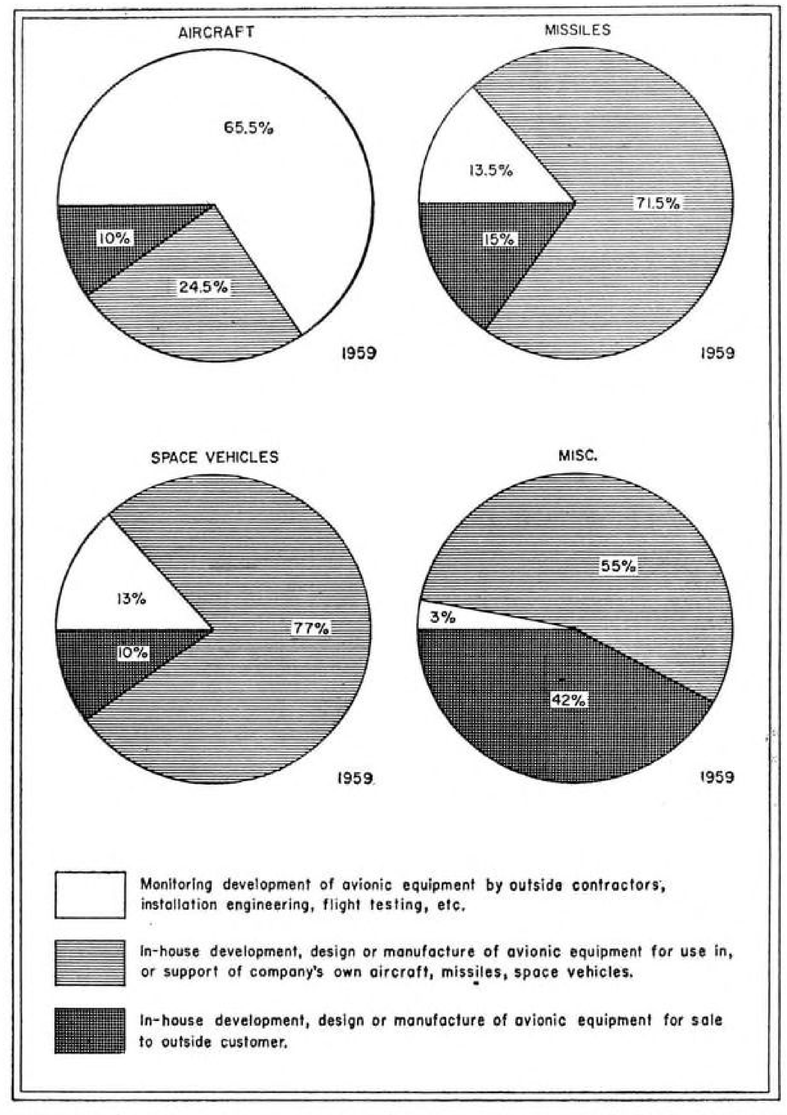
- **Bell:** 38% (41%).
- **Boeing:** 16% (14%).
- **Cessna:** 15% (3%).
- **Chance Vought:** 27% (26%).
- **Convair:** 23% (29%).
- **Grumman:** 14% (11%).
- **Lockheed:** 23% (12%).
- **Martin:** 25% (14%).
- **McDonnell:** 22% (7%).
- **North American:** 27% (9%).
- **Northrop:** 27% (34%).
- **Republic:** 18% (9%).
- **Ryan:** 19% (21%).
- **Temco:** 37% (22%).

Perhaps the most interesting thing about the new figures is the fact that there is far less spread between the industry average (24%) and the figures of individual companies than there was in 1954.

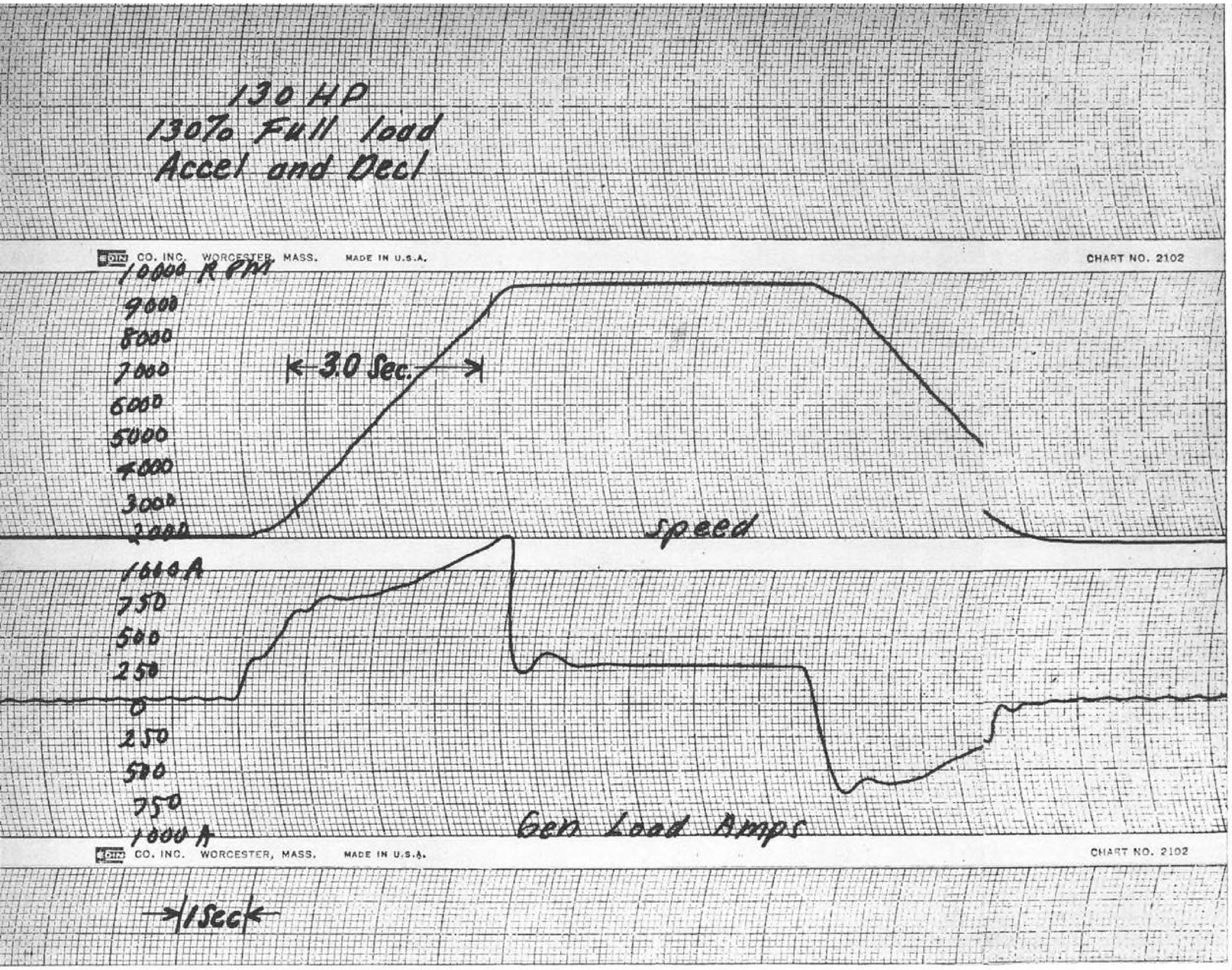
More than half (53%) of the aircraft industry's avionics engineers are engaged in in-house development or design of equipment for use in, or support of, the company's own aircraft, missiles, space vehicles or weapon systems, the survey shows. Another 14% of the industry total are engaged in in-house development or design of avionic equipment for sale to outside customers. (For example, Ryan is producing doppler radar navigators for use on Navy and Army aircraft produced by other companies; North American's Autonetics Division is making inertial navigators for use on Polaris submarines.) The remaining 33% are monitoring development of outside contractors, performing installation engineering or flight test functions.

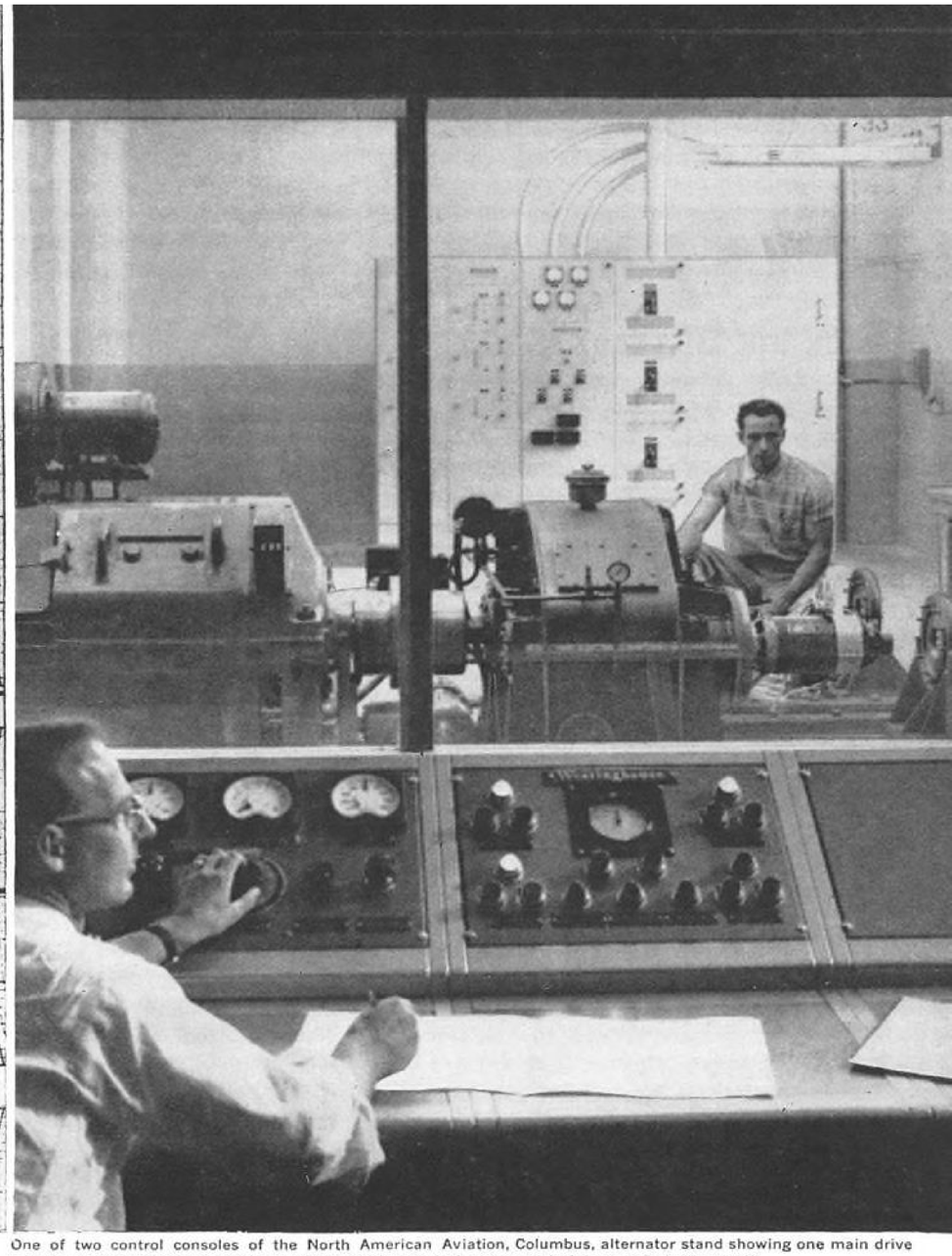
No Direct Comparison

No direct comparison with 1954 survey figures is possible because that survey did not ask for a breakdown between in-house work intended for the company's own weapons and that destined for outside customers. However, the



DIVISION of avionic engineering manpower between monitoring outside developments and in-house development for own use or outside sale is shown above for engineers working on aircraft, guided missiles, space vehicles and on miscellaneous projects.





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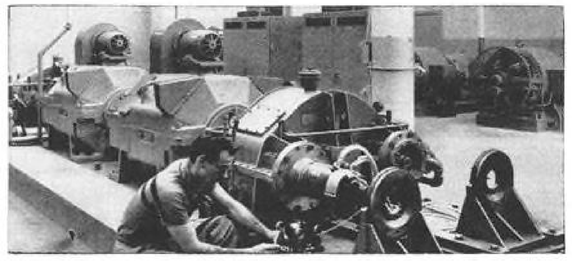
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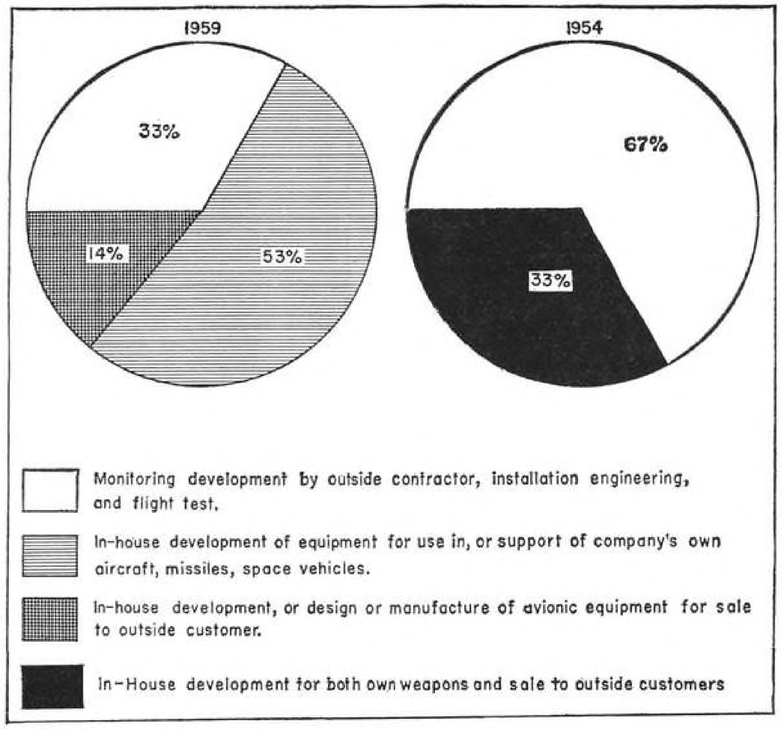
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DIVISION of avionic engineering manpower between monitoring outside developments and in-house development and design for own vehicles or sale to outsiders is shown above.

percentage of the industry total devoted to in-house development is twice that of 1954.

Since the industry now employs more than twice as many avionics engineers as in 1954, this suggests that aircraft manufacturers today are putting four times as much manpower into in-house development and design as in 1954.

A more revealing picture emerges when the work of aircraft company avionics engineers is analyzed according to the end product, i.e., aircraft, missiles, space vehicles and miscellaneous:

- **Aircraft:** 65½% monitoring development of outside contractors; 24½% in-house development for own vehicles; 10% in-house development for outside sale.
- **Missiles:** 13½% monitoring development of outside contractors; 71½% in-house development for own vehicles; 15% in-house development for outside sale.
- **Space vehicles:** 13% monitoring development of outside contractors; 77% in-house development for own vehicles; 10% in-house development for outside sale.
- **Miscellaneous:** 3% monitoring development of outside contractors; 55% in-house development for own weapons; 42% in-house development for outside sale. (This category would include such items as the Army Missile Master which was produced by Martin Co.)

The breakdown of avionic engineer-

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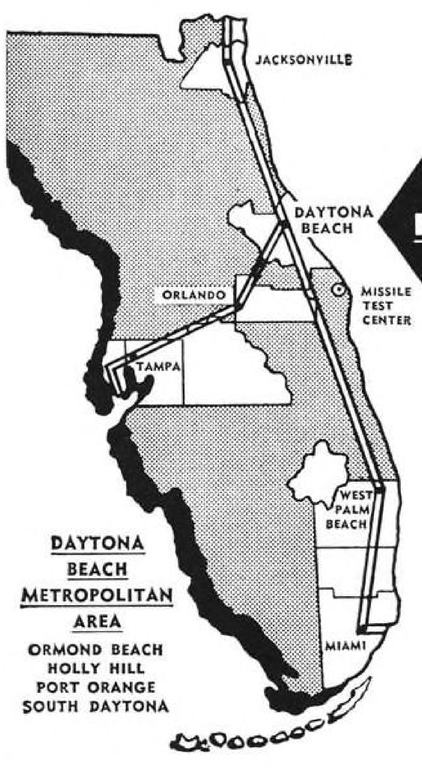
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ing activity for space vehicles more closely resembles the pattern for missiles than it does for aircraft, with the bulk of avionic manpower devoted to in-house work rather than monitoring outside developments.

Companies who supplied figures on their estimated avionics manufacturing output for 1959, 1960 and 1964 represented slightly more than 50% of the industry, as measured by the number of engineers they employ in in-house development for their own use relative to the industry wide total.

To determine whether this was a reasonable sample which could be extrapolated to obtain an industry-wide figure, AVIATION WEEK calculated the estimated sales per engineer, which worked out to $78,000 per avionic engineer in the aircraft companies that submitted figures. Then, half a dozen major avionics companies were asked for similar figures on their sales billed per engineer. These varied between $71,000 and $107,000 per engineer, bracketing the $78,000 figure obtained for aircraft companies who submitted sales figures.

On this basis it appeared reasonable to extrapolate to obtain industry-wide projections of avionic hardware output. The figures for avionic production intended for use in own vehicles and weapon systems are as follows:

- 1959: $590 million.
- 1960: $720 million.
- 1964: $1,210 million.

Similarly derived projection of aircraft industry sales of avionic hardware to outside customers, based on returns from companies representing about 15% of the industry in terms of avionic manpower applied to such work, is as follows:

- 1959: $295 million.
- 1960: $358 million.
- 1964: $745 million.

The ratio of factory output to the number of avionic engineers working in this area is $142,000 per engineer. This is somewhat higher than previously cited figures. It may indicate that aircraft manufacturers generally subcontract larger portions of such avionic equipment, thereby giving a higher output per engineer figure.

Combining the projected figures for aircraft companies avionics production both for own use and for sale to outside customers gives the following totals:

- 1959: $885 million.
- 1960: $1,078 million.
- 1964: $1,955 million.

The figures indicate that approximately two-thirds of the avionic equipment produced by aircraft companies goes into use in the company's own vehicles or weapon systems, with the remaining one-third being sold to outside customers.

The $885 million in avionics equip-



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ment which aircraft companies expect to turn out this year probably is greater than the dollar value of all avionics equipment produced by all of the nation's manufacturers a brief decade ago.

Despite the expanding inroads by aircraft manufacturers, there appears to be less concern and opposition from the established avionics manufacturers than there was four or five years ago. This is partially due to the expanding market for avionics. But there are other factors which have made the established avionics manufacturers more confident of their position. These factors, and other significant trends in the aircraft-avionics field, will be the subject of the concluding article in this series in a subsequent issue of Aviation Week.

Portable Landing Aid Designed by Boeing

Wichita, Kans.—Inexpensive, portable instrument landing aid for use at advanced military airbases and other undeveloped fields is being designed here by Boeing Airplane Co.

It weighs less than 10 lb. and requires addition of only two small units to airborne ADF receivers, plus two low frequency homer beacons on the ground. Beacons can be operated by untrained personnel. Patent application has been filed by Boeing and S. B. Luftig, research engineer in the company's advanced design-avionics section.

Boeing researchers concentrated on low frequency channels to escape line-of-sight limitation on VHF transmissions at low altitude. Problem areas:

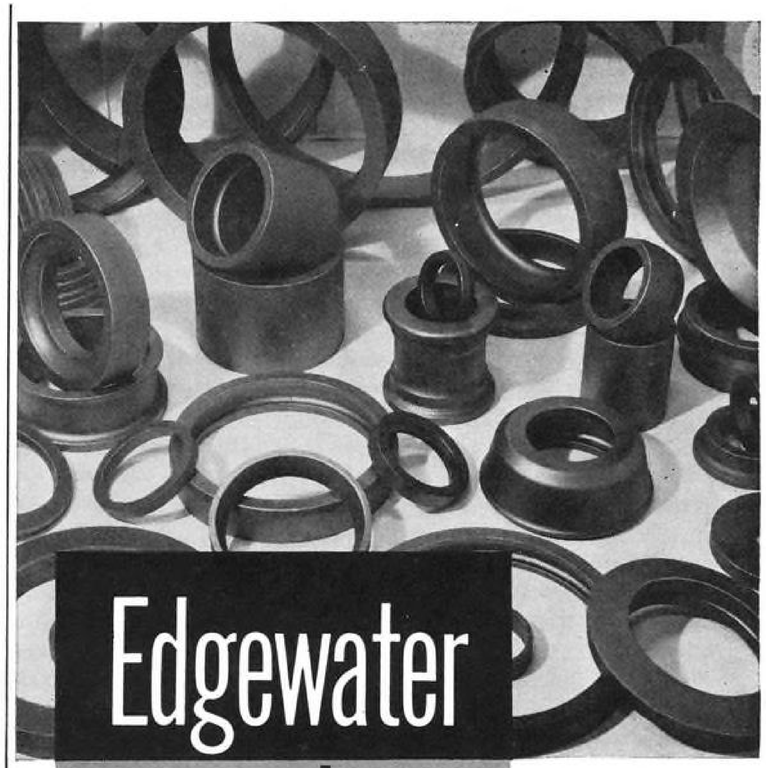
• **Static encountered** on low frequency channels which can induce bearing or heading errors.

• **Difficulty of providing** continuous position information normally supplied by more elaborate systems.

Basic idea calls for two ADF homer beacons transmitting steady, low frequency signals. One is placed on the centerline of the runway's departure end and the other at a known distance to the left or right of the approach end. Airplane's standard ADF receivers need a special filter and coupler, both weighing less than six pounds.

The filter, after screening information coming out of the ADF, feeds the system a true heading. The coupler then examines all available data and supplies the same intelligence to the pilot, except for altitude, that normally is given by instrument landing aids. Pilot is shown his location in horizontal reference to runway regardless of wind.

Altitude information is supplied by a radar altimeter and an ADF coupler continuously reports distance to touchdown. Altitude and distance-to-touchdown information is correlated by pilot to calculate glide slope and distance.



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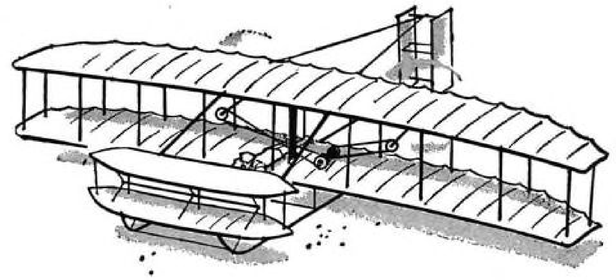
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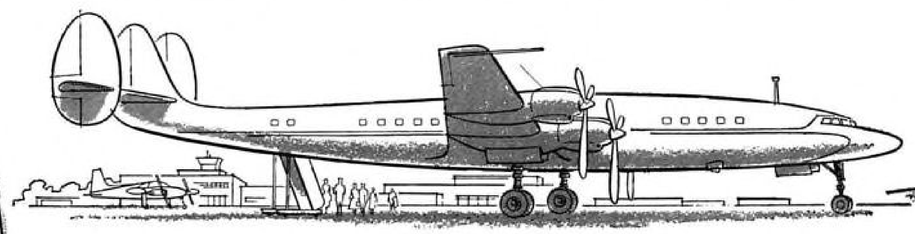
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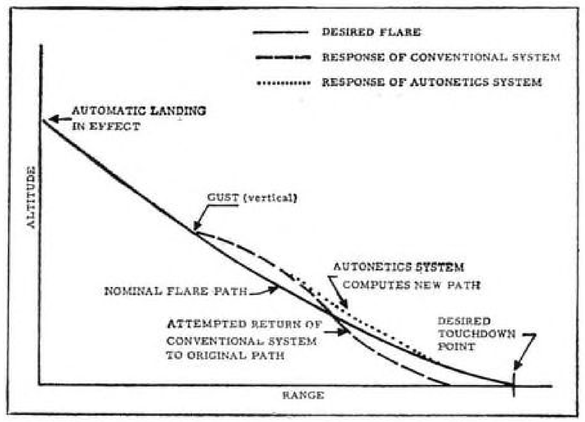


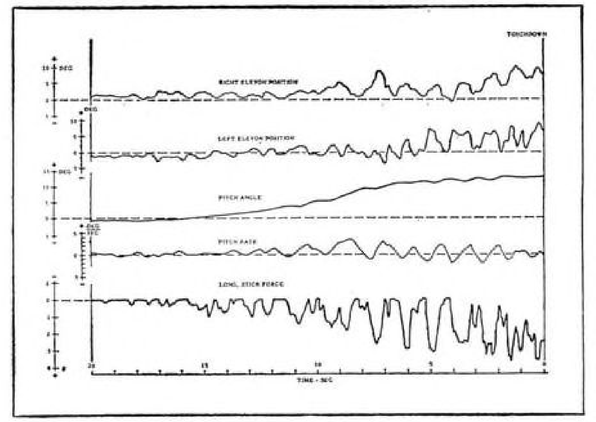
Submarine simulator and mobile training devices expert GORDON E. EWERTZ, with 31-years' electronics experience, is Stavid consultant to U. S. Submarine Base, Tactical Department, New London, Conn.

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EFFECTS of gust disturbance on the landing flare are illustrated at left; at right is control action during typical landing.

Computer Simulates Pilot 'Reasoning'

By Richard Sweeney

Downey, Calif.—Automatic landing system built around a flare computer which brings about "precognitive" flight technique has been developed by Autonetics Division of North American Aviation here.

The "precognitive" feature means simply that the computer uses the same line of "reasoning" that a human pilot would in flying the airplane through the critical last quarter mile of final approach and through the flare, making corrections in small increments as needed to compensate for deviations, rather than try to return to a preprogramed flight path.

Essentially, the Autonetics system uses an open cycle wherein the computer figures a new flare path after the airplane has been disturbed from its routine track by a wind gust or other perturbation.

Three essential variants in the Autonetics system are altitude, altitude rate of change, and time. Inputs include directional information from localizer radio beam, information on actual altitude above terrain and obstructions from a radar altimeter plus augmentation.

System Design

Functional design of the system is based on prediction techniques, which hold that from any initial set of conditions, a control action can be determined which will exactly adjust the aircraft's sink rate, at a predetermined touchdown time, to the desired value.

This offers a variety of possible control actions, essentially the same number as a human pilot would have to choose from, to obtain the desired effect.

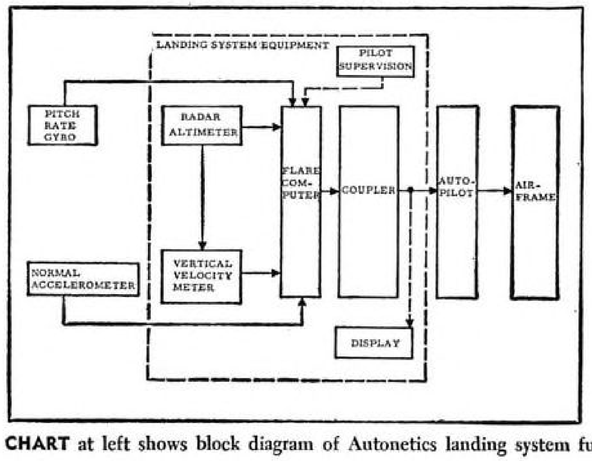
Following on this, the Autonetics system control action was chosen on the basis of "terminal control servo design theory" which holds that at a given instant of time all future events are predictable, provided that initial conditions and the differential equation of the process are known.

For linear systems, prediction is simple, according to Autonetics, using the superposition principle. Touchdown is mechanized by multiplying each of the initial conditions (altitude, sink rate, sink rate error and others) by the response function of the system to a unit initial value for that variable evaluated for the prediction interval. Algebraic summation of these terms then yields a good approximation of the end event.

It was further decided that constriction of control action to a minimum was desirable, either by a constant control setting or a non-oscillatory reduction of the control setting.

Flare computer output goes to the coupler which connects to the autopilot. A force stick steering of the airplane through the pilot's control is provided, which makes it possible for the pilot to override the flare computer, should he not be satisfied with the flight.

Elements of the system include radar



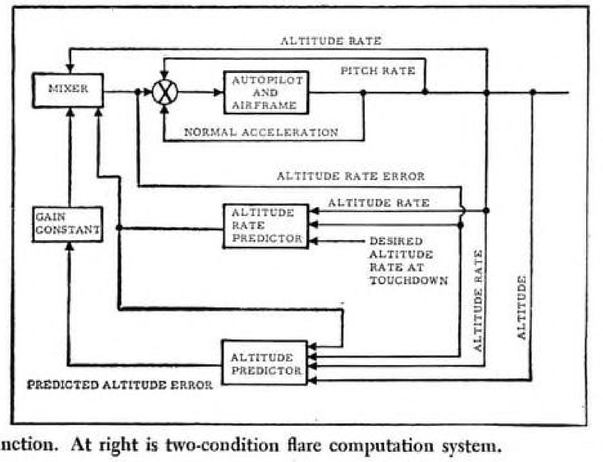
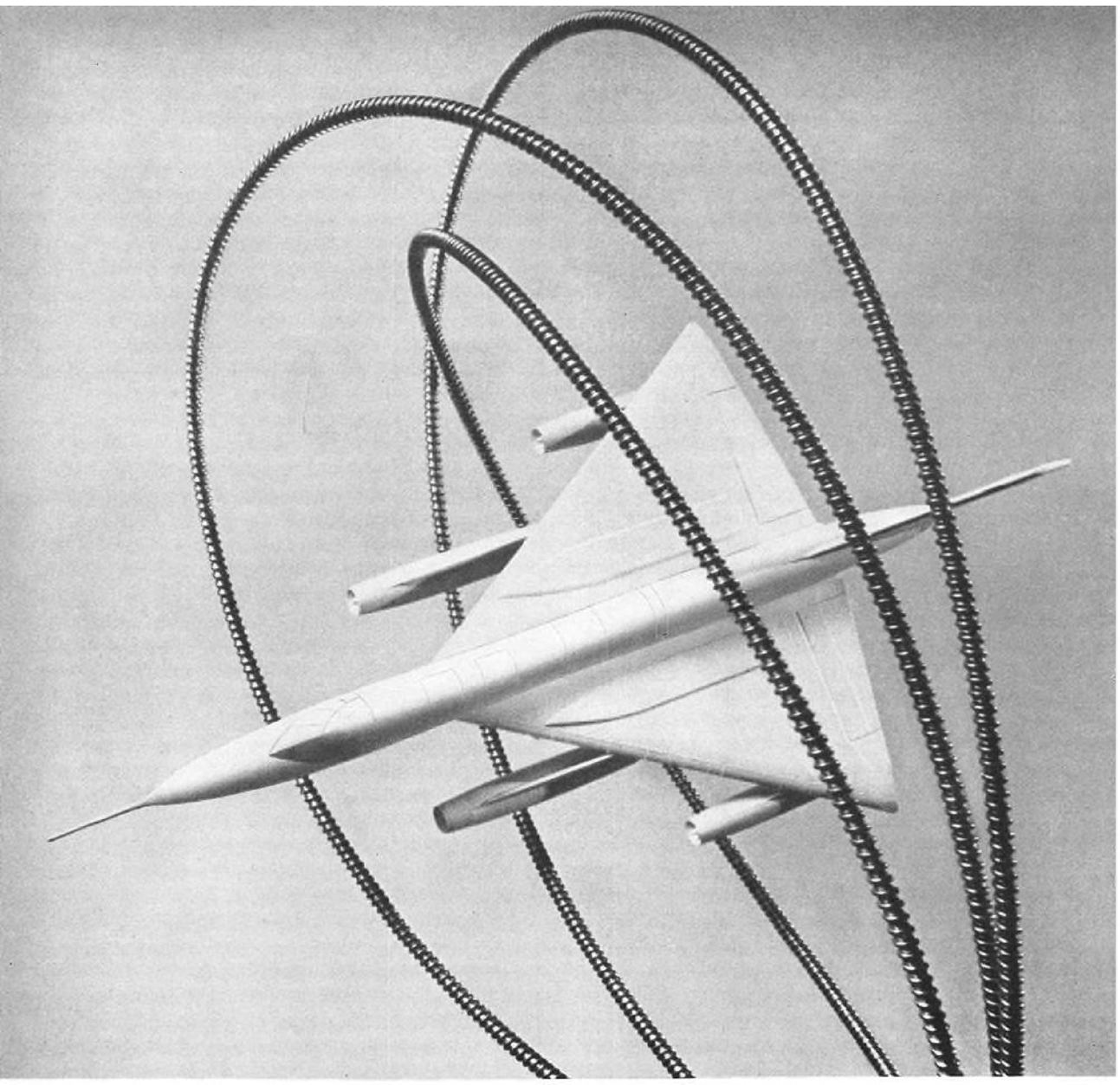


CHART at left shows block diagram of Autonetics landing system function. At right is two-condition flare computation system.



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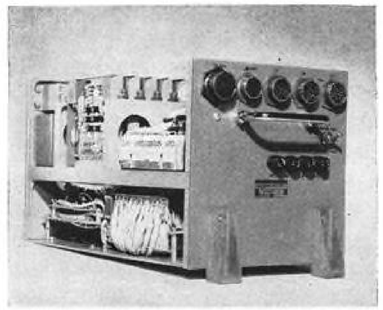
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PROTOTYPE of Autonetics flare computer for landing system.

altimeter, vertical velocity meter, the flare computer and appropriate coupler to the autopilot. Readout to the pilot's display is taken off the system between the coupler and autopilot, giving a measure of efficiency of both the computer and coupler.

The pilot's force stick steering signal is sent to the control system through the flare computer, rather than to the coupler or autopilot directly, enabling the system to integrate the changes commanded by the pilot rather than, after the changes have been made, trying to return the airplane to the track it was following before the pilot made the correction.

An additional value of the system design is that since the computer's signals are reaching the pilot's display in the form of a command, should the autopilot malfunction the pilot can continue his landing flare by keeping the needles of his display centered.

Two Control Loops

Computer is known as a two-condition terminal controller, with conditions to be controlled being altitude and altitude rate of change at desired touchdown point.

This is accomplished by two control loops in the computer.

The inner loop compares a predicted altitude rate (actually based on preselected angle or rate of descent or airspeed), with the desired value at touchdown, and acts on the error by producing a gain which is a function of range or time to go to touchdown.

To provide tighter control on altitude rate, which is the important parameter at touchdown, this gain is increased as touchdown is neared.

The outer loop compares the actual altitude with predicted altitude at a specific time, based on the current altitude rate of change and command signal to the autopilot.

In effect the two loops function so that the inner one constantly predicts the minimum constant control input that will bring about the desired final value of sink rate. The outer loop predicts the altitude at touchdown time, including the effect of the control action required to achieve the end value of sink rate. Any error in the outer loop is inserted in a closed loop fashion, resulting in a continuous servo action to the desired end conditions, with minimum control action resulting.

Basic idea behind design of the computer system was to duplicate, insofar as possible, the same type of flare flight control as a human pilot would use; that is, make corrections as required but not necessarily returning to a fixed flight path, and keeping control action to a minimum to keep the flight path smooth as possible and touching down as easily as possible without necessarily using up all the runway or trying to touch down at a precise, preprogramed point on the runway.

Presently the system is designed to effect a sink rate of 2 fps. at touchdown.

One important fact which Autonetics is stressing is reliability of the equipment. The design is based on transistors, which are used throughout. This, Autonetics says, really means that transistor circuits were laid out from the start, rather than adaptations made of former vacuum tube circuits.

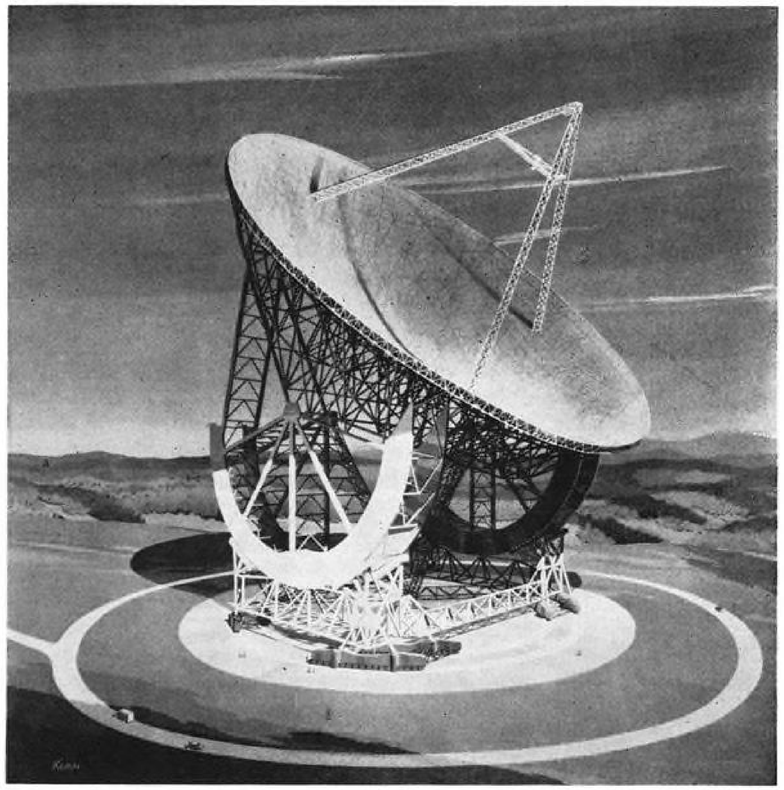
A checking feature is incorporated into the automatic landing system so that the pilot can check it out during approach, just prior to the system taking charge of the flight control.

Autonetics estimates that critical operating time for the system will be 30 sec., reducing the chances of failure on a statistical basis.

Currently, hardware is being fabricated at Autonetics which will be installed in a Convair TF-102A trainer in the near future.

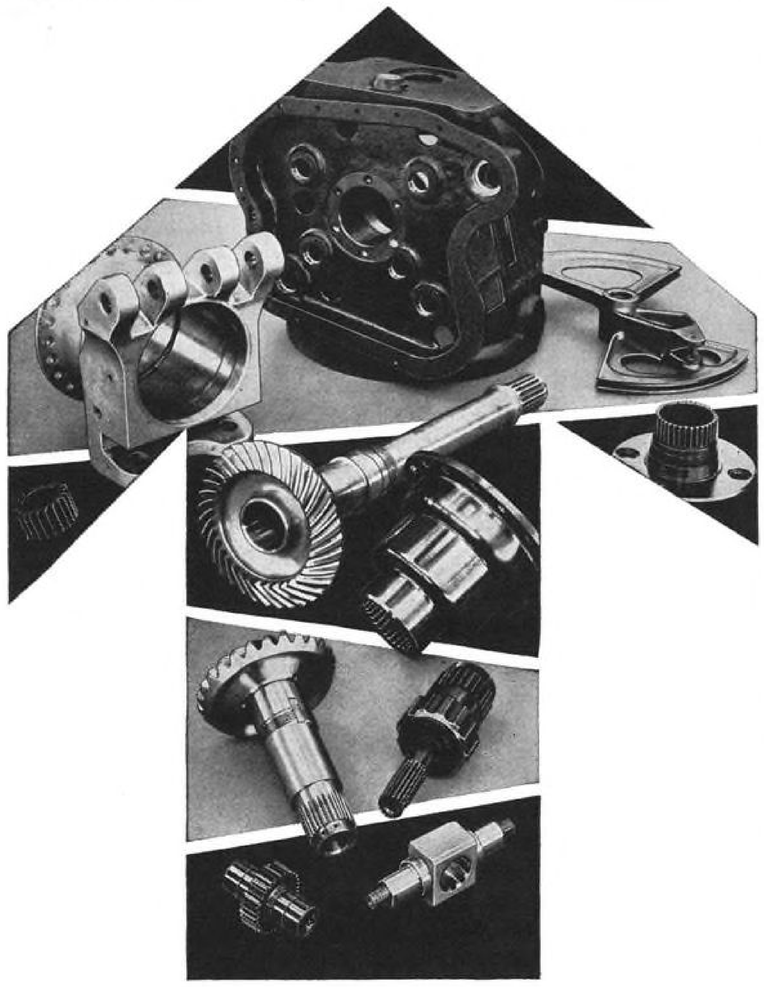
As with the system in any airplane, the equations of motion for the TF-102A will have to be set into the computer. The same would hold true of any airplane, and design provisions for changing a computer from one type of airplane to another are such that the switch is not a major effort.

Additionally, modular construction is employed throughout, to reduce effort



Artist's Conception of 600-ft. Radio Telescope

Design details of Naval Research Laboratory's 600-ft. dia. parabolic antenna (AW Aug. 31, p. 32) are shown in this artist's conception. The dish, supported on a central pintle, can be elevated 180 deg. in azimuth along semicircular tracks. Entire structure will rotate through 360 deg. heading on ground-tracks. Dish is constructed of panels about 55 ft. square. Total weight will be about 20,000 tons. Construction on the 1,500-acre Sugar Grove, W. Va., site will be completed in 1962 at a cost of $79 million. Range of the world's largest radio telescope will be about 38 billion light years, roughly 19 times farther than the 200-in. reflector on Mt. Palomar, Calif.



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and expedite the maintenance time.

When the system is installed in the TF-102A it will be evaluated by Flight Control Laboratory at Wright Air Development Center, and Federal Aviation Agency also will accomplish an evaluation, according to Autonetics.

Essentially, the designers felt, the automatic flare computer, to gain acceptance by pilots, would have to do at least as well as they do and do it in a way which, if not exactly like theirs, at least was close enough so that the pilot feels comfortable flying through it.

Vertical velocity meter was specially developed for this application to produce an altitude rate signal lacking the undesirable effects of noise, terrain irregularity and others which normally are present in radar altimeter output. The unit functions as an inertial sensing device and exhibits the required high frequency characteristics for augmenting the differentiated radar altimeter output.

System operation is projected for use with ILS equipment having narrow beam localizer and glide path system such as MRN7 or 8. The airplane would be flown through the initial part of the approach through the ILS coupler, with the flare computer taking charge gradually, and becoming the predominant control by either the middle marker or some particular altitude above the terrain, perhaps that which usually would obtain as the airplane passes the middle marker.

The flare computer system has the advantage, Autonetics says, of being able to function well with airplanes of high performance category. It can be used with approach angles between 2 and 16 deg., and sink rates as great as 100 fps. can be handled along with airspeeds up to 230 kt. and flare initiation points varying from 1,000 ft. to 60 ft.



Collins Transceiver

Lightweight VHF transceiver, designed for panel mounting in small aircraft, provides 360 channels, weighs only 12.6 lb. New model 618F-1 transceiver, made by Collins Radio Co., covers 118 to 136 mc. band, provides 50 kc. channel spacing, with digital tuning and single channel simplex or double channel simplex operation. Transmitter puts out six watts minimum, Collins reports.

FILTER CENTER

► **Meteor-Burst Communications**—After three years of tests on meteor-burst communications, National Bureau of Standards scientists report that a daily average communications rate of 40 words per minute can be expected with a character error rate of 0.35% based upon a burst transmission rate of 2,400 words per minute. Higher rates up to 4,800 words per minute are possible with improved control systems and rapid-access tape storage facilities, NBS scientists report. Error rates as low as 0.004% have been achieved over an 800-mi. range at an average rate of 30 words per minute for periods of several weeks, contrasted with error rates as high as 10% under thunderstorm and precipitation static conditions.

► **Airborne Passive Radar**—Loral Electronics will produce an airborne passive radar under recently awarded Air Force contract. Delivery is scheduled to begin late next year. For description of principles of passive radar, see AVIATION WEEK, July 1, 1957 (p. 62).

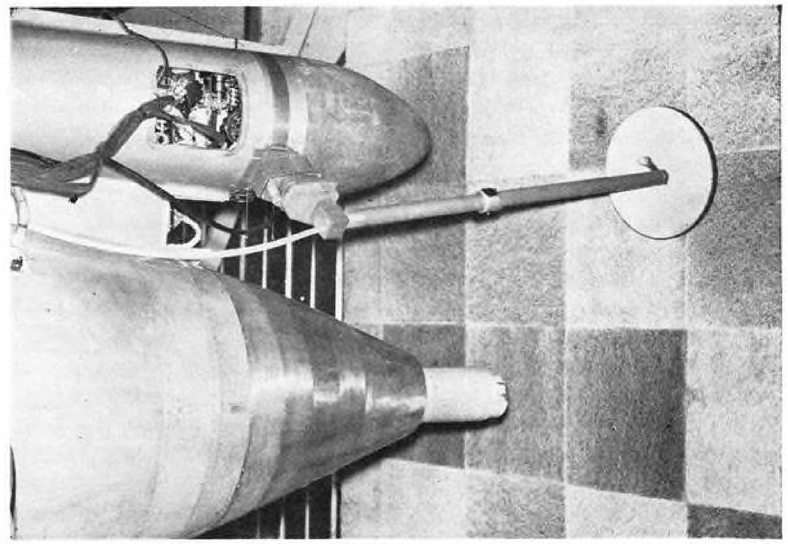
► **NATO Gets First "Ace High"**—First tropospheric scatter communications equipment that will form NATO's new 6,500-mi.-long "Ace High" communications network connecting NATO countries from Norway to Turkey has been shipped by Radio Engineering Laboratories in Long Island City, N. Y. Company is scheduled to produce 117 of the 10 kw. transmitters and 328 combining receivers for a total of 41 stations to be located in nine West European countries. Ace High will be the largest tropo scatter network ever constructed.

► **Doppler Radar Milestone**—General Precision Laboratory has turned out its 2,000th doppler radar navigation system, which the company says is more than the combined total of all other doppler air navigation systems produced.

► **Future Electric Power Needs**—Air Force and Navy requirements for electrical power generation systems needed for future aircraft, missiles and space vehicles are outlined in newly available report by the U.S. Aircraft Electrical Systems Advisory Staff. The 22-man advisory group consisting of Defense Department and industry specialists reviewed both USAF and Navy long-range weapon programs to develop recommended areas for future industry research and development. The report, entitled "Recommendations of the Advisory Staff for Aircraft Electrical Systems," can be obtained by writing to the Airborne Equipment Division, Bureau of Aeronautics, Department of the Navy, Washington 25, D. C.

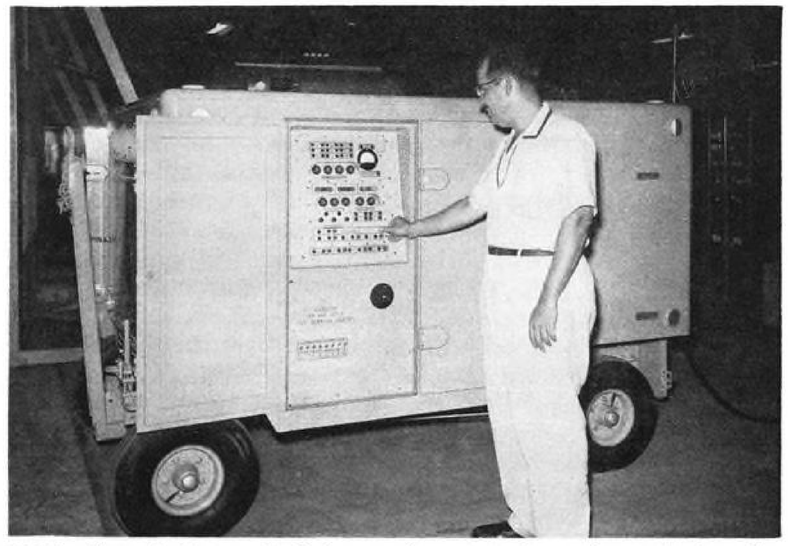
► **Electronics Industries Assn.** has asked the Office of Civil and Defense Mobilization to investigate mushrooming imports of Japanese transistors and semiconductor products to determine whether they "threaten American security." In 1956, imports from Japan represented only 4% of domestic production, whereas by 1958 they exceeded 50% of domestic production, according to EIA. Despite present 15% import duty, extremely low labor costs in a product that has a high labor content enable Japanese producers to underprice domestic manufacturers.

► **Signed on the Dotted Line**—Major contract awards recently announced by

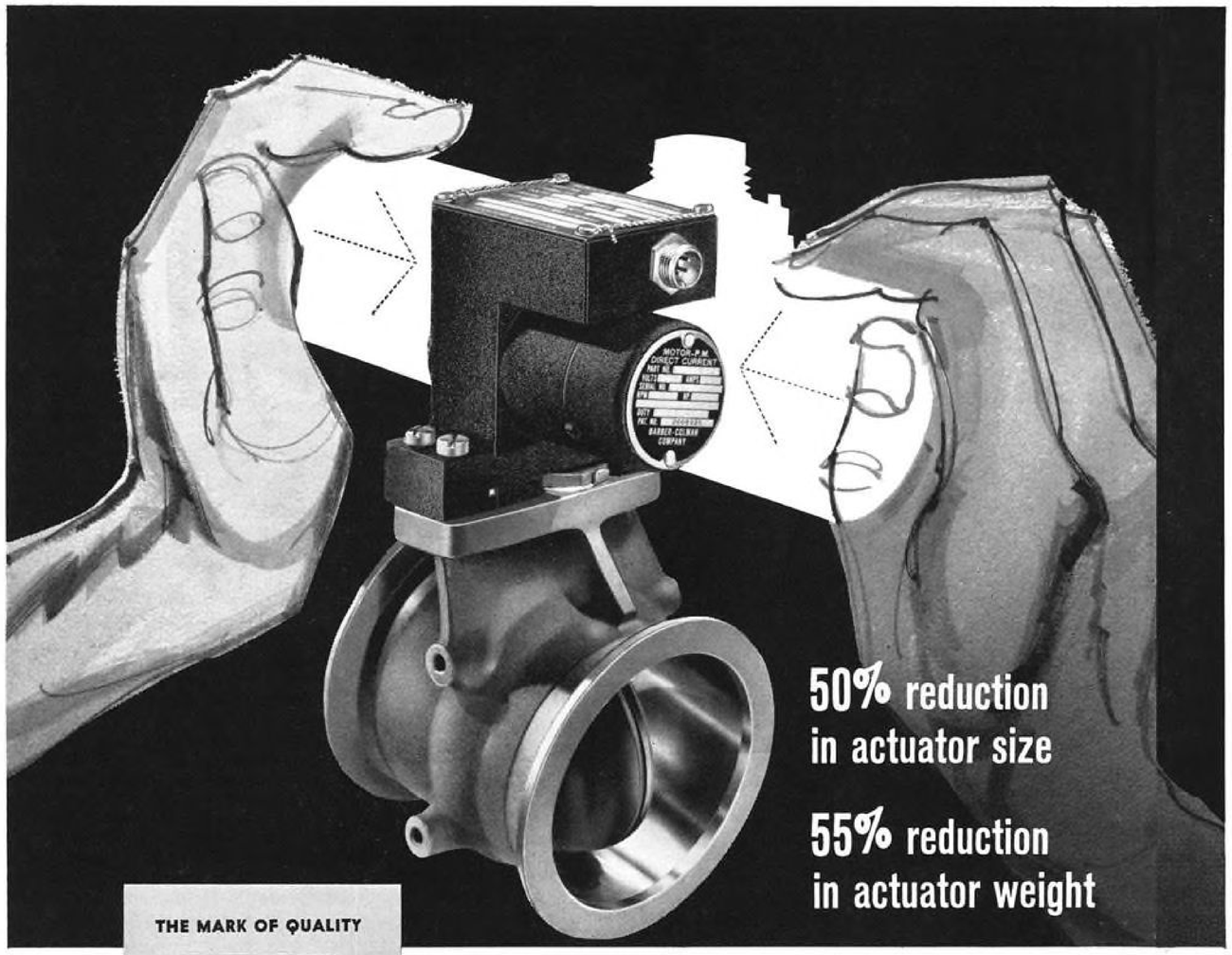


Convair B-58 Defense System Checkout

Convair B-58 radar-directed tail defense system, Type MD-7, developed and produced by Emerson Electric, can be given a complete operational checkout on the line in 10 min., including test of radar tracking, using small portable tactical performance test set (not shown) and simulated radar target, shown attached to boom in front of K-band radar radome. The B-58 armament (shown underneath the radome) consists of a six-barrel 20 mm. cannon capable of firing up to 6,000 rounds per minute.



Mobile self-contained automatic checkout equipment is used to make quantitative evaluation of B-58 defense system performance and isolate malfunction down to a line-replaceable unit. Mobile tester, plus portable performance tester and a complete set of test equipment for use in shop maintenance and overhaul, were developed, produced by Emerson Electric.



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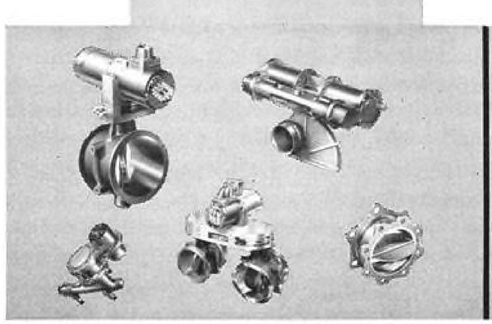
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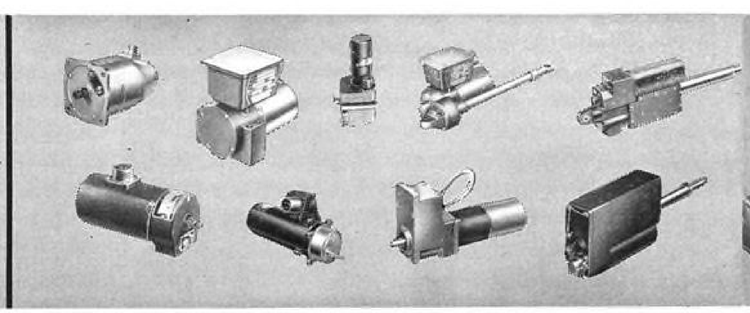
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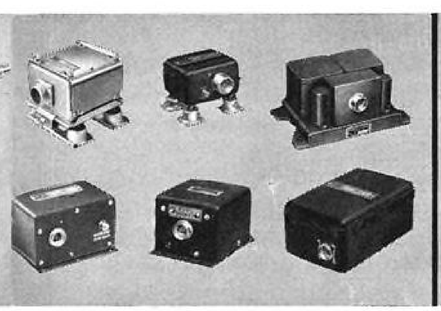
Aircraft and Missile Accessories



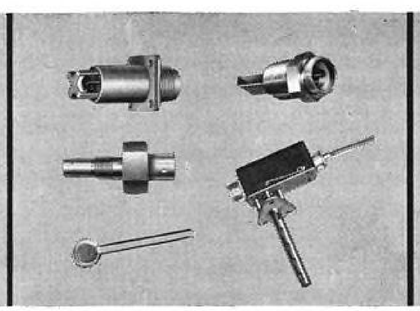
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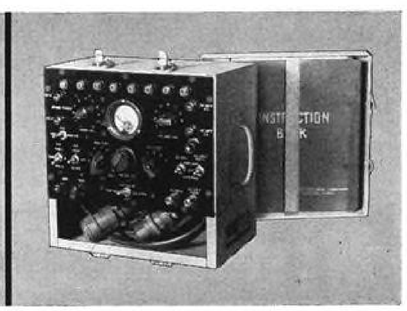
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A: Binks offers you a complete line of spraying equipment. Only Binks offers you the opportunity to objectively compare airless with other techniques to select the equipment best suited to *your* requirements. Binks engineering assistance on finishing problems is likewise completely objective.

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ARDC Laboratory

Air Research and Development Command will build a central inertial guidance laboratory to test and evaluate inertial components and systems at the Air Force Missile Development Center near Alamagordo, N. M. The new laboratory is expected to be fully operational by 1963. Facility is expected to employ about 100 engineers and technicians within two years, increasing to 350 by 1963.

In addition to static facilities, the new laboratory will use AFMDC's 35,000 ft. high-speed rocket sled track, stratospheric chamber.

avionics manufacturers include the following:

• **Hoffman Laboratories,** Los Angeles, will develop large-area solar electric power system for use in satellites under $600,000 contract awarded by Wright Air Development Center. System is to be capable of producing 100 w. of power continuously, 500 w. peak.

• **Telemeter Magnetics, Inc.,** Los Angeles, $200,000 contract from Office of Naval Research for large high-speed core-type computer memory with capacity of more than 850,000 bits. The transistorized core memory will permit a complete read/write operation in six microseconds, the company reports.

• **Bell Aircraft Co.,** Avionics Division, Buffalo, N. Y., $1.6 million contract for a visual surveillance system for Army Signal Corps.

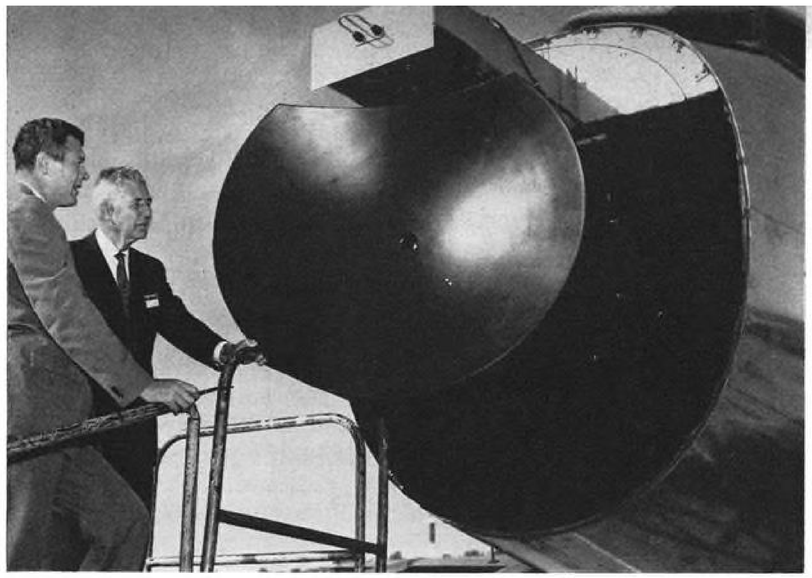
• **Electronic Specialty Co.,** Avionics Division, Los Angeles, $500,000 contract from Douglas Aircraft for fusing timers to be used in Genie air-to-air nuclear-warhead missile.

• **Allen B. DuMont Laboratories, Inc.,** Clifton, N. J., $266,706 award from Army Signal Corps for development and fabrication of an electronic countermeasures set. Company also reports a $450,000 award from Navy Bureau of Aeronautics for study to evaluate test requirements for future air-to-surface, air-to-air missiles and target drones.

• **Data Control Systems,** Danbury, Conn., will develop FM/FM ground station telemetry system for Minuteman ICBM under recent Boeing Airplane Co. award.

• **ASCOP Division** of Electro-Mechanical Research, Inc., Princeton, N. J., $245,000 contract from Naval Air Development Center for four mobile, self-propelled FM/FM telemetry trucks, with built-in power sources and air conditioning.

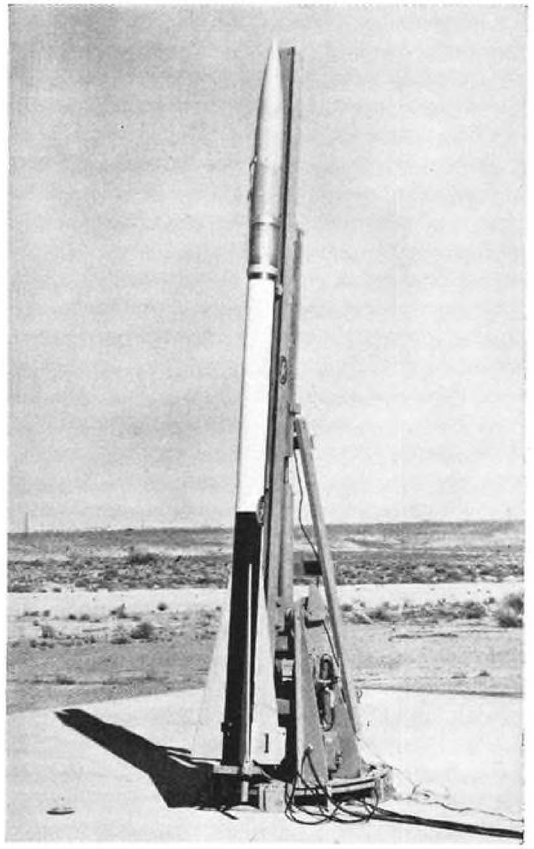
• **Avion Division of** ACF Industries, Inc., Paramus, N. J., $360,000 contract from Temco for radar beacons for use in testing Navy Corvus air-to-surface missile.

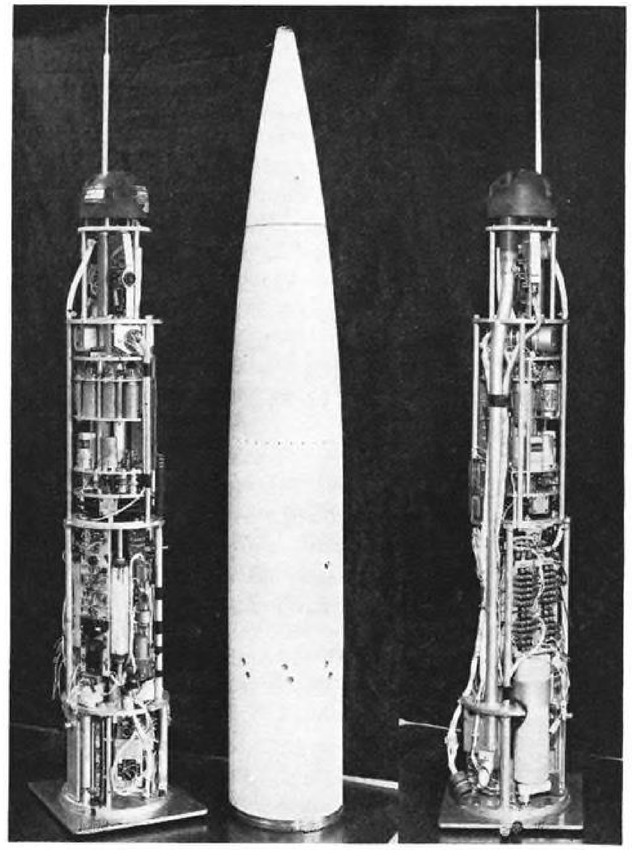




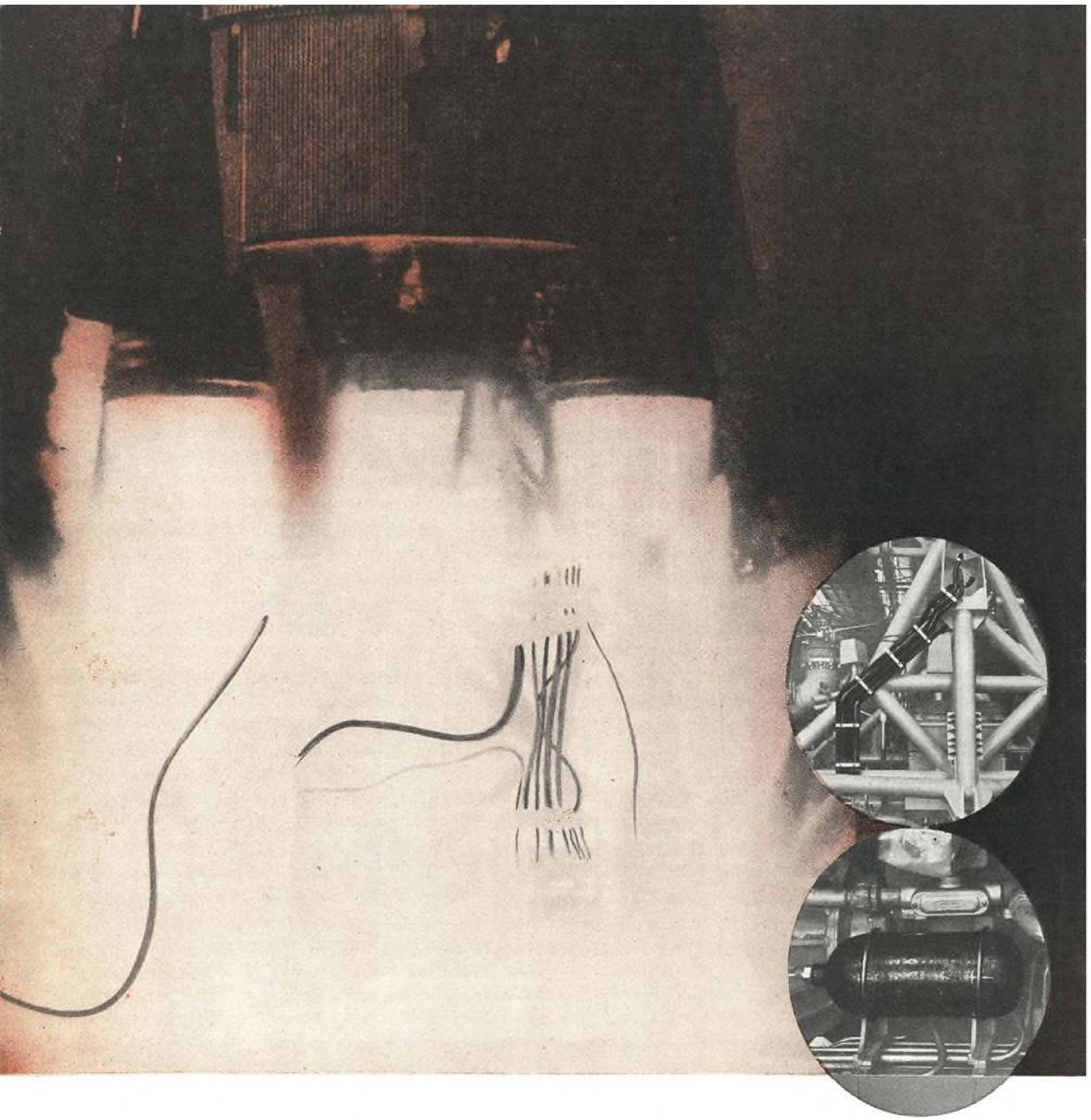
Storm radar in nose of Boeing 707 weather reconnaissance test airplane (left) and weather-sensing dropsonde (right), which is ejected from tube in rear of aircraft (AW Oct. 6, 1958, p. 80), are inspected prior to initial flight test. Flight marked end of Phase I of Air Force AN/AMQ-15 weather reconnaissance project under development by Bendix Systems Division (AW Sept. 21, p. 98).

USAF Gets Weather Reconnaissance Hardware





ASP sounding rocket (left) was used in ground firings at Holloman AFB as test vehicle for air-launched AN/AMQ-15 rocketsonde. Picture at right shows modified forebody of the ASP and two views of rocketsonde instrument package in which can be seen, from top to bottom, antenna, nose cap, transmitter, timer, index of refraction sensor, dewpoint hygrometer, and transmitter commutator.



NEW ROCKET BLAST PROTECTION — by Swedlow

New ablative/insulative wrapping by Swedlow protects Atlas missile launcher tubes from direct rocket blast up to 5000°F. The materials and methods developed to meet this extreme demand hold great promise for many other applications requiring resistance to elevated temperatures.

To meet the rigid standards for this CONVAIR missile Swedlow has developed methods of:

(1) Impregnating a refractory silica fabric with a Swedlow modified high temperature phenolic resin, and

(2) Covering the ¼" to 1" tubes and pressure vessels shown above, by tension winding with augmented pressure—a highly skilled operation, and

(3) Special heat treating or curing for maximum shock temperature resistance.

Here is another of Swedlow's contributions to industry, including high temperature resistance welded honeycomb core products, high temperature materials, heat reflective laminates, stretched acrylic transparent glazing materials and others.

Write for technical bulletin "S" entitled "High Temperature Phenolic Laminates." Please refer to Dept. 10.

Swedlow

SWEDLOW Inc. / LOS ANGELES 22, CALIFORNIA / YOUNGSTOWN 9, OHIO

PRODUCTION BRIEFING

United States Steel's Consolidated Western Division, Los Angeles will fabricate and erect service and umbilical towers for the Minuteman solid propellant intercontinental ballistic missile. Contract, awarded by Boeing, calls for two service and two umbilical towers.

Kawasaki Aircraft Corp., Gifu, Japan has completed the first Japanese-assembled Lockheed P2V patrol plane. The aircraft is the first of 42 P2Vs to be built under license from Lockheed. Aircraft will cost $33 million.

Goddard Space Flight Control Center, Beltsville, Md., will expand with construction of a third building to house flight control and range operations functions scheduled for partial completon by spring of next year. The $2,244,695 contract has been awarded to Humphreys and Harding, Inc., N. Y. First section scheduled for completion will be a tracking, data handling and ground command center.

Polaris missile-firing submarine Ethan Allen, first of a new class of nuclear-powered submarines to join the ballistic missile fleet, has had its keel laid at General Dynamics Electric Boat Division in Groton, Conn. Sub's over-all length of 410 ft. will be 30 ft. longer than the original Polaris-firing submarine George Washington, now being outfitted for sea trials (AW Sept. 28, p. 37.)

Unmanned balloon-carrying radar and aerial camera ascended from Fleming Field, St. Paul, Wis., for purpose of evaluating the characteristics of radar at an altitude of 100,000 ft. Two-million cubic foot balloon was launched by Goodyear Aircraft Corp.

General Atomic Division of General Dynamics Corp. is continuing its feasibility study of using nuclear explosions for space propulsion under Project Orion. Program was extended for one year beginning Sept. 1 under a $1 million contract.

Chemical Milling International Corp., El Segundo, Calif., is contouring honeycomb core by means of chemical etching. The patented process is said to offer the most logical method of close tolerance cutting of a large area of foil edge.

Hoffman Laboratories Division has been awarded a $600,000 contract by Wright Air Development Center for development of a large area solar-electric power system for use in space satellites. Power system will be capable of producing 100 w. of electricity continuously and 500 w. peak, using silicon solar cells.

U. S. Army awarded Aerojet-General a $56,000 study contract to determine feasibility of using rocket lift devices to power combat troops on special missions. Small rockets would be used to enable soldiers to overcome terrain obstacles.

British army now has officially adopted the Australian Malkara anti-tank guided missile. A "substantial" order has been placed with the Australian government, the Ministry of Supply said.

Kaiser Steel Corp. has a $3,898,999 contract from Army Corps of Engineers for construction of a 305-ft. tower at Cape Canaveral, Fla., for erection and service of the Saturn space vehicle. Blockhouse construction for the Advanced Research Projects Agency, Army Ballistic Missile Agency vehicle already is under way.

Martin Bullpup air-to-surface missile is going into Sixth Fleet service with Attack Squadron 34 on the USS Saratoga, now en route to the Mediterranean Sea. The Bullpup missile already is operational at this time with the Seventh Fleet on the USS Lexington.

NEW

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NEW VENTRAL FIN on Bell's XV-3 convertiplane is shown. The aircraft has masts in VTOL-hover configuration.

XV-3 Indicates Convertiplane Feasibility

By Erwin J. Bulban

Dallas, Tex.—Operational experience with Bell Helicopter Corp.'s tilt-rotor XV-3 convertiplane testbed during evaluation indicates that the advent of tactically suitable vehicles of this class is much closer than was believed early in the Army-Navy programs.

In fact, the major drawback now to design and construction of actual hardware is a budgetary, rather than an engineering problem, according to technicians familiar with convertiplane projects here. Indications are that the services are ready to have a design competition for operational type vehicles and that such a competition would begin within several months, if funding becomes available (AW Sept. 28, p. 23). USAF, Army and Marines have a definite requirement for a convertiplane and the pending design competition is expected to define this need by providing specifications for these initial two classes; small command-utility-reconnaissance vehicle and a large medical evacuation assault transport type. Turbine power would be a must.

Bell's entries will be strongly influenced by its experience with the tilt-rotor XV-3—this basic conversion configuration would be retained, but numerous refinements to fit the mission will be applied. For example, future designs would have a higher rotor disk loading than the XV-3's 5.78 lb./sq. ft.—perhaps double. Rotor rigging would be considerably simplified.

As regards general design (AW Dec. 29, 1958, p. 24), the aircraft would represent a slightly greater magnitude of complexity than that of a helicopter, rather than several times magnitude as was thought originally, R. L. Lichten, XV-3 chief experimental project engineer told AVIATION WEEK. He noted that the XV-3, which is now being test-flown by National Aeronautics and Space Administration personnel at Ames Research Center, Calif., is flying almost daily, has been experiencing no mechanical difficulties and is available for flight on such schedules as wanted.

Aircraft is being maintained by personnel with no previous helicopter experience.

Bell maintained a representative with the project earlier, but NASA felt he was not needed and he has left the base.

Pilots report that the XV-3 has shown considerable flexibility and forgiveness, being capable of comfortable handling at a wide range of airspeeds and configurations.

Aircraft is said to have a low vibration level at high speed, compared with conventional helicopters.

Four of the five pilots who have flown the XV-3 soloed after their first time up and also made conversions during their first flight. NASA test pilot Fred Drinkwater, who made his first hovering, altitude and conversion flight Aug. 12, has less than 100 hr. in rotary wing aircraft.

Total flight test time on the aircraft is approximately 80 hr., with total test time, including ground run-ups and full-scale wind tunnel time, nearing 250 hr., Lichten reports.

In evaluation trials conducted by USAF for the Army at Edwards AFB, Calif., official records note that during the 38 working days of his seven-week program, there was 100% availability on the XV-3 for all scheduled flights, and 38 programed flights were accomplished.

Bell XV-3

Normal gross weight	4,800 lb.
Empty weight	3,600 lb.
Rotor/propeller diameter	23 ft.
Disk area	831 sq. ft.
Solidity	.051
Disk loading	5.78 lb./sq. ft.
Wing span	31.3 ft.
Effective wing area	120 sq. ft.
Wing loading	40 lb./sq. ft.
Fuselage length	30.3 ft.
Powerplant	1 P & WA R-985 at 450 bhp. at 2,300 rpm.
Transmission gear ratios:	
High rotational speed	4.3
Low rotational speed	7.2
Power loading	10.7 lb./bhp.

USAF Evaluation

Evaluation by USAF test pilot Maj. Robert Ferry indicated that, while pilots should be helicopter and fixed wing qualified for minimum VTOL conversion in the XV-3 type, no basically new techniques or reflexes needed to be required. Most difficult flight regime is hovering the XV-3 in ground effect. Due to marginal power of the testbed, it is effected by recirculation causing buffeting in this area, and is less stable than most helicopters.

The XV-3 also is statically or dynamically unstable about various axes at speeds below 30 kt. At airspeeds over this figure, stability increases markedly about all axes and longitudinally; airplane characteristics are considered outstanding with long period response essentially deadbeat to disturbances in pitch. Above 120 kt., short period longitudinal damping requires improvement.

The XV-3's fixed wing concept provides flexibility in the conversion maneuver, with airspeed, conversion angle and power found to independent variables and no tight programing of the maneuver required. Conversions were made successfully at constant and varying airspeeds, in straight and maneuvering flight, at low and high power settings and even with the wing stalled during a considerable portion of the maneuver.

Flight Regimes

The aircraft demonstrated its capability of flying equally well at any intermediate fixed conversion angle over a wide airspeed range with good stability, permitting the pilots to pay attention to traffic monitoring and selecting their landing spots. Approximately 65 conversions have been made and the maneuver is considered routine.

Operationally, the results indicate maximum flight flexibility for future multi-engine types in converting during initial climbout and final approach, with an inoperative engine or at any desired point in the flight path, Lichten notes.

Autorotation evaluation indicated that XV-3's descent in helicopter con-



NASA PILOT John P. Reeder hovers the XV-3 at NASA's Ames Research Center, Moffett Field, Calif. (above). Cockpit view shows "beep type" control button (2) which activates rotor tilt conversion. Lever (1) is for mechanically operated emergency conversion system.



figuration was conventional at approximately 1,600 fpm., with the pilot holding an airspeed of 55-70 kt. to minimize wing wake airflow interference with autorotating rotors. Upswept tail boom permitted the pilots to hold a pronounced positive flare prior to ground contact in an autorotative landing.

Considerable experimentation was done in determining the XV-3's characteristics in converting to helicopter autorotation from airplane configuration following a power failure. Several reconversions were made power-off, from windmilling airplane glides to full helicopter evaluation, with altitude loss of less than 1,000 ft. using a technique developed by Maj. Ferry.

Rpm. Loss

Ferry noted a loss of approximately 20% rpm. when converting, power-off, using a steady reconversion rate, but that rpm. was recovered quickly once autorotation was established. Ferry cut this rpm. loss in half by establishing a flare-up as soon as rpm. started to drop, maintaining nearly constant loading on the rotors.

XV-3's design provides for a transmission gear shift to obtain optimum propulsive efficiency in airplane cruising flight, where propeller rpm is reduced to 60% of rotational speed used in helicopter and conversion operation. Tests indicate that a propulsive efficiency of 75% is obtained after a gear shift to cruise conditions– considered relatively high in view of the XV-3's blade design, which is actually a modification of the Bell 47 helicopter rotor blade. Approximately 30 gear shifts have been made, including 20 during USAF's evaluation program. Shifting gears on the XV-3 requires throttling back and declutching the engine briefly –a process which initially involved an altitude loss of over 1,000 ft. This has been reduced to less than 500 ft. due to improve techniques.

This characteristic applies only to the single-engine XV-3 testbed; any future operational type vehicle would be a multi-engine turbine design which would eliminate this altitude loss condition during rpm. change process either by declutching one engine at a time or using the power governing characteristics of turbine engines to effect this change without declutching.

Climb tests were made at rotor mast settings ranging from 0 deg. to 60 deg. and at airspeeds from 40 kt. to 90 kt., with optimum climb attained with masts at 30 deg. and airspeed of 60 kt., providing a maximum rate of climb of 900 fpm. at altitude, correcting to approximately 1,400 fpm. at sea level, standard day conditions.

Flight tests have been made with the aircraft in a high-drag configuration–



Sikorsky S-60 —opens a new world of helicopter usefulness

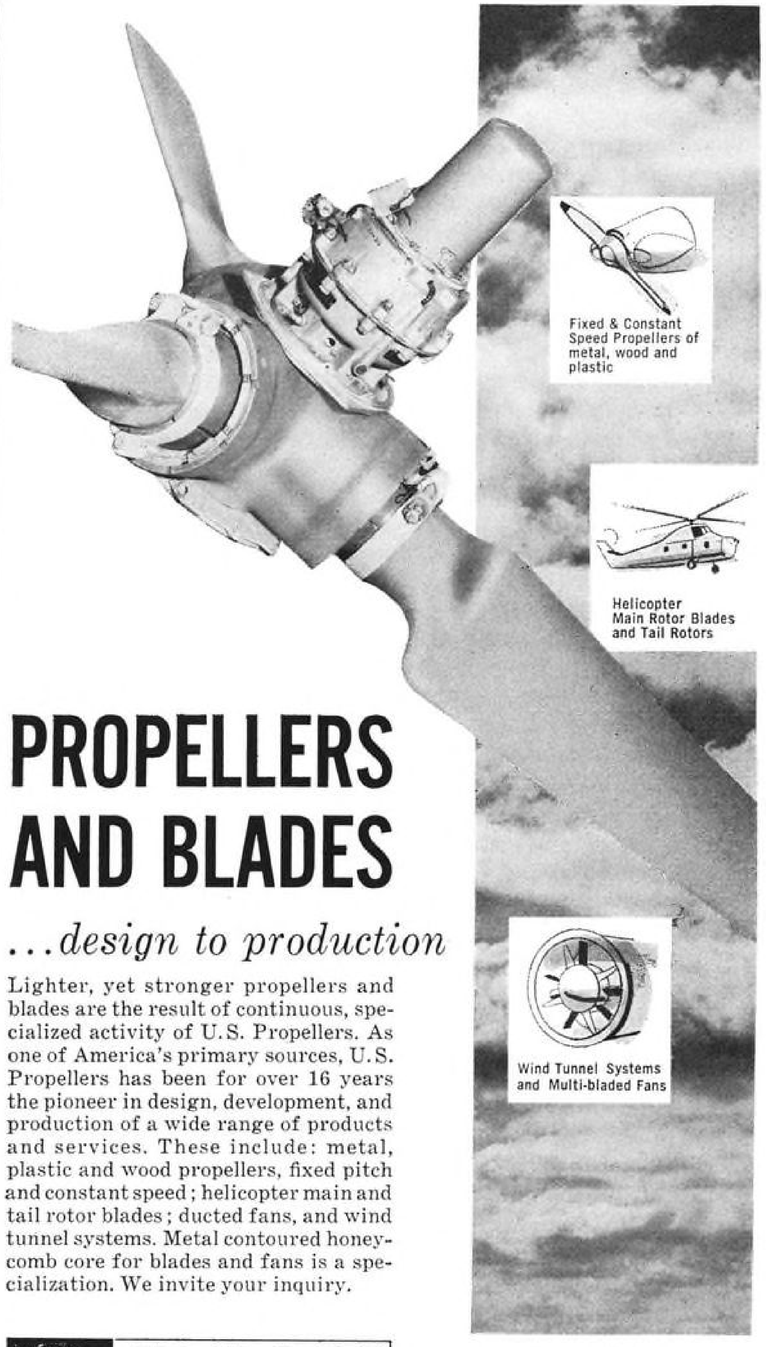
PRIME MOVER—The Sikorsky S-60 crane helicopter, with a five-ton payload, is the prototype of a new family of UTVs (Universal Transport Vehicles) of almost unlimited usefulness. It is an aerial prime mover, an airborne cousin to such ground prime movers as locomotives and truck trailers.

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(Above, the dump truck technique makes possible quick unloading of transported fuel drums.)

SMOOTH FLIGHT—Loads suspended under the S-60 fuselage are virtually free of vibration—a major advantage in carrying big passenger pods or in transporting sensitive cargoes such as missiles.

NEW POWER—Sikorsky crane helicopters now in design will have high-powered gas turbine engines and will carry payloads from eight to 40 tons.

SIKORSKY AIRCRAFT, Stratford, Connecticut
A division of United Aircraft Corporation



PROPELLERS AND BLADES

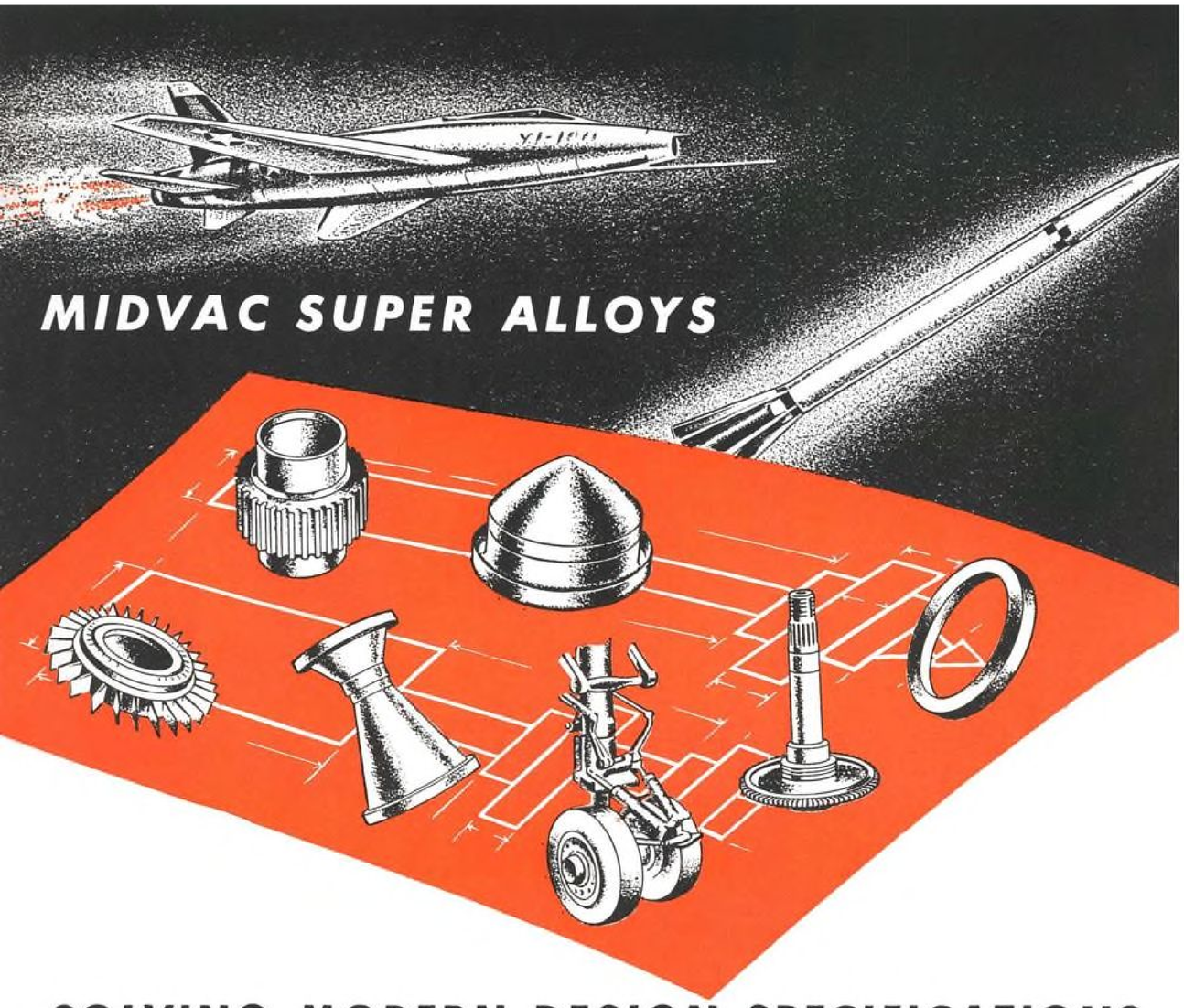
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MidVac Steels

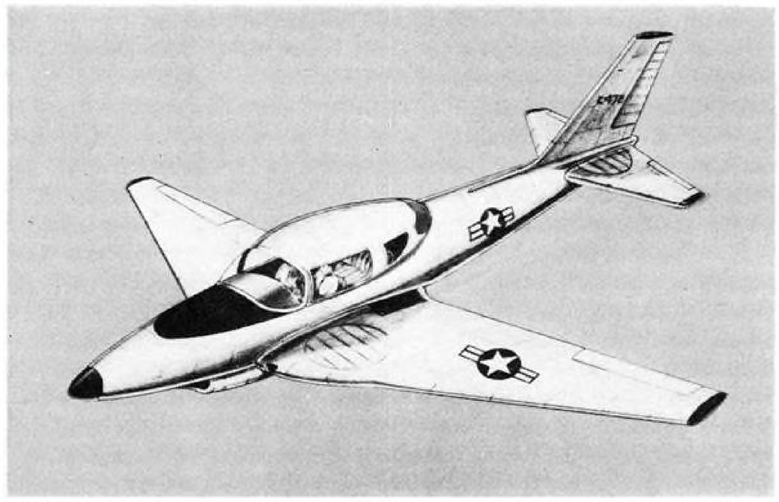
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with temporary wing struts installed, no propeller hub spinners or wing root fairings. As a result, the airplane's speed performance is not considered outstanding, Lichten pointed out. Maximum level flight speed, corrected, has been approximately 120 kt. under sea level standard conditions. A speed of 157 kt. was attained in a moderate power dive at full power. Maximum available propeller pitch was the limiting factor in this procedure. Maneuvers and step control inputs have been investigated at speed of 140 to 150 kt.

The XV-3 has shown that it can take off as a STOL (when fitted with wheels to permit ground roll) in very short distances at loads where it would be incapable of hovering. This is attributed to sharp drop-off in power required, occurring at about 15 kt., in this configuration. Bell tests showed that lift-off could be made in about 150 ft. using no more than 70% of power needed for hovering, while at close to gross weight of 4,800 lb. In USAF tests, the aircraft took 450 ft. to clear a 50-ft. obstacle on either landing or takeoff under zero-wind conditions at close to gross weight. Both tests showed that there was no benefit attained by going beyond 10-deg. mast angle, since optimum climb-out occurs at 30 kt. or below, at which speed the rotors are the primary lift source.

With wheeled landing gear to permit STOL takeoffs, Bell engineers estimate that an improved configuration, embodying XV-3 lessons, could take off in 500-600 ft. carrying 150% more payload than in the VTOL configuration.



ARTIST'S conception of Ryan Aeronautical's Vertifan command-type aircraft.

Ryan Adds Buried Fan Vertifan As Third VTOL Research Program

San Diego, Calif.—Combining features of both helicopters and pure jets, the Ryan Vertifan is designed to ascend vertically from a small area like a rotary-winged aircraft, but still possess the forward speed and weight carrying ability of a jet aircraft.

Ryan's chief of design, W. L. Wheeler said that considering disk loading, helicopters which derive lift by moving a large mass of air at low velocity appear at one end of the spectrum, while a pure jet VTOL, such as Ryan's X-13 appears at the other end. The Vertifan, which would move a relatively small mass of air at high velocity, comes closer to a pure jet VTOL than it does a helicopter. Ryan now is working on the Vertifan under an Air Force preliminary design contract covering study phases and probably some hardware needed for preliminary testing (AW Aug. 17, p. 111).

Lift for vertical takeoff and hovering flight will be derived from a fan, or fans, buried within the wing structure. Plane of rotation of the fan is parallel with the longitudinal axis of the aircraft. The fan operates as a free turbine powered by turbojet engine exhaust gases which are diverted into a scroll. Vanes on the upper and lower surfaces of the wing are full open for vertical flight and hovering, and are partially closed to divert the thrust of the fans to produce a forward vector. Vanes fit flush with the wing surfaces when the aircraft is in forward flight.

Stability will be achieved by the addition of a fan, or set of fans, on the vertical stabilizer or by the inclusion of cruciform jetavators in the engine exhaust wake. General Electric is working with Ryan on the project and probably will be responsible for providing propulsion. General Electric has been doing work on diverter valves, a critical part of the concept (AW Aug. 10, p. 35).

Ryan's experience with short takeoff and landing aircraft dates back to the Dragonfly, a postwar aircraft, which achieved short takeoffs and landings through the use of large flap area.

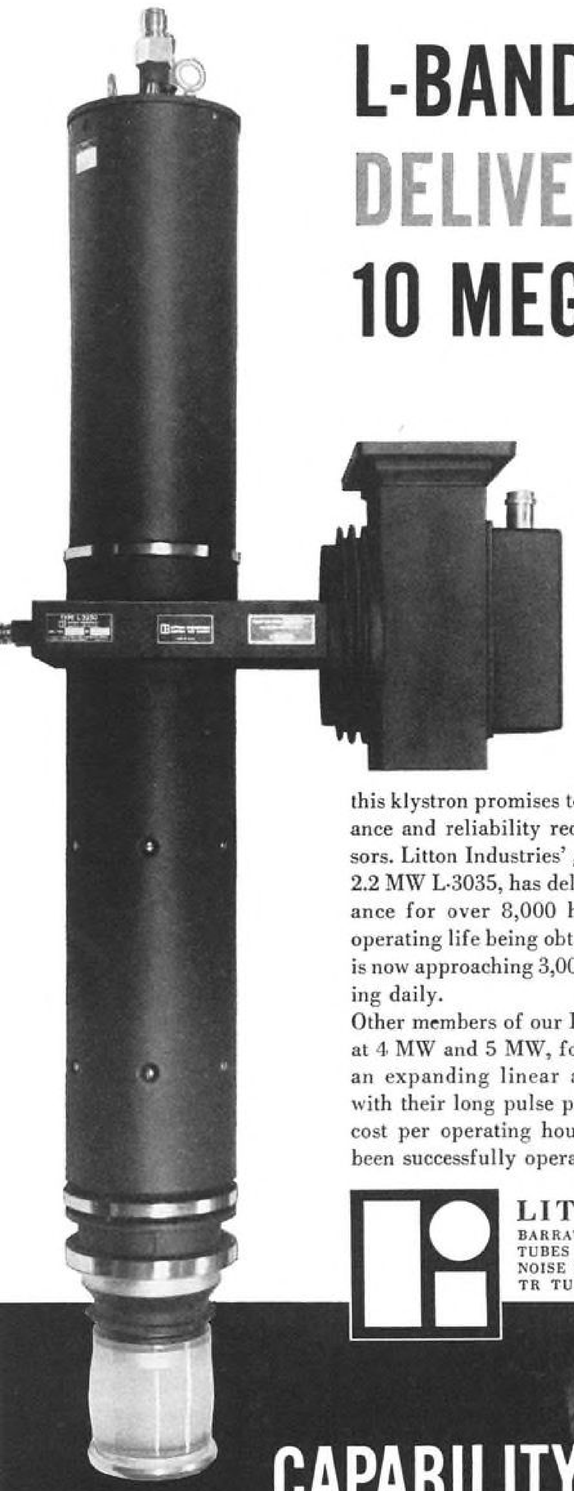
One of the most significant contributions to the art of vertical takeoff and landing was the Ryan X-13 Vertijet. More than 125 flights were successfully performed by the Rolls-Royce Avon-powered aircraft and it is now en route for a "world tour" which, according to Ryan, will be terminated at the Smithsonian Institution in Washington, D. C.

Scheduled to resume its flight test program, interrupted by a landing accident last February, the Vertiplane is another research aircraft aimed at investigating the minimum landing and takeoff distance concept. Designated VZ-3-RY by the U. S. Army, the aircraft is powered by a Lycoming T53 engine driving two large-diameter propellers. Theory here is to produce lift through deflected slipstream principle.

Wheeler is not convinced that the deflected slipstream is the best answer to the STOL problem, but neither is the Army, for whom Ryan is conducting the project. Complete performance envelope of the aircraft has not been explored, however, and the Vertiplane project is only one of many VTOL and STOL projects which the Army is funding.

Ryan engineers are convinced that there is a large market for an entire family of short and vertical takeoff and landing aircraft. Company has proposals for a tactical version of the X-13 Vertijet, none of which reached a hardware stage. Although there may be several reasons for not producing a tactical type X-13, one main reason given by Wheeler was the lack of a suitable support aircraft. He said that it would not be feasible to have a VTOL fighter without a suitable VTOL support aircraft capable of operating successfully from the same small clearing required for the VTOL fighter.

Big drawback in an aircraft of the X-13 type is its inability to cruise economically. Ryan engineers say that one advantage of the Vertifan is that it will not require an engine with thrust greater than the takeoff weight of the aircraft because the wing-buried fans will provide lift for takeoff. In the case of the X-13, thrust required for vertical takeoff was about 2,000 lb. in excess of aircraft gross weight, with the result that the aircraft could not cruise



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CAPABILITY THAT CAN CHANGE YOUR PLANNING

economically. The engine was too powerful to operate at a cruise power setting compatible with the airframe. X-13 was, however, purely for research and not required to do more than demonstrate feasibility.

Combat versions of the X-13 also would necessitate a new concept in tactical warfare with a resulting expenditure of funds. The Vertijet might have proven a valuable type weapon for the services to have on hand in case of a brush fire type war where first class airdromes might not be available. But, development of the vehicle, plus support type aircraft and ground handling equipment, would be costly, especially when the U. S. is attempting to build an arsenal of retaliatory and deterrant strategic weapons.

Cuba Asks Britain For Hawker Hunters

London—Cuba, anxious over arms sent to the Dominican Republic by France, Italy and Belgium, has repeated its request to the British government for 17 Hawker Hunter jet fighters. Cuban Ambassador Serio Rojas Santa Maria presented the request to the Ministry of State for Foreign Affairs.

The foreign office has stated that "in view of the tense situation still existing in the Caribbean" the government had previously decided that the wisest policy would be to refrain from sending any further arms into the area. However because the request is for replacements for obsolete piston aircraft, it is being held under consideration.

The aircraft Cuba would like to exchange for the jets are Hawker Sea Furies which were contracted for by the Batista administration.

Temco to Market Production Services

Garland, Tex.—In an effort to make fuller use of in-house capabilities, Temco Aircraft Corp. has created a new industrial division to provide commercial products manufacturers with a Southwest production capacity.

Temco's early experience in producing farm tractors, soft drink dispensers, truck bodies, popcorn machines and other civilian goods provides the potential for the new division. Considerable business is expected in the future for the newly organized division, particularly from companies that have oversold their production capacity and find it uneconomical to expand during their current schedules, or from those who wish to develop manufacturing and distribution capacity in the Southwest area without making major new capital investments.

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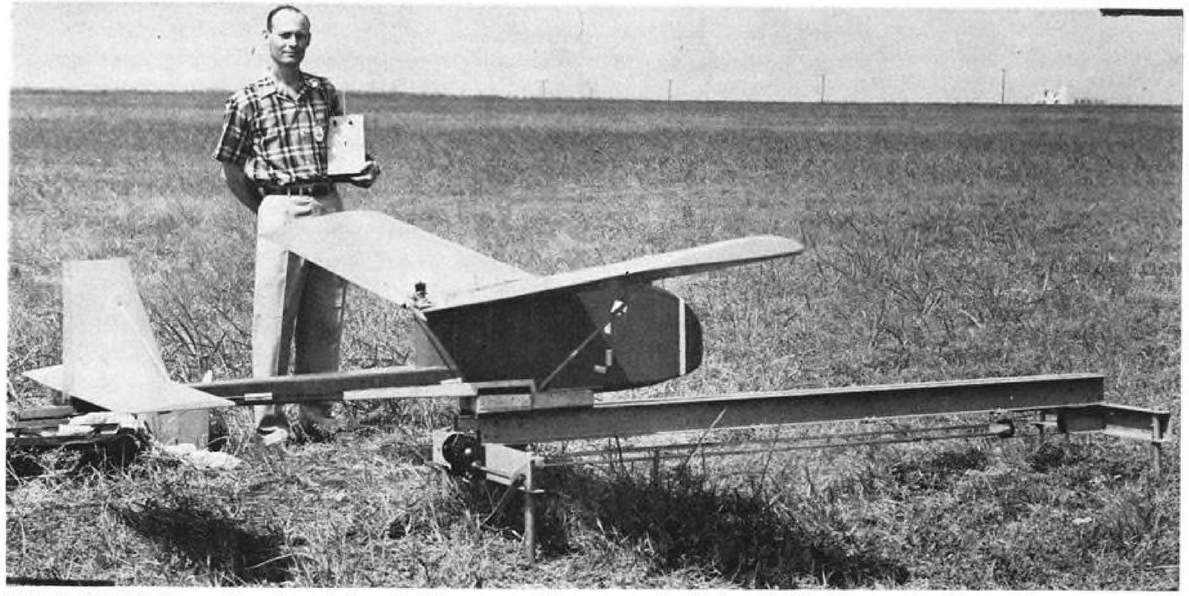
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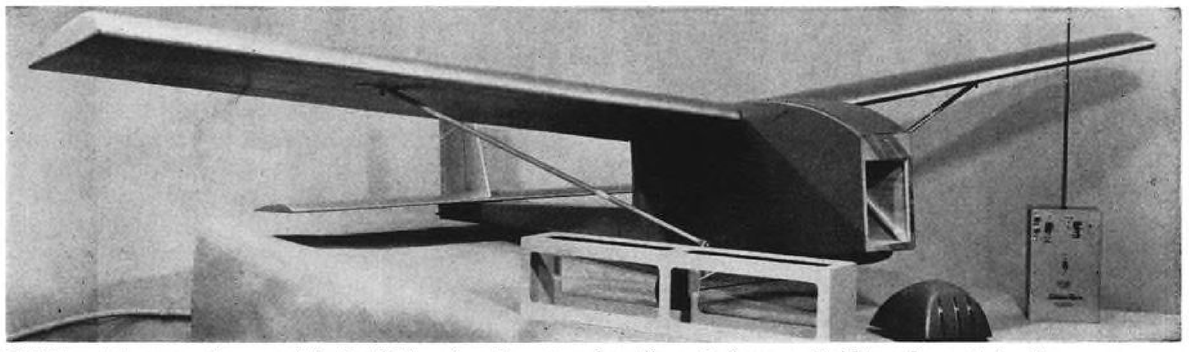
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TEMCO GDD-1 air sampling drone is launched by means of bungee cords. Engineer holds the ground radio control unit.



DRONE prototype nose is removed for installation of equipment package (frame in foreground). Note radio control unit.

Temco Designs Drone for Air Sampling

Garland, Tex.—A miniature drone aircraft, designed to provide needed meteorological and air pollution data at low cost, is under development here for the U. S. Weather Bureau and U. S. Public Health Service by Temco Aircraft Corp.

This venture is tied closely to the manufacturer's interest in penetrating the fields of geophysical sciences and meteorological support as part of its diversification program. The company also sees the equipment having value in nuclear radiation programs.

On the basis of a market study conducted by the company, it estimates a potential of approximately 1,000 units existing in a year for use by government and non-government customers.

Small GDD-1 (Geophysical Data Drone-Weather Bureau Public Health Service) air sampling drone has completed its initial flight test program successfully—the next step will be to deliver the prototype to the government agencies in Cincinnati, Ohio, for field tests and evaluation in October pending a production contract. Meanwhile, feeling that a worthwhile potential market exists for the equipment by other government military and civilian agencies and private companies, Temco is going ahead with an initial production run of 10 machines, which it will stock as "off-the-shelf" items.

Potential Customers

The manufacturer states that it has had contact with approximately 18 possible customers, including Army's Chemical Warfare Section, a major airframe builder who sees a use for the equipment in its nuclear aircraft program, and several companies which specialize in air pollution studies. Of these, eight have asked for cost data and three for demonstrations.

The company also sees the drone, or a development of it, as fitting into U. S. Army's Electronic Proving Ground program at Ft. Huachucha, on nuclear surveillance to sample "hot" combat areas prior to releasing troops to occupy these zones.

GDD-1 is seen as being far less costly than sampling towers, more easily handled than balloons and more effective in retrieving low-altitude atmospheric data than full-scale aircraft because its slow speed and small size tends to cause less disturbance during its penetrations of desired layers.

Drone is powered by a McCoy 1.2 hp. model aircraft engine which delivers approximately .70 effective hp. at 10,000 rpm. It has a 10 ft. span and is 8 ft. long. Wing area is 2,460 sq. in. Airfoil is an 11.7% Clark Y. It can fly at approximately 15 kt. for at least 15 min. under power; endurance can be extended considerably by utilizing thermals after power is shut off.

The machine is designed to carry approximately five pounds of payload. An instrument package measuring 30 in. x 5 in. x 7 in. is fitted in the fuselage. Payload could include meteorological equipment capable of taking temperature, pressure and relative humidity measurements as well as collecting dust, smoke and fume samples on filter paper, also collection of chemical vapors through the use of a bubbler, and measurement of sulphur dioxide. Telemetering equipment could provide ozone concentration data.

A PPM telemetering system would record data on tape for IBM data reduction processing—a hand portable receiver on the ground being powered by a car battery. Guidance is provided by Citizenship MSR-8 and MST-8 superheterodyne radio gear operating on 27.235 mc. and is line of sight. A 14-ft. canopy parachute recovery system is fitted for emergency letdowns.

Construction is basically of Fiberglas for wings and fuselage, with tail of aluminum filled with Lockfoam. There are also Lockfoam fills in fuselage compartments. Temco development of GDD-1 resulted from the company winning a Weather Bureau-Public Health Service competition last April against eight other firms.

Navy Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U. S. Navy contracting offices.

DEPARTMENT OF THE NAVY, Bureau of Aeronautics, Washington 25, D. C.

Cox Instrument Division, George L. Nankervis Co., Detroit, Mich., fabricate and furnish nine (9) calibrating secondary standard flowmeters in accordance with BuAer Spec. XMA-117, NOas 59-4233-f (MA-51-488-59), $96,383.

Friez Instrument Division, Bendix Aviation Corp., Baltimore, Md., 228 field change kits and 1,028 field change instructions in accodrance with Spec. AER-AY-40-X2, NOas 59-4247-f(AY-40-2636-59), $33,825.

Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y., rehabilitate and retrofit one (1) government-owned No. 4 CK-Kearney and Trecker Milling Machine with a numerical control system, NOas 59-4164-f(IP-31-4365-59), $60,155.

General Electric Co., Cincinnati, Ohio, research program on the mechanism of jet noise generation and suppression, NOas 59-6160-c(PP-33-190-59), $209,515.

Kollsman Instrument Corp., Elmhurst, N. Y., three (3) counter-pointer altitude indicators and one (1) counter-pointer altitude indicator test transmitter, NOas 59-6207-c(AV-43-2959-9), $77,926.

Avionics Division, Bell Aircraft Corp., Buffalo, N. Y., engineering study to assure compatibility between automatic flight control systems and the AN/SPN-10 landing system, NOas 59-6245-O(AV-43-2995-9), $71,723.

Chance Vought Aircraft, Inc., Dallas, Tex., retrofit Cincinnati Hydrotel milling machine with numerical control system, NOas 59-4217-f(IP-31-4375-59), $128,561.

Pratt & Whitney Aircraft Division, United Aircraft Corp., East Hartford, Conn., product improvement and development support of the T-34 engine in accordance with contractor's Spec. A-2541-A, NOas 59-8057-f (PP-23-200-9), $2,625,000.

Beech Aircraft Corp., Wichita, Kans., design, develop, fabricate and furnish a missile target system (including one (1) target prototype), in accordance with Spec. MIL-W-7622B as modified by SD-2017 and supplement No. 1 thereto, NOas 59-6262, letter contract (GM-64-2517-9), $2,400,000.

Bell Helicopter Corp., Fort Worth, Tex., one (1) model 47G-2 helicopter and related support equipment, NOas 59-0305-f(PD-22-1425-9), $51,240.

The Martin Co., Baltimore, Md., evaluation of ultrasonic test equipment devices, NOas 59-6266-c(AE-44-4778-9), $149,641.

Titanium Metals Corporation of America, New York, N. Y. materials, services, facilities and personnel necessary to establish satisfactory proceedures for producing titanium alloy sheet, NOas 59-6227-c(AE-41-4767-9), $260,000.

Van Zelm Associates, Inc., Baltimore, Md., design and provide one (1) prototype and two (2) preproduction on holdback pendant assemblies for aircraft, NOas 59-6270-c(SI-32-4580-9), $26,515.

Storchheim Research and Development Corp., Woodside, N. J., materials and services for the development of lead base materials, NOas 59-6249-c(AE-41-4772-59), $37,735.

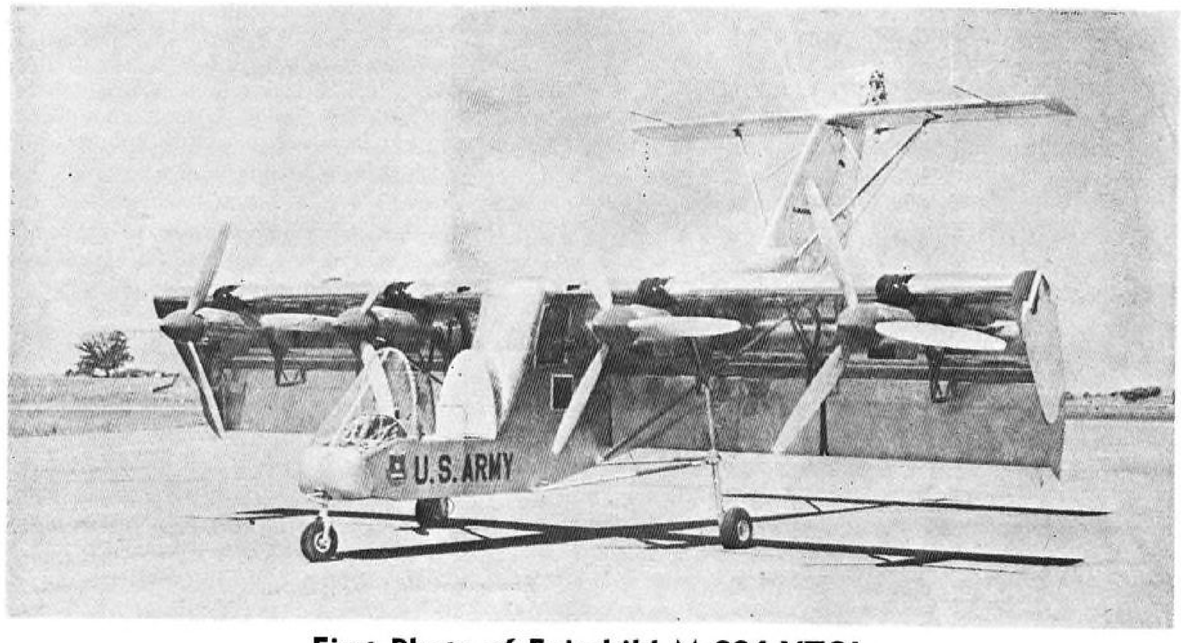
Bausch & Lomb Optical Co., Rochester, N. Y., rear protection stereoscope viewers in accordance with BuAer Spec. XPH-132A (revised March 23, 1959), NOas 59-4269-f (PH-46-3308-9), $44,147.

Burner-Holloman Manufacturing Corp., Hyattsville, Md., design, develop, fabricate and evaluate one prototype and 15 maintenance platforms, aircraft, adjustable in accordance with Spec. XMA-121, NOas 59-6267-f(MA-55-501-9), $32,829.

The Franklin Institute, Philadelphia, Pa., develop high purity beryllium and determine the mechanical properties of material produced, NOas 59-6242-c(AE-41-4776-9), $29,-568.

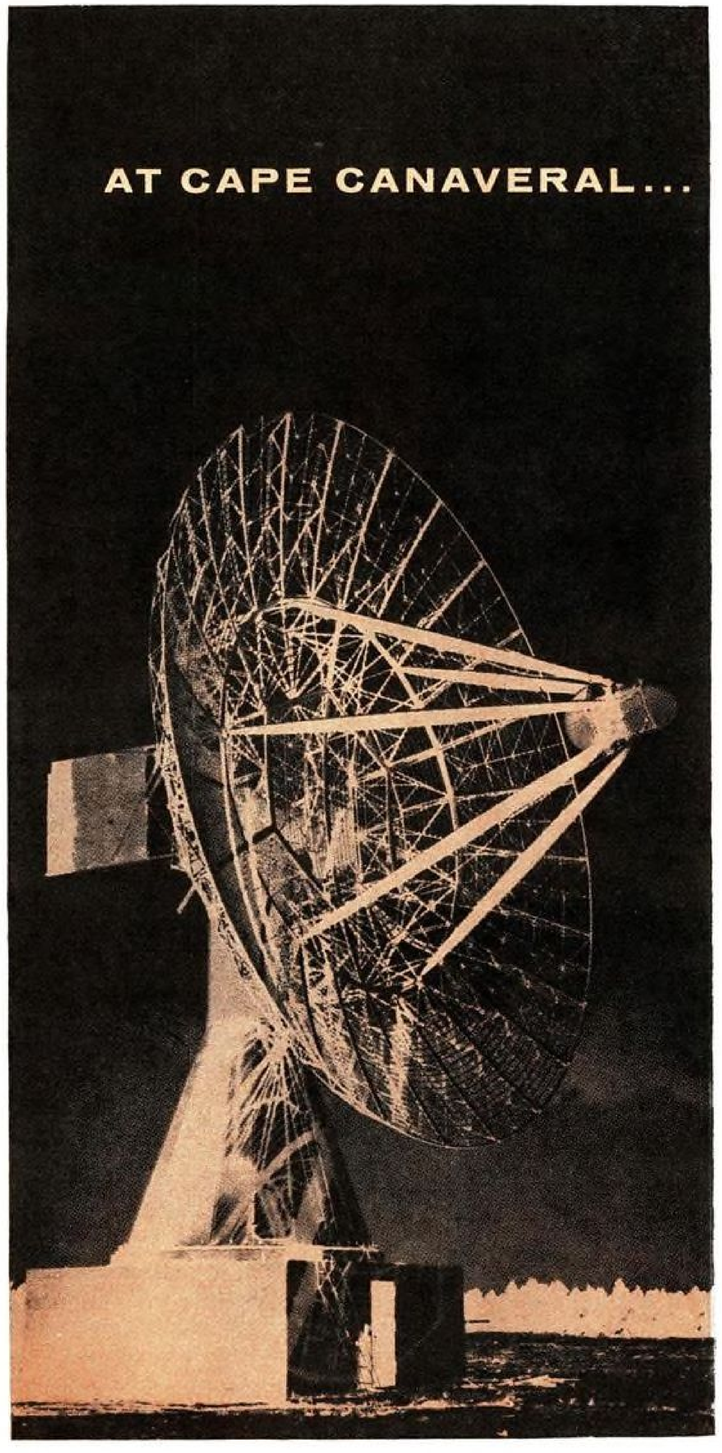
Consolidated Diesel Electric Corp., Stamford, Conn., 12 sweepers, vacuum, self propelled, mechanical agitation, type MC-1 in accordance with specification MIL-S-26130A (USAF) and amendment no. 1 thereto, NOas 60-4002-f (SE-73-1144-0), $241,826.

Temco Aircraft Corp., Dallas, Tex., services of two (2) material handling personnel for concept evaluation for TT-1 aircraft, and one (1) material handling personnel to provide logistic support; two (2) technical representatives to provide technical assist-



First Photo of Fairchild M-224 VTOL

First photo of Fairchild M-224 vectored slipstream short takeoff and land flying testbed for U. S. Army shows small coaxial rotors atop horizontal tail that can be tilted and rotated at different speeds for control purposes. Plane has been ground tested at Hagerstown, Md. (AW July 27, p. 23). System involves turning slipstream downward by large flaps.



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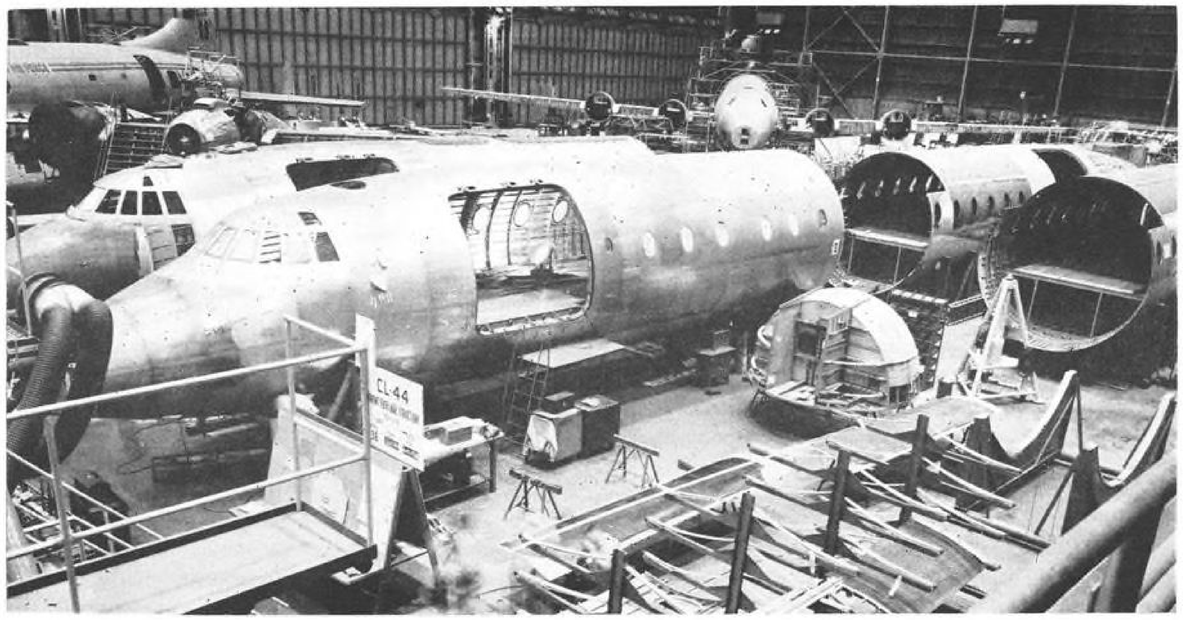
The remarkable characteristics of Styroflex® cable not only meet these rigid specifications but also have extra operational advantages, including long operating life under severe conditions and stable electrical properties during wide temperature variations.

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Second Canadair CL-44 Nears Completion

Second Canadair CL-44 turboprop transport (top, rear) is well advanced at the company's Montreal, Can., production facility. Fuselage and wings have been mated and tail section is being added; several fuselage front and rear halves are in foreground. The first CL-44 is nearly completed. Fuselage interior has been soundproofed and water ballast tanks have been added in preparation for first flight in November. Powerplants are four Rolls-Royce Tyne 12 turboprops. Plane has been ordered by RCAF, Seaboard & Western and Flying Tiger Line.

ance and guidance and one (1) technical representative to provide logistic support, NOas 60-0158-f (PR-22-1442-9), $48,000.

Webcor, Inc., Chicago, Ill., 672 AM-1777/ARA-25A electronic control amplifiers with J891/ARA-25A interconnecting box, federal stock number to be assigned, NOas 59-0313-f(PD-32-1866-59), $155,937.

Grand Rapids Division, Lear, Inc., 498 AN/AJB-3 loft bomb release computer sets and components in accordance with applicable specifications SR-1428A, -1368A, 1363A, 1145c, 1303D, 1254G, 1306F and 1312E, NOas 60-0171-r(PD-42-2277-59), $12,368,579.

Douglas Aircraft Co., Inc., Santa Monica, Calif., conduct a Phase I factory training program on the maintenance and operation of the AN/ASB-7 bombing system, NOas 59-0274-c(MA-60-1011-59), $156,186.

Ampex Corp., Redwood City, Calif., 411 AN/UNH-6(RO-28/UN) magnetic tape recorders in accordance with specification MIL-R-19533A(Aer) with exceptions, NOas 59-0293-f(PD-32-1763-59), $817,927.

Aircraft Gas Turbine Division, General Electric Co., Cincinnati, Ohio, services and spare parts and warehouseman to conduct inventory control study, NOas 59-0276-f (MA-41-723-59), $77,061.

Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn., develop, fabricate and furnish three (3) model 63E60 propeller assemblies, NOas 59-0319-c(PP-32-204-9), $651,073.

Pratt & Whitney Aircraft Corp. Division, United Aircraft Corp., East Hartford, Conn., services and materials to convert two (2) J57-P-42WB mockups to TF-33-P-3 mockup configuration, NOas 59-0319-f(PD-41-3914-0), $70,000.

Radio Receptor Co., Inc., a subsidiary of General Instrument Corp., Brooklyn, N. Y., AN/ARM-26 radio test set, cable set, bench set, AN/ARM-29, AN/ARM-21, spare parts, etc., in accordance with specification MIL-T-19250(Aer) and amendment no. 1 thereto, NOas 60-0164-a(PD-31-1669-59), $2,204,199.

Lockheed Aircraft Service, Inc., Ontario Calif., services and materials to perform 400-hr. airline maintenance on 162 aircraft and install changes and other technical directives, NOas 60-4003 letter contract(MA-33-405-9), $6,403,859.

Telephonic Corp., Huntington, N. Y., 2,000 AN/PRT-3 emergency beacons, contractor's model no. 40023, NOas 59-032-f(MA-45-733-9), $310,657.

AiResearch Manufacturing Corporation of Arizona Division, the Garrett Corp., Phoenix, Ariz., three (3) gas turbine power units, GTP-30-11 in accordance with AiResearch, specification SC-5311, NOas 59-0277-f(MA-4-720-9), $43,383.

General Electric Co., West Lynn, Mass., G-2 compass system components in accordance with specification MIL-C-7128(Aer) and amendment no. 1 thereto, NOas 59-0307-f(PD-42-2389-59), $497,466.

Electronic Assistance Corp., Red Bank, N. J., components of the APN-22 radar system in accordance with specification MIL-R-7722B(Aer), NOas 60-0179-f(PD-32-5189-9), $1,204,656.

Lockheed Aircraft Corp., Burbank, Calif., 26 model P2V-7 aircraft in accordance with detail specification SD-344-7-4(s), NOas 60-0135-r(PD-22-3214-O), $19,110,000.

Utica Division, Bendix Aviation Corp., Utica, N. Y., 60 air turbine starters, contractor's part number 36E62-2A to be furnished in accordance with specification MIL-S-19957A(Aer.), NOas 59-0302-f(PD-42-2150-59), $109,680.

Raytheon Co., Waltham, Mass., materials and services necessary to acquire, rehabilitate and install machine tools and other capital equipment, NOas 59-0051-c(IP-3-4449-9), $109,425.

Raytheon Co., Waltham, Mass., materials and services necessary to acquire, rehabilitate and install machine tools and other capital equipment, NOas 59-0049-c(IP-12-4449-0), $326,550.

The Dahlberg Co., Minneapolis, Minn., 1,719, C-2459/ARC-27A radio set controls in accordance with specification MIL-I-19890(Aer), NOas 60-0178-a(PD-31-1725-0), invitation no. IFB 600-213159-A, $174,105.

AVIATION SUPPLY OFFICE, 700 Robbins Avenue, Philadelphia 11, Pa.

The Goodyear Tire & Rubber Co., Akron, Ohio, brake assemblies for various aircraft, N383-61020A(383/211003/60-383/211004/60), various, $198,830.

Jetronic Industries, Inc., Philadelphia, Pa., frequency comparator sets required to generate harmonics up to 18,000 mc. for comparison with unknown frequencies, N383(17 - 383) - 61157A(1IFB - 383-934-59, various, $324,554.

Electronics Division, Van Norman Industries, Inc., Manchester, N. H., test kits and altimeter test sets used in maintenance and overhaul of radar sets, N383-60769A, (IFB-383-939-59), various, $80,509.

Northeastern Engineering, Inc., Manchester, N. H., radio test sets to support aircraft transmitting and/or receiving equipment, N383-60771A,(JD-1FB-383-987-59), 364 ea., $199,472.

Electronics Division, Globe Industries, Inc., Belleville, N. J., radio test sets to support plug-in units of ARC-38 radio sets, N383-60773A, (IFB-383-898-59), 115 ea., $181,913.

Model Engineering and Manufacturing, Inc., Huntington, Ind., oscilloscopes for use in testing radar and radio equipment installed in ships and aircraft, N383(MIS-383)-60751A(JD-383/232459/59 MIPR 36-600-9-01L-50 item 2668 383/232694/59), various, $124,138.

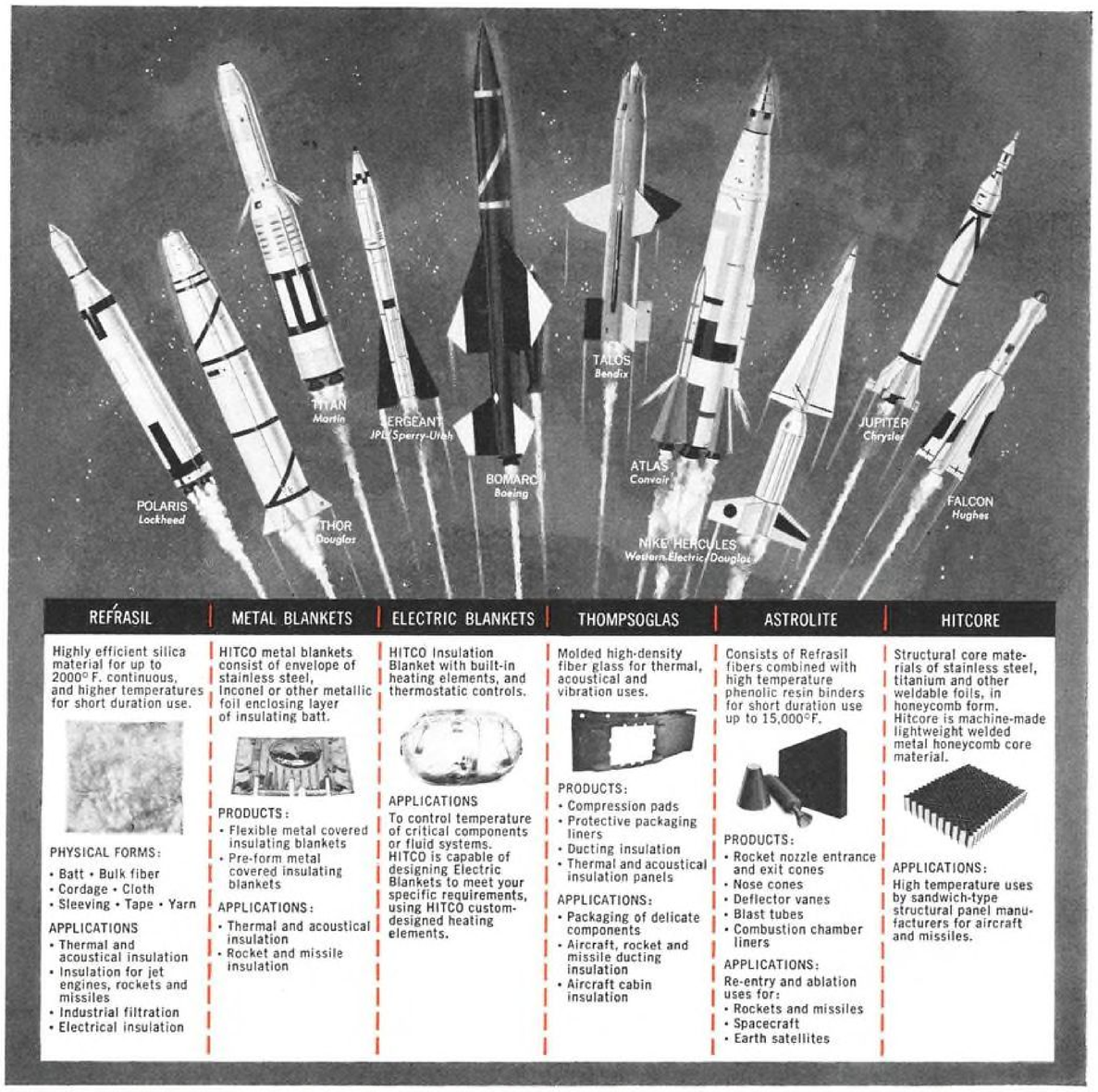
Nuclear Electronics Corp., Philadelphia, Pa., signal generators used for testing aircraft radio and radar receivers and other electronic equipment, N383(17-MIS-383)-6068A(PREN 11-3991/59 MIPR 33-604-9-17C-0062 PREN 11-5117/59), various, $797,-267.

Bell & Howell Co., Chicago, Ill., jettison bolt and tailcone assemblies to support motion picture cameras which record flights of missiles during tests, N383-60927A(383/628/59), various, $52,935.

Consolidated Aeronautics Corp., North Hollywood, Calif., section assemblies, fuselage, nose, for various aircraft, N383-60110A(383/224288/59), various, $96,029.

Do All Philadelphia Co., Philadelphia, Pa., kits to support contour saws used in O to R shops, N383-60844A(383/261203/60), various, $213,806.

ITT Federal Division, International Telephone and Telegraph Corp., Clifton, N. J., technical publications, Handbook of Operations and Service Instructions to cover bea-



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con simulator, N383(62767)-60916A(62767/2041/59(726-59)), various, $35,136.

Utica Division, Bendix Aviation Corp., Utica, N. Y., mounting heads to support starters on various jet engines, N383-60735A (383/256310/59), various, $41,378.

Eicor Division, the Scranton Corp., Chicago, Ill., motor generators for installation in various aircraft, N383-60784A(383/234421/60), 653 ea., $68,767.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., technical publications, Handbook of Overhaul Instructions and Illustrated Parts Breakdown to cover vertical gyro, N383-61123A(383/21644/59), various, $42,410.

Dorne & Margolin, Inc., Westbury, N. Y., antenna assemblies to support radio equipment in S2F-1 and TF-1 aircraft, N383-61162A(383/232600/59), 105 ea., $34,578.

United States Electrical Motors, Inc., Los Angeles, Calif., electrical motors to support model P5M-1-2 aircraft, N383-60502A(383/234223/59), 94 ea., $41,963.

Aeronautical Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., indicators, fuel quantity, to support various aircraft, N383-61215A(383/216111/60), various, $27,069.

Aircraft Equipment Division, Consolidated Diesel Electric Corp., Stamford, Conn., generators, electrical, to support NC5 power units, N383-61247A(383/261158/60 and 383/261031/60), 50 ea., $117,050.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., parts kits to support testers used on A3D, A4D and the F4D aircraft engines, N383-61214A(N383/261-166/60), various, $33,788.

Munston Manufacturing and Service, Inc., Islip, N. Y., signal generators, for general application in electronic testing, N383-61195A(JD-IFB-383-963-59), varous, $116,-197.

Union Electric and Manufacturing Co., Jersey City, N. J., radar test sets used in testing and calibration of radar set APN-22, N383(MIS) - 61163A, (MIPR - 33-603-9-17c--0048, MIPR-33-604-9-17c-0018), various, $168,131.

Montrose Division, Bendix Aviation Corp., South Montrose, Pa., transmitters to support various aircraft instruments, N383-61248A(383/216020/60), 469 ea., $43,866.

Meckum Engineering, Inc., Ottawa, Ill., modification kits for type IV B (KMN) airship mooring masts, N383(17)-60570A, (PREN 11-452-59), various, $216,404.

Sentinel Laboratories, Philadelphia, Pa., amplifier test sets for use with searchlight test equipment, N383-60698A, (IFB 383-668-59), 106 ea., $35,510.

Mansfield Aircraft Products Co. Division, Richland Aviation, Inc., Mansfield, Ohio, jugs, beverage containers, hot or cold, N383-60019A,(383/249595/59, 383/294696/59), various, $25,946.

Master Specialties Co., Los Angeles, Calif., actuator assemblies, parachute, barometric time delay, N383-60595A, (383/271223/59), 1,196 ea., $62,551.

Melstrom Manufacturing Co., Perth Amboy, N. J., test sets, radar, for preflight testing and calibration of radar set APG-30, N383-60504A, (383/232331/59), 41 ea., $52,193.

Lavoie Laboratories, Inc., Morganville, N. J., test sets, magnetic detector, used for overhaul and test of ASQS equipment, N383 (383-MIS) - 60513A,(3832110 - 211257/55); 383/9504-125/58; 383/232461/59), various, $35,490.

Flexible Tubing Corp., Guilford, Conn., ducts for use on preheater air filters, N383-60805A, (383/261430/59), various, $49,079.

Metal Manufacturing & Sales Corp., test bench harnesses to support AN/APS38A radar equipment, N383-60540A, (383/232442/59 and 383/232463/59), various, $203,227.

B. F. Goodrich Aviation Products Division, B. F. Goodrich Co., Akron, Ohio, boots, deicer, to support aircraft wings, N383-60386A, (383/217571/59, 383/217610/59 and 383/217630/59), various, $168,514.

Rubber Fabricators, Inc., Grantsville, W. Va., life preservers, underarm, casualty, type MB-1, N383(MIS-60400A), (MIPR-08-603-9-4220-156), 2,200 ea., $76,780.

Electronics Division, Van Norman Industries, Inc., Manchester, N. H., signal generators to furnish low power radio frequency test signals for use in airborne electronic equipment, N383(11-24(MIS)-383)-60516A, (IFB-383-762-59), various, $413,204.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., technical publications, Handbook of Overhaul Instructions to cover roll amplifiers and mount assemblies, N383 (62767)-60390A, (383/62767/2050/59(739-59)), various, $26,233.

General Electric Co., Philadelphia, Pa., rotors to support various aircraft instruments, N383-60711A,(383/216537/59), various, $46,496.

General Electric Co., Philadelphia, Pa., controllers to support automatic pilot mechanisms on various aircraft, N383-60714A, (383/216653/59), various, $72,051; thermocouples to support starters on various aircraft, N383-60716A, (383/256290/59), various, $298,825.

Stewart Steel Products, Inc., Brooklyn, N. Y., gaskets to support instruments on various aircraft, N383-60635A, 383/261438/59), various, $50,734.

General Electric Co., Philadelphia, Pa., screws used on indicators, aircraft instruments, N383-60713A, (383/216690/59), various, $102,390; adapters, compass, for various aircraft, N383-60715A, (383/216343/60), 120 ea., $295,082.

The Goodyear Tire & Rubber Co., Akron, Ohio, forged magnesium wheel assemblies, main, for FJ-2 and -4B aircraft, N383-60837A, (383/211618/59), 419 ea., $130,280.

Pioneer Central Division, Bendix Aviation Corp., Davenport, Iowa, indicators, flowmeter fuel, for various aircraft, N383-60728A, (383/216610/59), 118 ea., $64,310.

Cosmos Industries, Inc., Long Island City, N. Y., radio test sets, provide low power frequency test signals for use in maintenance of airborne electronic equipment, N383(383-MIS-24)-60767A, (JD-IFB-383-955-59), 342 ea., $492,558.

Electronic Brazing Co., Montclair, N. J., test stroboscopes, self-calibrating, test equipment to support AN/ASA13 radar equipment, N383-60503A, (383/232358/59 and 383/232666/59), 117 ea., $44,595.



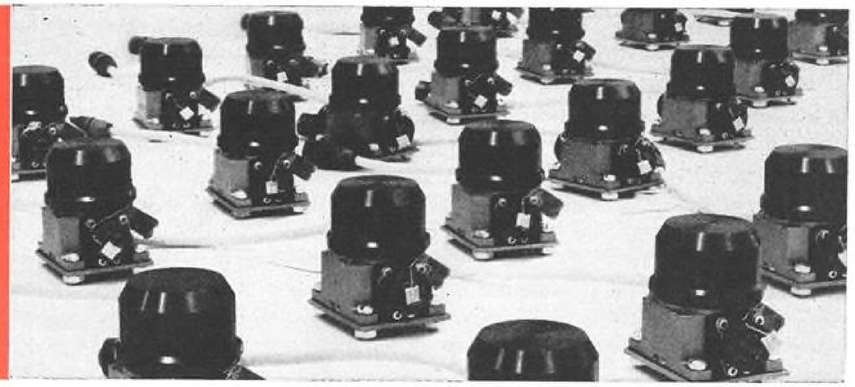
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R-M

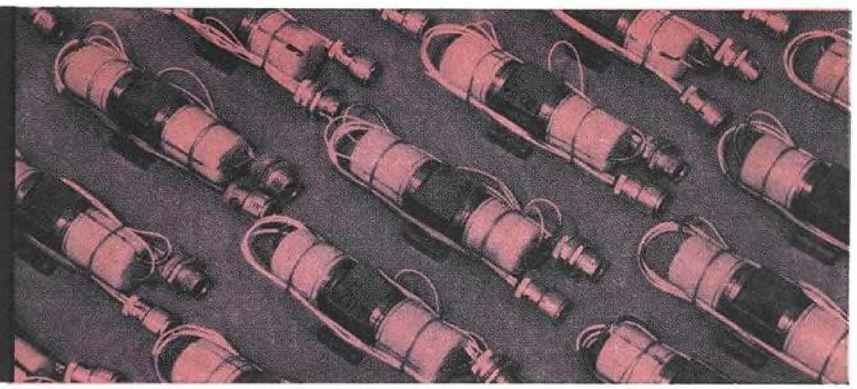
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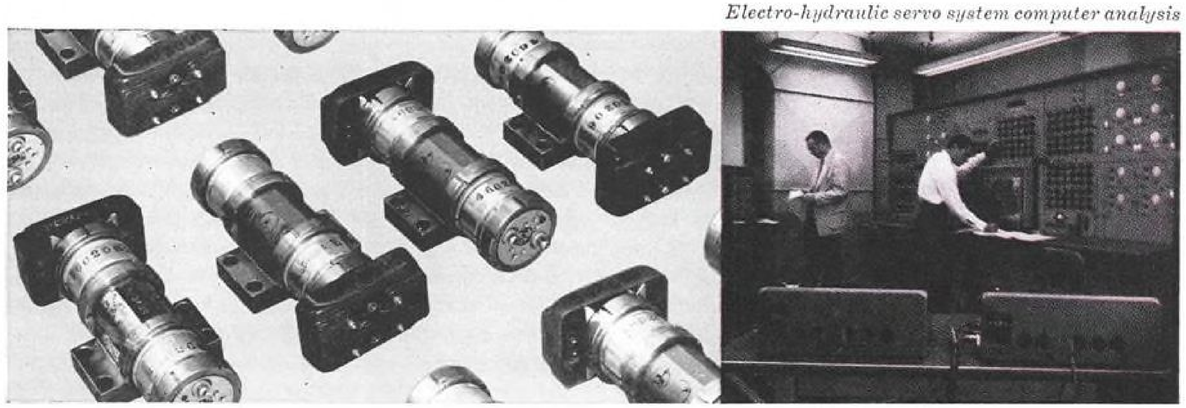
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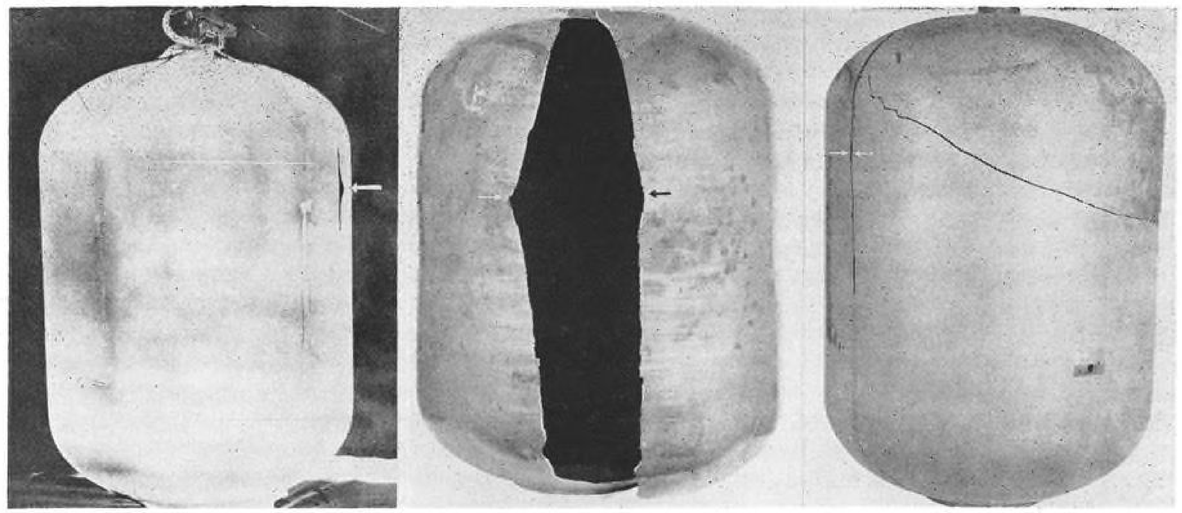
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THREE-FOOT-LONG pressure vessels were used in the Allison test program that led to a capability of consistently producing rocket cases with hoop bursting strengths of 248,000 to 274,000 psi. Unsatisfactory test vessel or bottle (bottle B in the story text) is shown in left and right photos above. Moment of failure is shown at left, with the arrow indicating the first rip. Brittle characteristics of bottle B are indicated by the numerous secondary ruptures (right hand picture) which followed the original longitudinal split (arrows). Typical failure of a high-strength test bottle (bottle A in story text) is shown in center photo. Ductility is evident from single longitudinal crack.

New Methods Applied to Minuteman Cases

By J. S. Butz, Jr.

Indianapolis—Decision to give Allison Division of General Motors Corp. a competitive contract for development of prototype Minuteman rocket cases (AW May 18, p. 119) was based on Allison's ability to fabricate high strength cases and to test them quickly and simply, according to company officials.

Allison says its contract from Thiokol Chemical Corp. to develop solid-propellant rocket cases for the first- and second-stage Minuteman engines is based on these two primary factors:

- **Demonstrated ability to consistently** fabricate cases with hoop bursting strengths of 248,000 to 274,000 psi.
- **Development of a simple,** small specimen laboratory test to quickly show the hoop bursting strength of each production case.

Allison developed these capabilities more than a year ago in a test program which concentrated on studying thin gage pressure bottles 2 ft. in diameter and 3 ft. long which were made by welding machined forgings of hot work die steels together. The test program showed that this basic type of welded forged steel construction would fill Minuteman requirements for a light, high strength engine case.

Requirement for a low engine case weight is one of the most stringent connected with long-range, solid-fueled ballistic missiles. If the size and weight of 5,000 mi. range missiles of this type are to be kept down to feasible proportions, either the engine case weight remaining after burnout must be very low or the propellant specific impulse must be very high by present standards.

In the case of the Minuteman, which is giving the solid fuel rocket art perhaps its biggest boost and biggest challenge, the estimated performance of the missile can be met only by pushing both engine weight and specific impulse well beyond present capability.

Prime Contractor

Thiokol Chemical Corp., which is the prime contractor on the first-stage engine and the first of the companies competing for the second stage prime contract to ship completed engines to the Air Force, awarded the developmental engine case contracts for both stages on the basis of Allison's "bottle" test program, according to Allison. Small scale development of Minuteman cases began here last November, and full scale engines have been test fired.

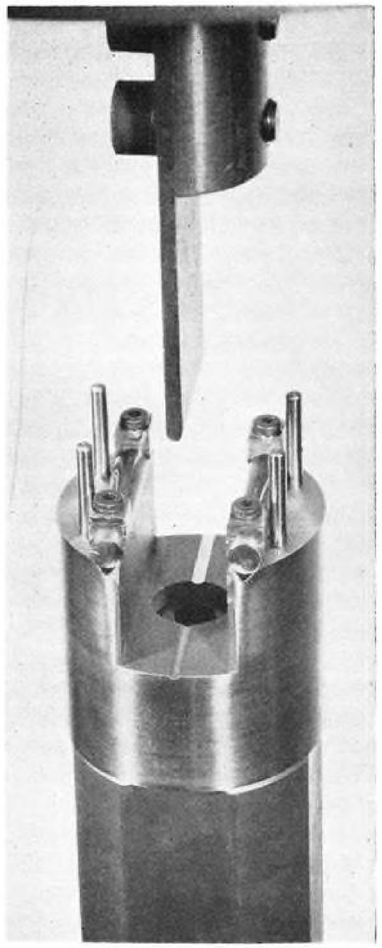
The test program, using steel pressure vessels (bottles), was initiated by Allison to get information needed to bid on projects such as Minuteman which were then under discussion by advanced planners in the Air Force. Difficulties encountered in the program led to the development of the Allison Instrumented Bend Test, which the company says is the major factor in its capability to consistently deliver maximum strength pressure vessels.

The main difficulties in the program resulted from a number of inconsistencies which persisted in the first test results. They were finally resolved after a detailed analysis and comparison of both good and bad test "bottles." At the beginning of the test program, test bottles were designed in accordance with the best existing metallurgical information and experience, and Allison decided to stay with steels normally used for dies in the hot forming of metal.

These steels had a good over-all performance record in solid fuel rocket casings in the past, mainly because of the following:

- **They could be heat treated** to very high strength levels by air cooling rather than by oil quenching from the hardening temperature, and therefore distortion was minimized.
- **They maintain their strength** up to 800-1,000F.
- **They can be successfully** joined by fusion welding.
- **They are commercially** available.

Allison chose a leaner alloy than is normally used for rocket casings. This alloy, called D-6-A, is distinctive primarily for its low chromium content of one per cent. It was selected over other hot work die steels because it had adequate hardenability and strength, its lower hardening temperature (1,500F)



FIXTURE above is used in Allison instrumented bend test which gives a quick check on the hoop bursting strength and crack propagation qualities of rocket case materials. Small test specimen is laid across the bottom portion of the fixture between the pins. Ram at top presses on it until it breaks.

should minimize distortion and its lower alloy content should make it easier to weld.

Melts of this D-6-A steel were prepared using conventional methods, roll forgings were made for the cylindrical sections of the bottles and dome forgings used for the ends. Forgings were machined down to a minimum thickness of 0.080 in. with thicker tapered sections on the edges so that the original weld joints would not be thinner than 0.125 in. Dome forgings were also thicker than the side portions.

Filler Wire

Welding was accomplished with D-6-A filler wire, using an automatic tungsten inert gas arc process with helium gas in the torch and argon gas backup. Standard radiographic inspection was performed, and all necessary weld repairs were made before heat treating. The bottles were annealed after each welding process to relieve all stresses. The weld bead was ground flush, but the tapered reinforcement was left.

First heat treatment for the bottles involved normalizing in argon atmosphere at 1,650F for 1 hr. and cooling under argon in a sealed retort to below 150F.

Argon Reheating

The cases were then hardened by reheating in an argon at 1,550F for an hour and air cooling to room temperature. A double tempering treatment of 600F for 4 hr. was chosen for the first D-6-A cases because laboratory tests had shown that such treatment produced uniaxial tensile strengths of 280,000 psi. and 0.2% yield strengths of 240,000 psi. with 5.6 elongation. These are about the highest uniaxial strengths it is possible to achieve with a reasonable amount of ductility. Uniaxial tensile strength is a measure of strength in a single direction, and at that time, it was believed that very high uniaxial strengths would produce the strongest cases.

The bottles were then subjected to fluorescent and radiographic inspections to ensure the soundness of the welds. Strain gages were cemented to the bottle surfaces in zig-zag patterns so that any failure would rupture them. Failure of any of the strain gages set off two high-speed cameras and sets of lights. This produced a photographic record of the beginning of a bottle failure during pressure testing. Pressure tests were made by pumping the bottles full of water and increasing the pressure in 150 psi. increments.

Failure Analysis

Failure analysis centered around two cases, one of which had shown a 264,000 psi. hoop bursting strength and another with a value of only 157,000 psi. The cases had received the same heat treatment, and there was no apparent difference between them which would account for the great difference in bursting strength.

The object of the comparison between good and bad bottles was to locate some simple laboratory-measured parameter or relationship which would show a difference between them and could be used to predict the performance of a rocket case. This parameter would also indicate the proper heat treatment for the D-6-A alloy when used in pressure vessels.

Photographs of the two vessels after testing are on p. 139, with the small arrows indicating where rupture first began. Both failures originated in the parent metal, so there was no question of the soundness of the welds.

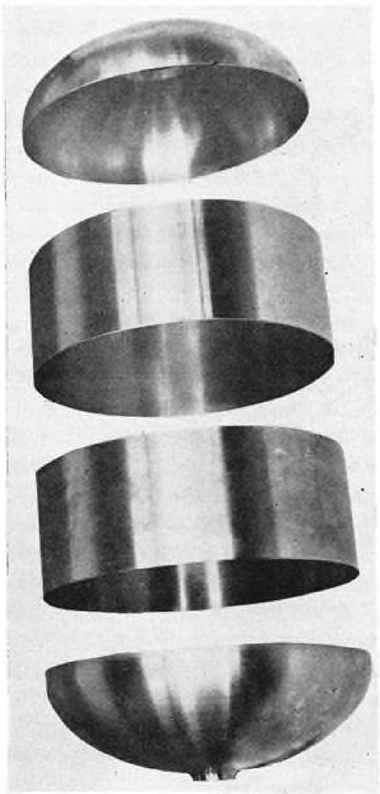
The main point revealed in a comparison of mechanical properties was that there was no correlation between the uniaxial tensile strength of the material and its hoop bursting strength. Hoop bursting strength is an indication of ability to resist biaxial stresses, which are combinations of longitudinal and circumferential stresses.

A chemical analysis was made to determine the cause for the obvious differences in hardness and strength of the two cases, which had been given the same heat treatment. This analysis showed that bottle (A), the stronger of the two, had low carbon content of 0.33 to 0.36% in comparison with bottle (B), which had the proper carbon proportion of 0.45 to 0.48%. The difference in hardness and uniaxial tensile strength could be attributed to this unsuspected variations in the bottle's carbon content.

Full Scale Cases

However, it was not considered feasible by Allison to build large scale cases out of the low carbon content material. It would be much more difficult to achieve uniform hardening with air cooling on the large cases than it would be on the small scale test bottles.

It was concluded that there must be



TEST BOTTLES were made by welding together the machined steel forgings shown above. Allison test program demonstrated that this method of construction could be used for Minuteman rocket cases.

CAPABILITIES FOR DEFENSE



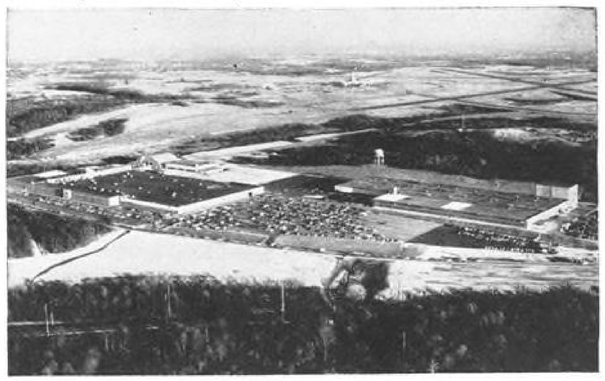
PLANNED COST REDUCTION: Each Westinghouse defense division has closely controlled programs to reduce costs. Manufacturing, engineering and accounting representatives establish goals in advance and see that they are achieved. Here, for example, members of the *Electronics Division* group inspect an automatic assembly device designed to help the division reduce production costs $630,000 in 1959.

Here's how Westinghouse manufacturing capabilities produce better defense systems faster, at lower cost

MODERN INSTRUCTION METHODS introduced by Westinghouse result in considerable savings in time and money. Video Instruction Technique (VIT), shown in use at *Air Arm Division*, eliminates costly, time-consuming training. Using this method, untrained personnel progress from one assembly to another without prior instruction.



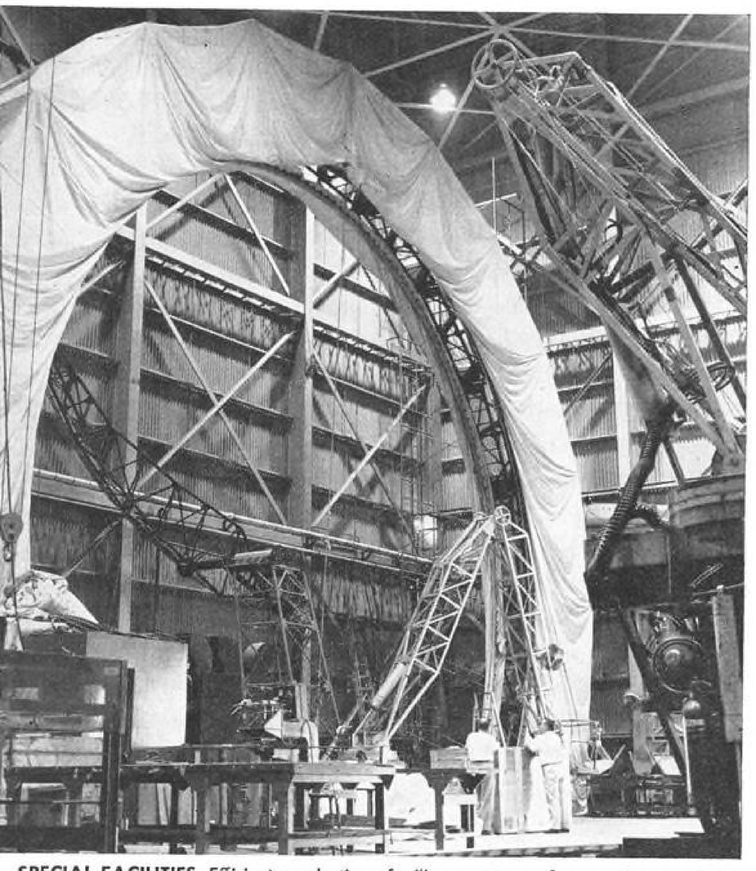
GROUPED FOR EFFICIENCY: Baltimore divisions of Westinghouse are located near each other for quick interchange of information, personnel and equipment, to meet schedules and balance work loads. The *Air Arm* and *Electronics* divisions, shown below, are adjacent to Baltimore's Friendship International Airport.



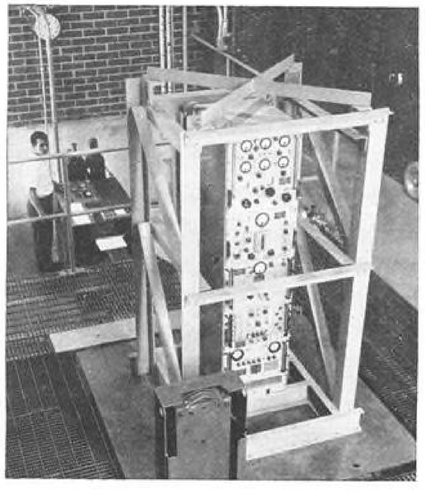
CONTINUED

Here's how Westinghouse manufacturing capabilities produce better defense systems faster, at lower cost

CONTINUED



SPECIAL FACILITIES: Efficient production of military systems often requires specially designed facilities. Above, *Electronics Division* antenna "hangar", built for assembly and testing of the "PARABALLOON" air-inflated antenna.

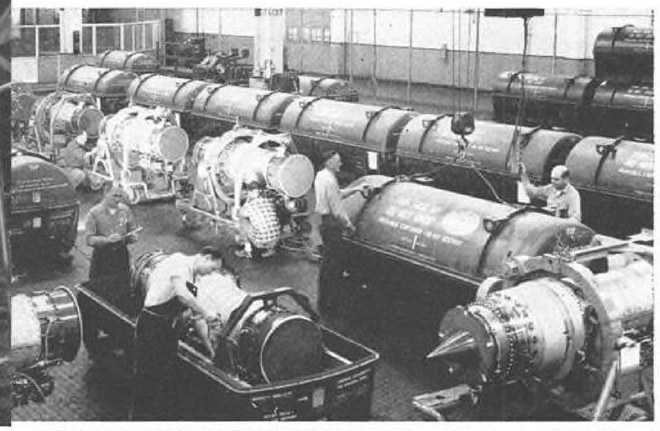


ENVIRONMENTAL TESTING: Military equipment must function reliably under extreme operating conditions. To insure such performance, each Westinghouse defense division makes available the most modern environmental test equipment. Here , a Navy shipboard transmitter undergoes vibration test at *Electronics Division*.

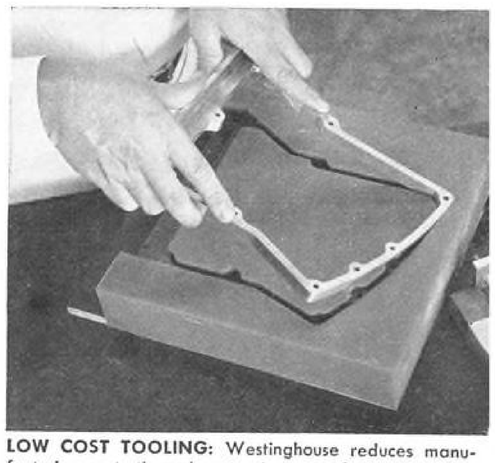
ADVANCED DEVELOPMENTS: The world's first brushless generators, shown at right, are typical of Westinghouse advances. Built by the *Aircraft Equipment Department*, these revolutionary brushless generators have performed for thousands of dependable hours. They are used in advanced electrical systems provided by Westinghouse for today's military and commercial jet planes.



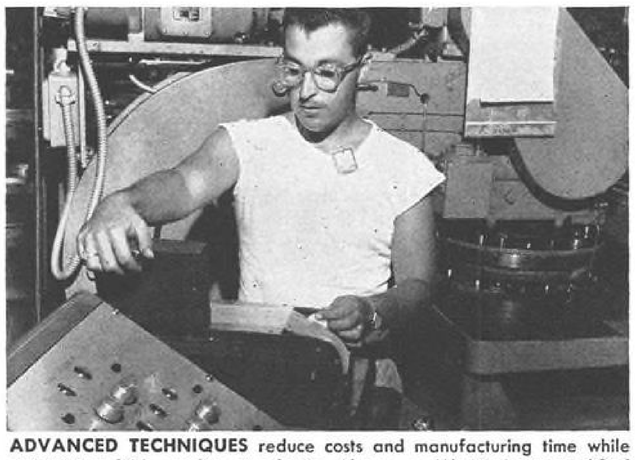
AUTOMATIC TESTING: Tape-controlled automatic equipment lowers test and inspection costs at Westinghouse defense plants. These controls are used in production as well as in environmental testing. Above, the Westinghouse-developed Self Programming Automatic Circuit Evaluator (SPACE) at the *Electronics Division* performs circuit tests 70 times faster than can be done manually.



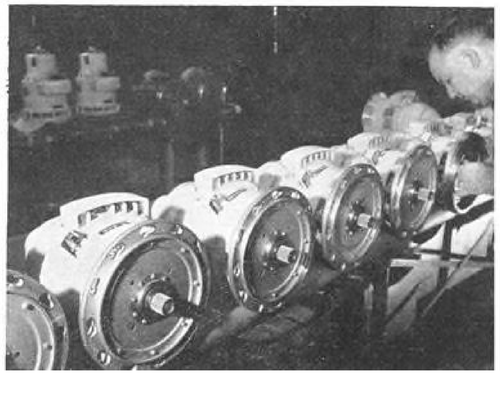
MASS PRODUCTION CAPABILITY: Aircraft engines come off the line at the 85-acre plant of the *Aviation Gas Turbine Division*. Facilities like these offer exceptional capacity for mass producing military items to rigid specifications.



LOW COST TOOLING: Westinghouse reduces manufacturing costs through extensive use of plastic tooling techniques. This flexible mold was fashioned at the *Air Arm Division* from one original machined part. It can be used to produce hundreds of duplicate plastic parts to exact dimensions in a fraction of the time required under previous methods. Cost reductions average five to one.



ADVANCED TECHNIQUES reduce costs and manufacturing time while maintaining high quality standards. Above, a Westinghouse-modified punch press at the *Air Arm Division* operates automatically by tape or dial control. It reduces lead time, cuts costs 60 to 70 percent over use of templates.



PROGRAM VISIBILITY: Efficient scheduling and shop loading are programmed at a glance by manufacturing planners keeping up-to-the-minute charts on individual equipments, manpower, machine loadings, material and assembly flow. Chart room below is at *Air Arm Division*.



REDUCED PRE-PRODUCTION COSTS: This new Westinghouse data communications system cuts up to 50 percent from time lapse between design and data availability for weapons production. Called MMI (Mechanized Manufacturing Information), the system is used by *Air Arm Division*





AUTOMATIC EQUIPMENT: Use of automatic equipment like th welding machine above at the *Ordnance Department* gives tim savings of 6 to 1 over manual methods. Automatic machinery als assures uniform high quality and low costs.

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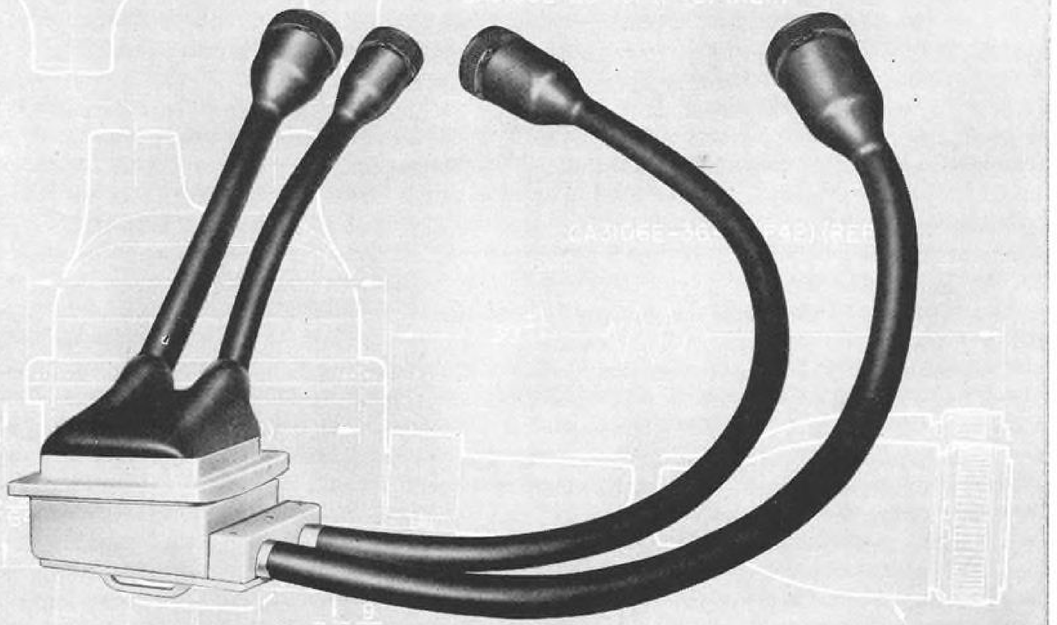
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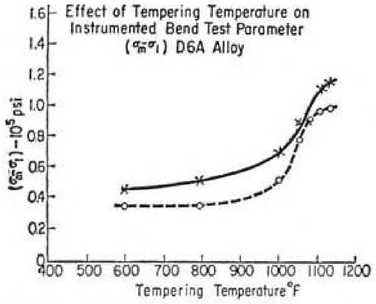
■ **FIELD TECHNICAL ASSISTANCE:** Experienced specialized sales engineers are available to discuss and assist customers in the technical aspects of plug-harness system requirements prior to manufacture and after installation in the field.

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CURVE above resulted from using various heat treatments. Curves for two different heats of D-6-A alloy are shown. These curves represent only two of several heats that were tested. Metallurgical work of this nature today is largely empirical.

an optimum tempering temperature which would give the material with normal carbon content a maximum ability to redistribute local stresses and take biaxial as well as uniaxial loads.

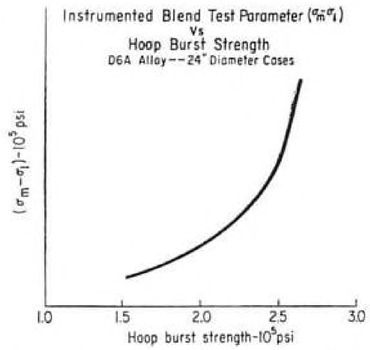
Theory showed that it would be possible to achieve bursting strengths of approximately 45,000 psi. higher than the uniaxial tensile strength if the proper heat treatment was achieved.

According to the known information concerning alloy D-6-A and the tests which had already been run, the tempering temperature after the original normalizing and hardening heat treatment should be around 1,050F rather than the 600F originally used on bottles (A) and (B).

The exact temperatures used in these heat treatments were determined through the development and use of the Instrumented Bend Test, Allison engineers did not think that tear or notch tests usually used to determine crack propagation properties were applicable in this case. They wanted to develop a test which would not require a large specimen and did not involve great difficulty in using material from failed cases. The object was to use small, reproducible specimens which would in some way give a simple measure of the hoop bursting strength.

A number of ideas were tried, and the one which proved successful was a simple beam bend test. During this test, the measured quantity which could be correlated to the hoop bursting strength was the rate at which the load decreased after first crack occurred.

The load on bottle (B) dropped very rapidly after the first crack appeared. However, on bottle (A) the first crack began when maximum load was reached, and then the load began to fall off very slowly until a major crack occurred and the beam failed. Normal strain gage instrumentation with a strip recorder and a standard tensile test machine with a very simple fixture are equipment needed to perform bend test.



CURVE above correlates the stress differential parameter and hoop bursting strength. Stress differential parameter is defined as the difference between the stress at first crack (sigma $_m$) and stress at failure (sigma $_1$).

From the record on the strip recorder it was possible to obtain the maximum load (P_m) at which first cracking occurred and the load (P_1) at which the specimen failed with a rapid cracking across its width. Knowing these loads, the stress in the specimens in these two



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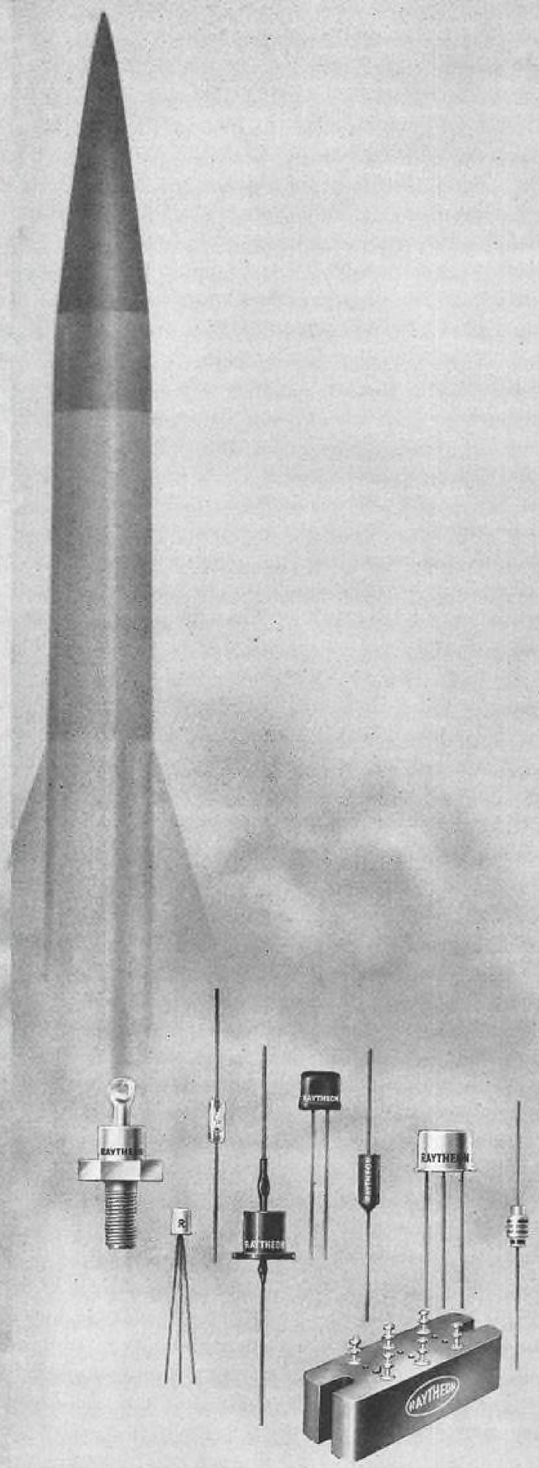
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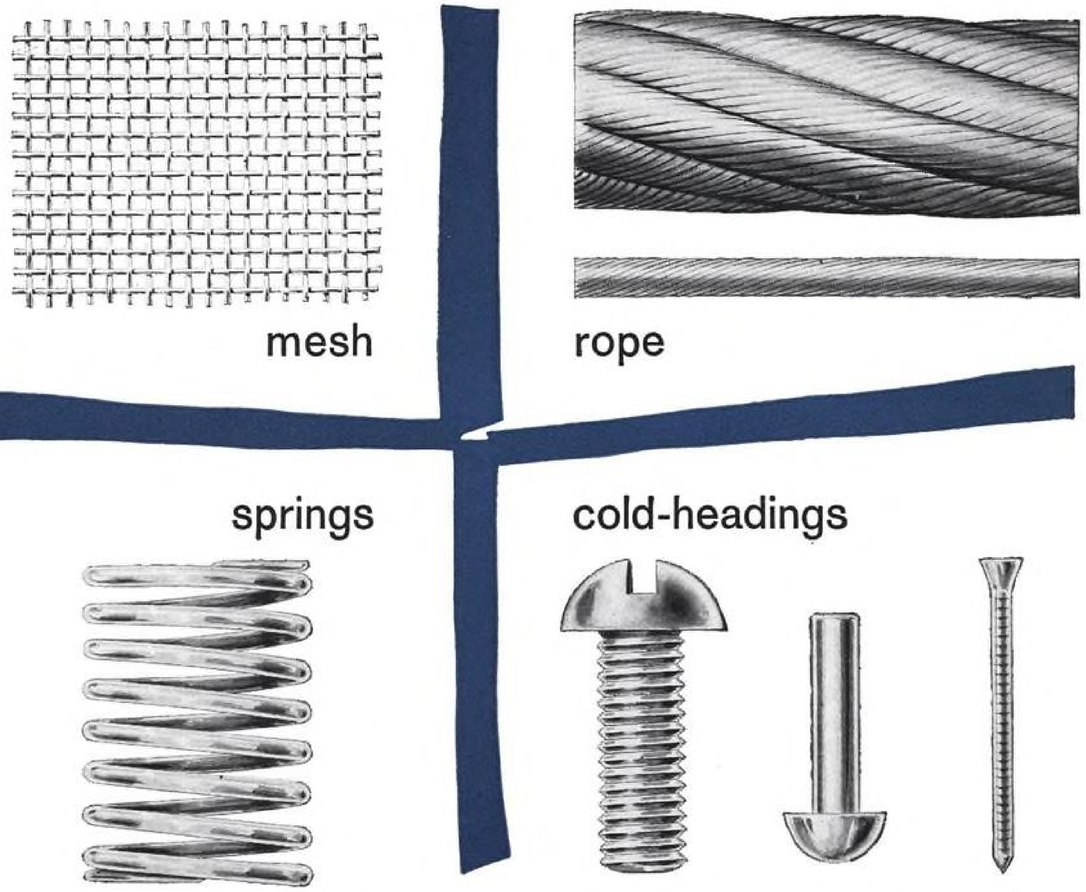
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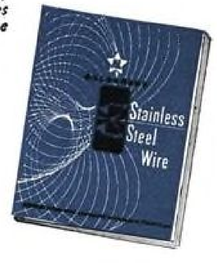
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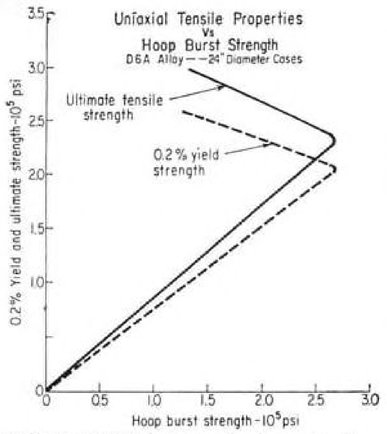
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CORRELATION between the hoop bursting strength and the uniaxial tensile strength is shown to be good below 220,000 psi., and normal tensile tests may be used. Above this stress other tests such as the Allison bend experiment must be used.

conditions can be calculated. The difference between the stress at first crack and the stress at catastrophic failure then is a measure of a material's capacity for redistributing high localized stresses before major cracking occurs. It should also serve as a laboratory tool for determining the optimum heat treatment for rocket motor case materials.

Using this test with D-6-A alloy bottles subjected to various heat treats, Allison was able to develop the chart curves. In the graph at left, on p. 145, the curves for two different heats of D-6-A alloy steel are shown. The curves do not extend beyond 1,150F because beyond these temperatures distinct breaking points could not be obtained. They showed, however, that maximum tempering temperature should be 1,050 to 1,100F to obtain a maximum differential between stress at first crack ($sigma_m$) and stress at failure ($sigma_t$).

The curve (sketch at right, p. 145) shows the success which was obtained in correlating this stress differential parameter with the hoop bursting strength of a rocket case.

The above curve was plotted to show that uniaxial tensile strength tests are an accurate indication of the bursting strength only up to about 220,000 psi. If a higher strength is required, then the instrumented bend test is used to check the material.

AMC Contracts

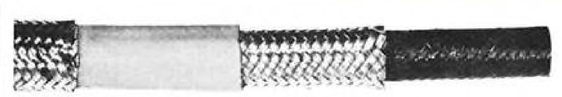
Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Kollsman Instrument Corp., Elmhurst, N. Y., components of MD-1 automatic astro compass (application—B-52 aircraft), (PR EG-9-05A-4863), $353,000.

AiResearch Manufacturing Co. of Arizona Division, the Garrett Corp., Phoenix, Ariz.,

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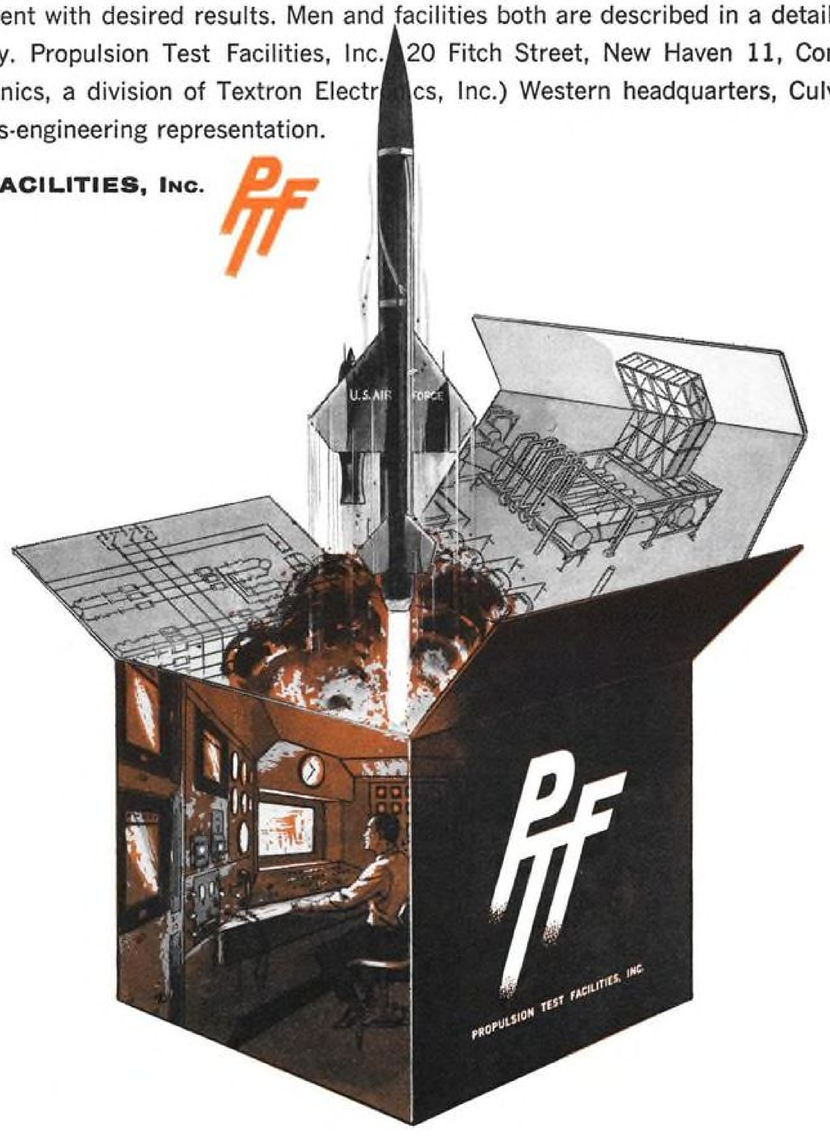
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product improvement program for STU-3/A cartridge starter on F-105 aircraft, (PR EA-9-2995-5996), $239,000.

R & D Constructors, Inc., Detroit, Mich., 1 ea., maintenance dock, type SHU-1/F, fabricated and delivered to McGuire AFB, N. J., platforms for C-118 type aircraft, fuselage closure shall be for B-52 type aircraft, docks to be furnished in accordance with specification MIL-D-26226B(USAF) dated Dec. 12, 1958, and subject to the provisions of exhibit "A," IFB 33-600-59-225 (PR EM-9-F-6377), $243,966.

Cessna Aircraft Co., Wichita, Kan., T-37B trainer airplanes, spare parts, ground services equipment, machinery and tools and data, (PR TR-0-1510-5001), $1 million.

Ampex Corp., Villa Park, Ill., 2 ea., seven channel magnetic tape recording systems for recording airborne infrared reconnaissance data; 1 ea., ground based image play-back system, spare parts and data for aircraft: unknown, (PR EC-9-RD-4355), $68,921.

Allison Division, Aero-Products Operations, General Motors Corp., Dayton, Ohio, development of propeller for Allison T-63-A-1 engine, (PR 57173), $96,300.

Ordnance Division, Minneapolis-Honeywell Regulator Co., North Hopkins, Minn., preliminary design drawings—dynamic analyzer for advanced reconnaissance system, end use: to simulate flight conditions for testing reconnaissance equipment, (PR EC-9-ST-4353), $270,000.

Flight Propulsion Division, General Electric Co., Cincinnati, Ohio, 8 ea., J79-GS-9 turbojet aircraft engines for B-58 test program, (PR EP-9-2840-4917), $1,305,000.

Laboratory for Electronics, Boston, Mass., engineering services to assist with installation and flight test of AN/APN/-105 and AN/APN-13 doppler navigation system, (PR EC-9-16K1-4920), $68,000.

Lumen, Inc., Rockdale (Joliet), Ill., 44 ea., photographic print chopper FM-6 with related spare parts and data for ground engineering equipment, IFB 33-600-59-211(PR MO-9-10B-1803 and amendment No. 1), $31,890.

Old Delft Optical Co., Inc., Hicksville, N. Y., one ea., camera, reconnaissance, TA-90V subsystem, data and reports for: aircraft—unknown, (PR EC-9-ST-4349), $50,730.

Collins Radio Co., Cedar Rapids, Iowa, 16 ea., radio receivers, R844/ARN, Aerno 81-8088, end use: T-38A aircraft, (PR EC-9-5826-4815 and amendment No. 1), $71,243.

Bulova Research and Development Laboratories, Inc., Woodside 77, N. Y., 25 ea., altimeters, servoid display.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., 200 ea., indicators, attitude, gyro, type J-8, Aerno 60-5933 (for use on H-34A, H-37A, H-19, H-21C, L-23D and HU-1A aircraft), (MIPR R59-4463-TCSMC-A), $122,498.

Electronic Specialty Co., Los Angeles, Calif., 700 ea., antennas, AT-741/A, Aerno 8-0676 (for use in the F-100D, F-100F, et al aircraft), (PR MD-9-5985-39149), $31,931.

Red Bank Division, Bendix Aviation Corp., Eatontown, N. J., 30 ea., generators, 20 kva, a.c., three-phase, in accordance with Lockheed Specification ER-2-283, dated Feb. 3, 1956, Revision A, contractor's P/N 28B23-3-A, Aerno 42-6053 (spares for F-104D aircraft), (PR SA-9-03C-9300), $40,297.

A. Quincy Jones and Frederick S. Emmons Associates, Los Angeles, Calif., additional architectural and engineering construction inspection services for McClellan AFB, Calif., family housing project, (PR PD-9-S-1099), $54,362.

AC Spark Plug Division, General Motors Corp., Milwaukee, Wis., maintenance tools and test equipment in support of AN/AJQ-3 BNC, data and drawings, used in: B-47 aircraft, (PR EG-9-11A-4905), $298,500.

X-Ray Department, General Electric Co., Milwaukee, Wis., 12 ea., magazine, film, type LD-45A, Aerno 74-0282; 12 ea., body, 35 mm. radarscope image-recording camera, type LD-48A, Aerno 74-0084; 24 ea., control, exposure, type M-2, Aerno 74-0340 (Components of KS-32A camera system used on B-52 aircraft), (PR RG-9-10D-4933), $30,000.

McDonnell Aircraft Corp., St. Louis, Mo., long lead time items and production effort to support Fiscal 1960 production of GAM-72 missiles and launch gear, (PR SO-9-1410-7355), $780,000.

R. A. Hawks Division, Sierra Engineering Co., Sierra Madre, Calif., lightweight oxygen masks assemblies for part of Project Headstart, (PR 65691), $79,200.

R & C Machine Co., Inc., Dayton, Ohio, 1,800 ea., adapters, accessory mounting, 6 in. QAD in accordance with drawing 5106728B dated May 10, 1957, including clamp 6 in. QAD, drawing dated November, 1955, Aerno 42-0760, (item is required to support B-57, F-84, C-124 and C-130 aircraft), IFB 33-600-59-234, (PR SA-9-03C1-9270), $76,140.

Morse Instrument Co., Hudson, Ohio, various replacement parts for D-1, E-1 printers and EH-7A, A-8 processing machine, photographic, use: ground support equipment, (PR MO-9-6740-1752), $26,848.

Mine Safety Appliances Co., Pittsburgh, Pa., 120 ea., HGU-2/P crash helmets, contractor's P/N 83806, medium size: 180 ea., HGU-2/P crash helmets, contractor's P/N 83807, large size, (PR 65684), $39,783.

Permanent Filter Corp., Los Angeles, Calif., filter-separator vehicle, spare parts and related data, (PR EM-Q-2330-6139), $411,506.

Bowser, Inc., Fort Wayne, Ind., filter-separator vehicles, spare parts and related data, (PR EM-0-2330-6138), $418,307.

Allison Division, General Motors Corp., Indianapolis, Ind., 223 ea., phase detector-torquemeter indicators, contractor's part number 6005150, FSC 6620-621-4269, for: supply, (PR MA-9-05D-480), $348,995.

Lear, Inc., Grand Rapids, Mich., type MD-1 and MC-1 gyros, phase II VGI components, in support of KC-135 and B-52 aircraft installation and retrofit program, (PR EA-9-05C-4909), $360,000.

Crosley Division, Avco Manufacturing Corp., 20 ea., junction boxes, FSC 1270-522-2197; 13 ea., panels, FSC 1270-522-2198 (applicable to MD4 fire control systems, B-47 aircraft), (PR WR-9-1270-1030), $37,385.

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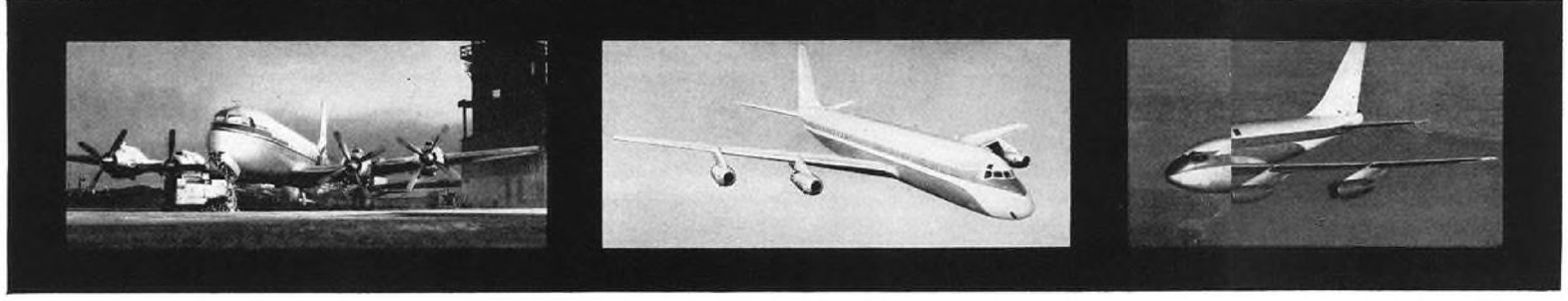
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• *J. W. Murray, chairman of parent General Precision Equipment Corp., congratulates R. W. Lee, GPL president. GPL vice presidents W. J. Tull and W. P. Hilliard participate in the ceremony.*

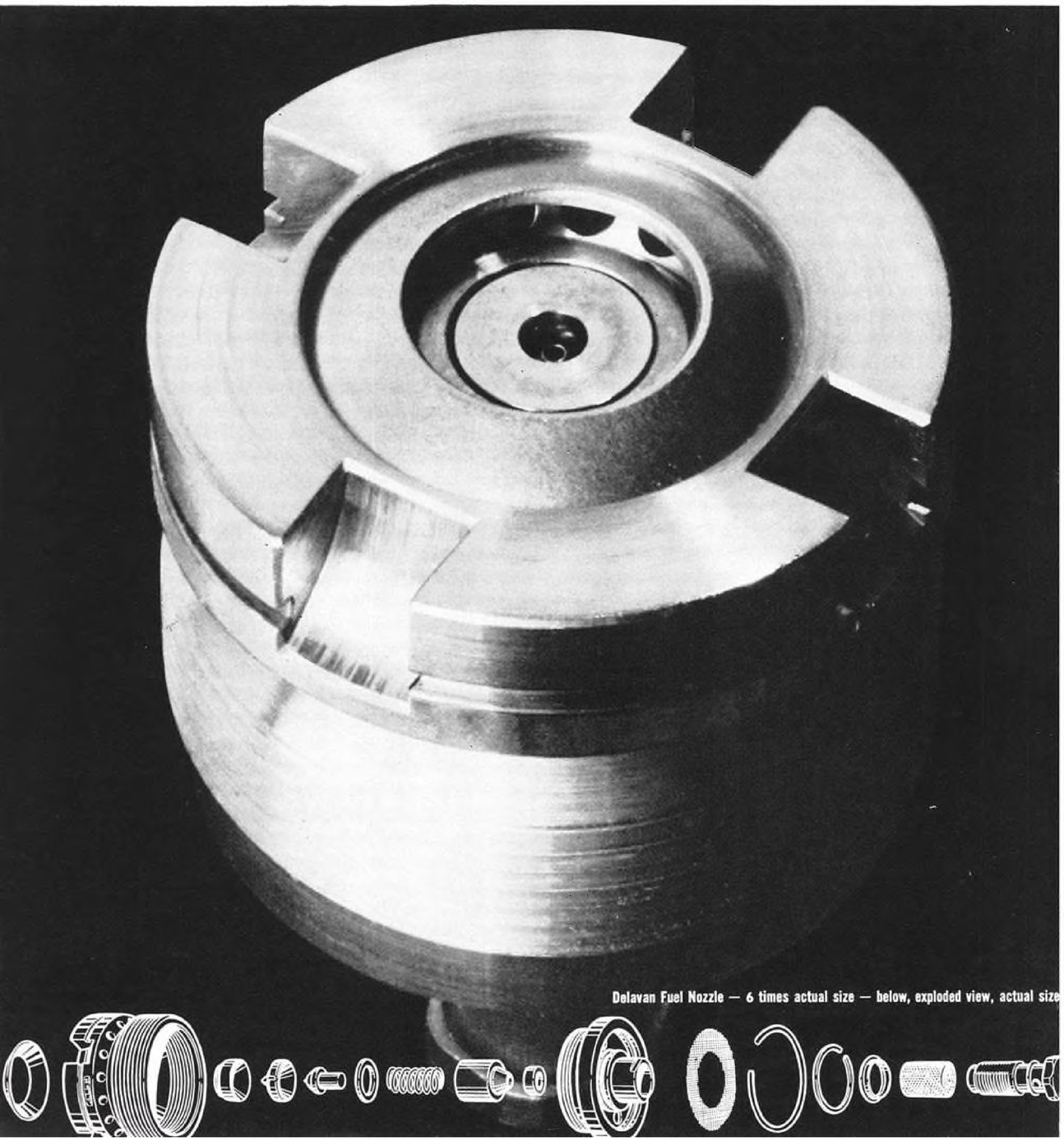
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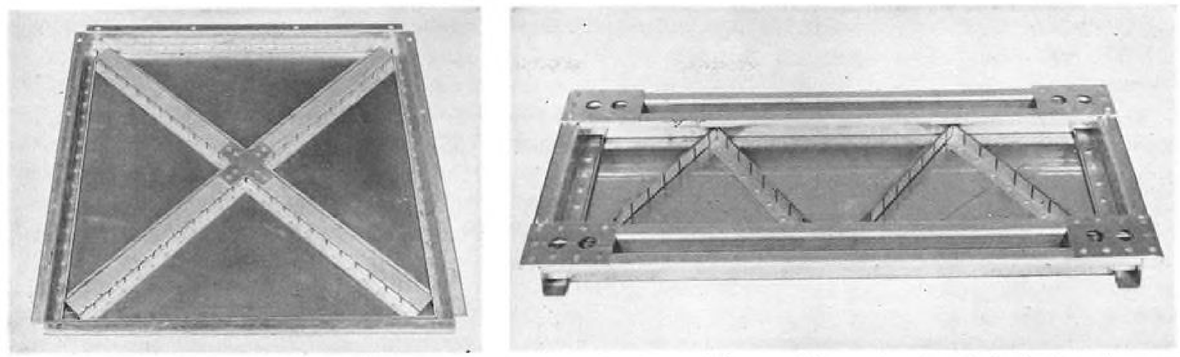
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EQUIPMENT



ALUMINUM panels are used to test the effectiveness of acoustic damping structural beams which are riveted to the back. Damping structure, developed by Lord Manufacturing Co., is applied in various patterns to determine the most effective damping.

Designers Combat Acoustical Fatigue

By Barry Tully

Aircraft structural fatigue from the acoustic energy generated by high thrust turbojet engines is becoming an increasingly important design problem in the development of large supersonic aircraft. Acoustic fatigue problems already present on large multi-jet aircraft will increase as engine thrust increases.

Approaches to the problem include research toward reduction of sonic pressure in jet engines, aircraft design configurations which reduce the surface area exposed to destructive acoustical energy and development of structural material which will withstand the acoustic pressure.

Critical Areas

In the case of contemporary multi-jet aircraft, the most critical areas are the flaps and wing trailing edges.

Aircraft designers can reduce the surface area subject to acoustic damage by placing the engines as far aft as possible. Examples of this include the North American B-70 Mach 3 bomber and certain proposed supersonic transport designs. These designs utilize a delta wing aft on the fuselage with the engines suspended on pods at the wing trailing edge. Such designs will eliminate a large percentage of the critical acoustic pressure area, but not the entire problem.

Air Force and engine manufacturers are conducting research in the area of engine noise in an effort to develop relatively quiet turbojet engines. Turbofan engines generate less noise than present turbojets at a given thrust level, however, supersonic transports and bomber will operate with 30,000 lb. thrust engines generating noise at pressure levels of 160 db. In any event, structural designers cannot wait for the silent engine to solve the structural fatigue problems, as aerodynamic flow also will produce destructive acoustic energy.

The structural approach to combating acoustic fatigue includes the development of fatigue resistant paneling. Present designs make extensive use of aluminum and stainless steel honeycomb, a rigid, lightweight material highly resistant to acoustic fatigue. The material has proved effective despite many problems which include faulty brazing solders and difficult production and fabricating techniques. The material offers little damping action, but foam filled honeycomb and dynamic damping action with metal shot is under development.

The Air Force's Wright Air Development Center is engaged in a program to develop an acoustic damping structure which will attenuate the destructive sonic energy. The center has appealed to the visco-elastic industry to develop coatings which will transmit the sonic vibration into shear stresses, thus attenuating the energy.

Assisting WADC in this field is the University of Minnesota, which is conducting research in the area of acoustic fatigue. Also in on the project are some European companies, chiefly in England and West Germany, with Air Force research contracts.

Chief difficulties in developing damping structures are that the acoustic energy generated by jet engines is "white" (wide band) noise rather than any discrete frequency, and that most damping compounds developed thus far have severe temperature limitations. The white noise characteristic of the acoustic energy precludes detuning the panels as would be possible if the energy had a discrete frequency. In regard to temperature limitations, most compounds tested so far lose their damping qualities at both ends of the scale. High temperature limitations are presently causing the most concern. In the words of one WADC engineer, "Most damping compounds tested thus far go to pot above 150F."

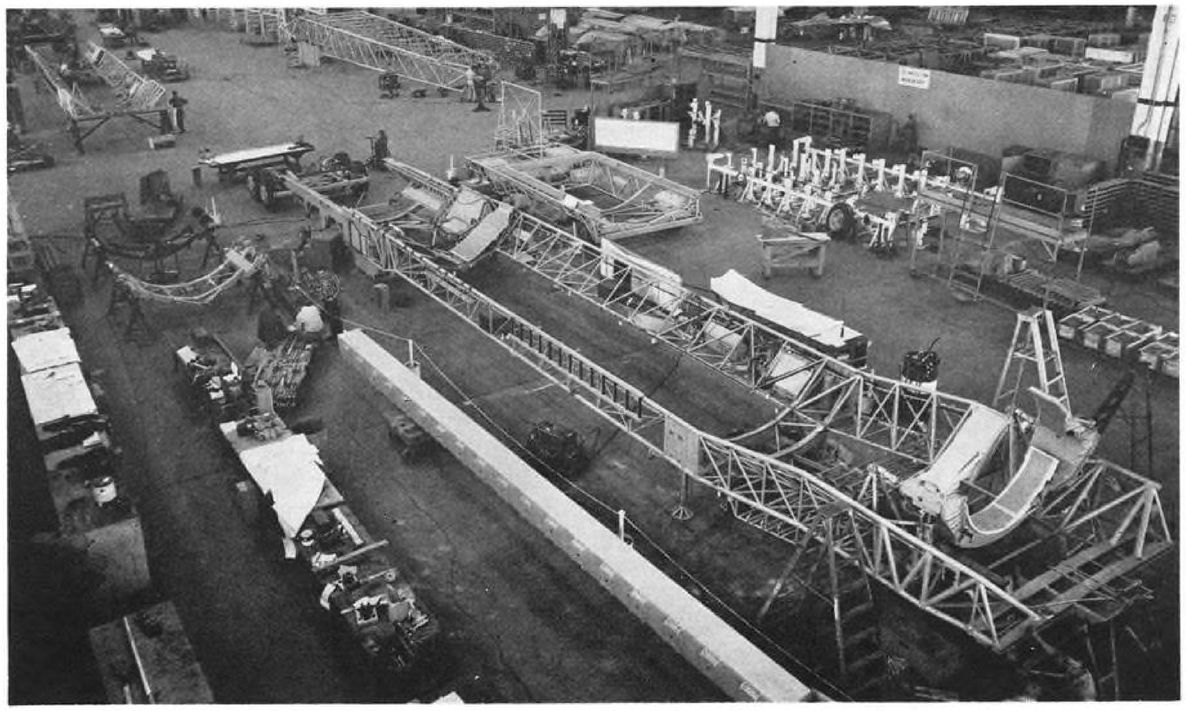
Foil Tape

Minnesota Mining and Manufacturing Co. is marketing its acoustic damping aluminum foil tape which is extensively used in the production of jet transport aircraft. However, this too is limited to temperatures below 150F.

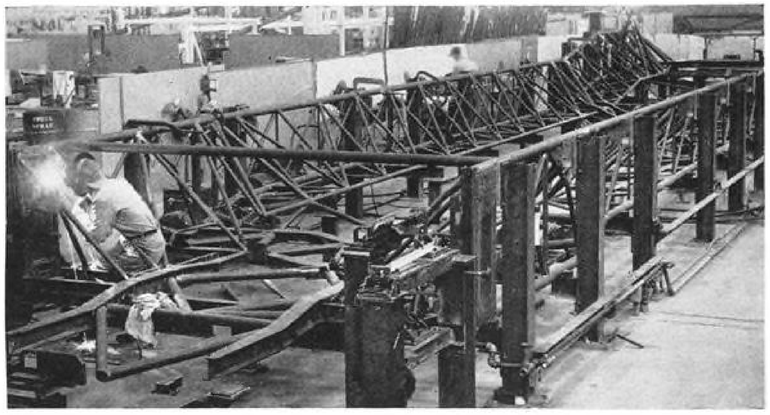
In one approach, Lord Manufacturing Co., Erie, Pa. is experimenting with bonded structural members using its BTR (broad temperature range) elastomer for the acoustic damping bonding agent. The compound has a temperature range of −65 to +300F; however, the band of effective damping is somewhat narrower than this.

Nevertheless, Lord feels that this will not restrict the material in most aircraft applications. The company points out that it is still experimenting with the bonded structure and has not come up with any specific applications for the damping structure. Airframe manufacturer's have submitted test panels to Lord for modification and testing.

Testing the effectiveness of acoustic damping panels is difficult because sound generators operate on a discrete frequency and at much lower pressure levels than jet engines. The development of air pressure sound generators that operate over a wide frequency band is easing this problem; yet, at least one major airframe manufacturer tests structural panels by placing them in a jet engine exhaust, observing the results.

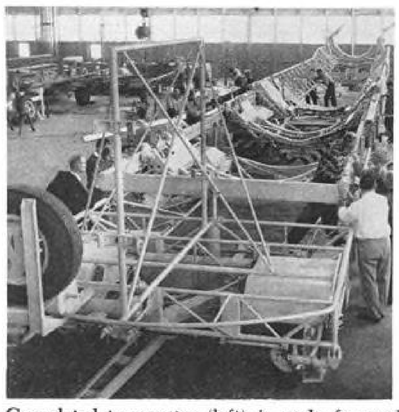


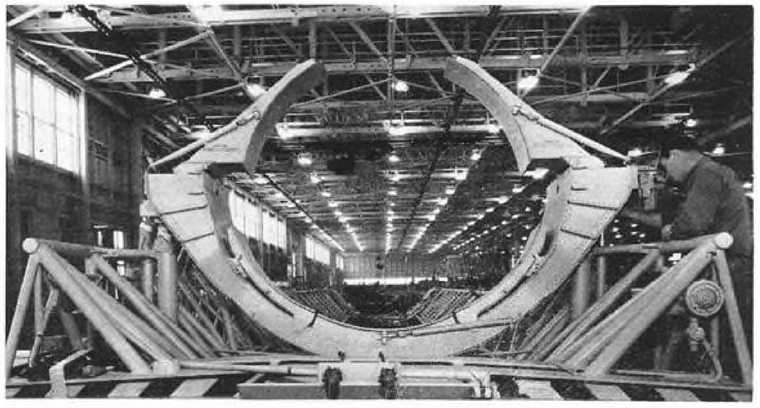
Small vehicle (above) to right of Atlas ICBM transport trailer's rear section is designed for carrying rocket booster engines.



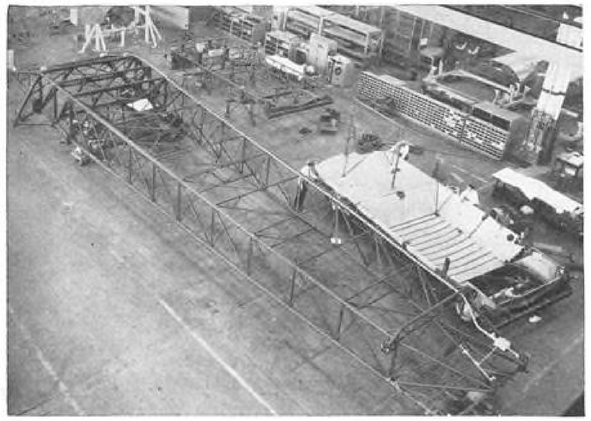
Erecting Boom, Transport Trailers Built for Atlas

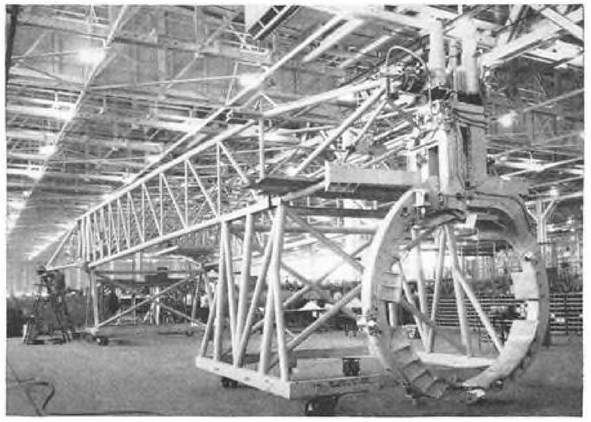
Frame for the Convair Atlas ICBM transport vehicle (left) is welded in the ground support production area of Goodyear Aircraft Corp.'s Litchfield Park, Ariz., plant.



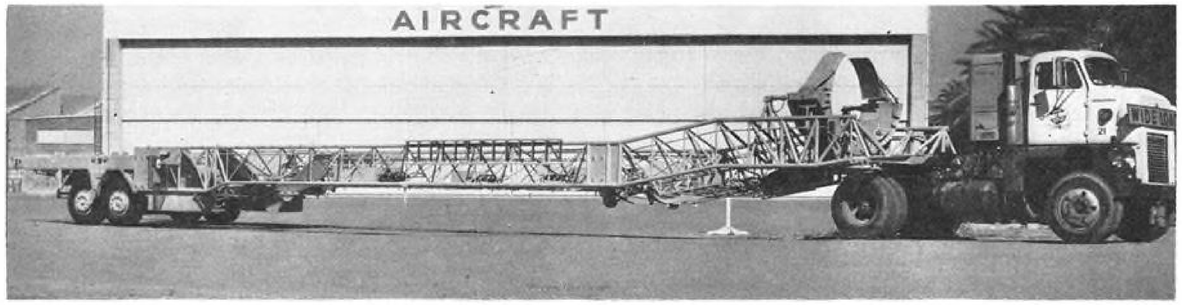


Completed transporter (left) is ready for road test. Clamp at right fits near nose section and holds missile in transit.

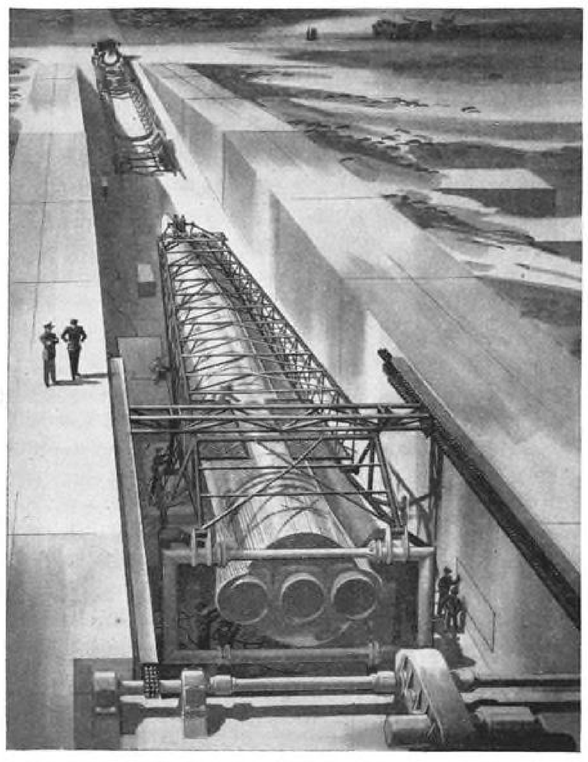




Erecting boom in foreground of left photo is almost completed. A booster engine trailer with white canvas cover is in front of the framework for a similar vehicle. The nose clamp on the erecting boom in the photo at right holds the Atlas during the erecting operation.

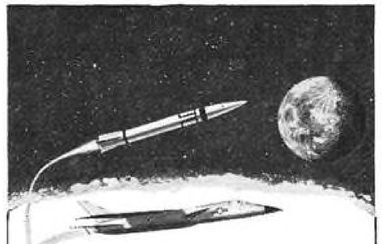


Transporter is attached to tractor. Vehicle will be used to transport missiles from Convair-Astronautics' San Diego plant to ICBM bases.





Drawings show missile trailer with booster carrier attached leaving launch site (left); erecting boom positioning Atlas (right).



STRUCTURAL ENGINEERS

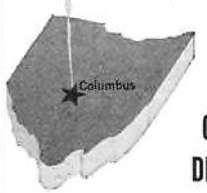
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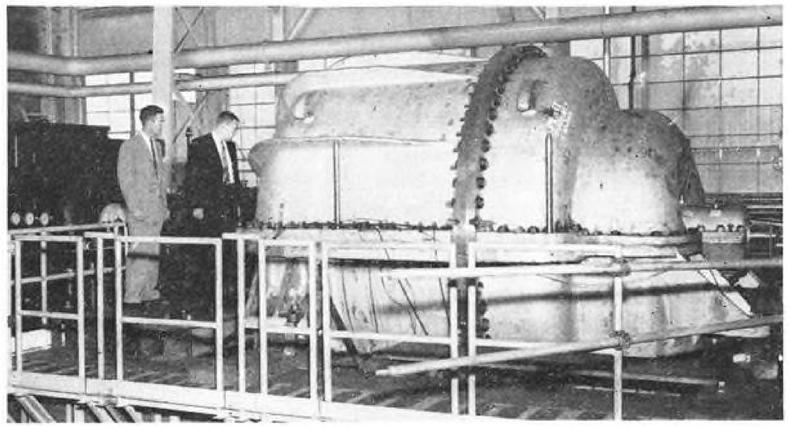
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Engineering Personnel Manager, Box AW-584
North American Aviation, Inc.
Columbus, Ohio



THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

Home of the T2J Buckeye and the A3J Vigilante

NEW AVIATION PRODUCTS



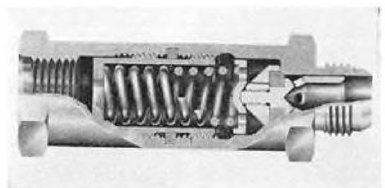
P&W Orders Jet Engine Test Compressors

Six compressors will be installed at West Palm Beach, Fla., plant of Pratt & Whitney Division of United Aircraft for research and testing of turbojet engines. First compressor (above) is undergoing tests at Allis-Chalmers Mfg. Co., West Allis, Wis., works. Centrifugal compressor is rated at 100,000 cfm. at a 3.7 pressure ratio. The units can be driven in tandem.

Cryogenic Relief Valve

Stainless steel relief valve for use with liquid oxygen and liquid nitrogen is available with cracking pressures ranging from 100 psi. to 2,400 psi.

The in-line valve has poppet ports which fully open when the valve starts to crack, but the flow is throttled between the poppet shoulder and seat, providing regularly increasing flow area with increasing flow rates. When the valve is closing, a spring equalizer transmits only the axial component of

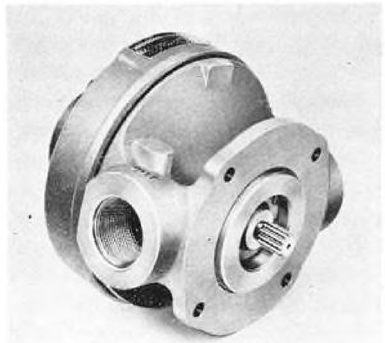


spring force to the poppet, causing it to slide in the bore. The Teflon "O" ring is effectively removed from the flow pattern when the valve is open. The seal prevails at normal system pressures against the passage of liquids or gases at temperatures to −320F. The K5120T is produced with tube connections in sizes from ¼ in. to 1 in. and in pipe sizes from ⅛ to 1 in.

James, Pond & Clark, Inc., 2181 E. Foothill Blvd., Pasadena, Calif.

Hydraulic Boost Pump

Boost pump provides a supply of fluid to high pressure piston pumps on missile and aircraft test stands, overcoming dry starts and pump starvation.



Gerotor pump delivers a minimum of 31 gpm. at 3,450 rpm., using MIL 5606 or 6083 fluids at 160F. It operates with inlet conditions ranging from 125 psi. to in excess of 18 in. of hg. With optimum operating speed matched to the prime mover, the boost pump is mounted in direct drive, eliminating gears, clutches and belts. The standard model (No. 702) is supplied with AND 20,001 mounting pad and shaft end configurations.

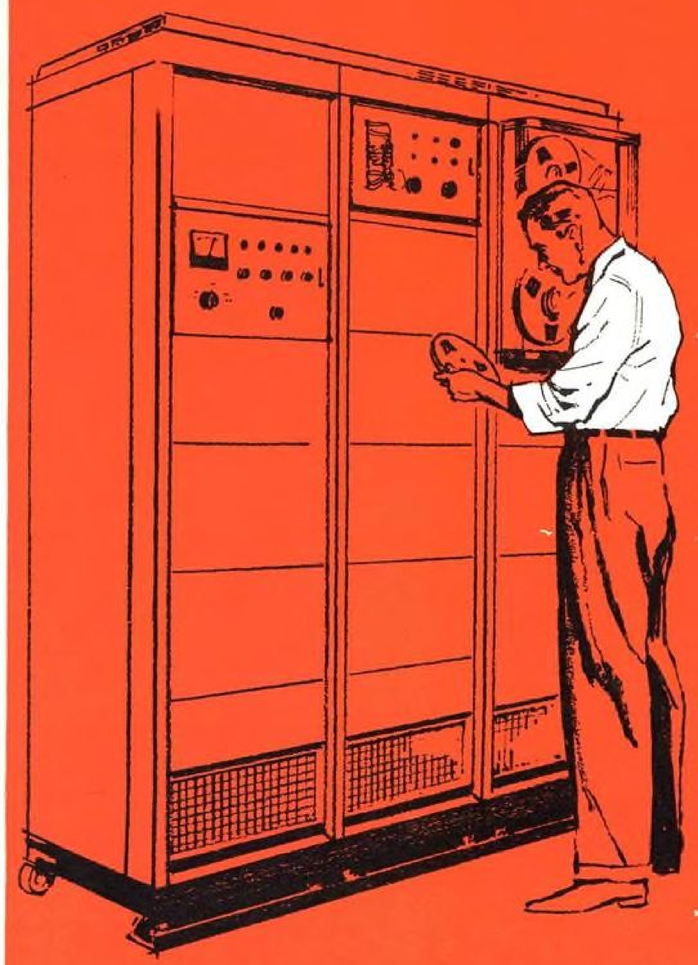
Double A Products Co., Manchester, Mich.

Water-Injection Pump

Pump designed for the Republic F-105 fighter-bomber is hydraulically driven, but is easily adaptable to turbine electric motor or engine accessory pad drive. The water-injection pump will dry running for most of its operational life.

Model 188 pump handles 35 gpm.

YOUR digital data input
Computer-format tape output



The Epsco Model S-2000

Digital Recorder accepts your digital data in parallel form, either synchronous or asynchronous rates, and prepares magnetic tape in a format suitable for direct entry into your computer.

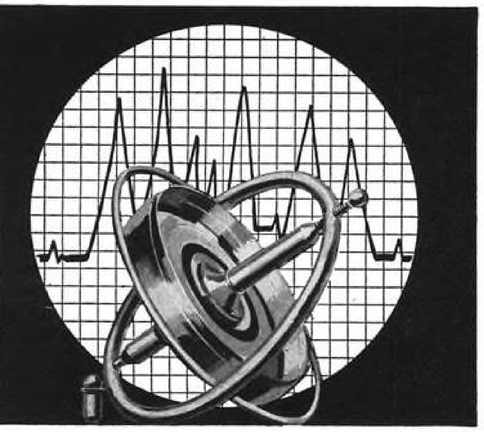
As a standard production unit, the Model S-2000 Digital Recorder incorporates design features that insure compatibility with a broad range of data processing requirements. Automatic processing of digital data into computer format permits you to increase the usefulness of your computer facility and to reduce significantly the time and cost of data preparation.

For complete technical information write: Systems Division, Epsco, Inc., 275 Mass. Ave., Cambridge, Mass.

Assembly-line techniques are effecting substantial time and cost savings in the production of Epsco Digital Recorders.

Epsco
First in data control





b

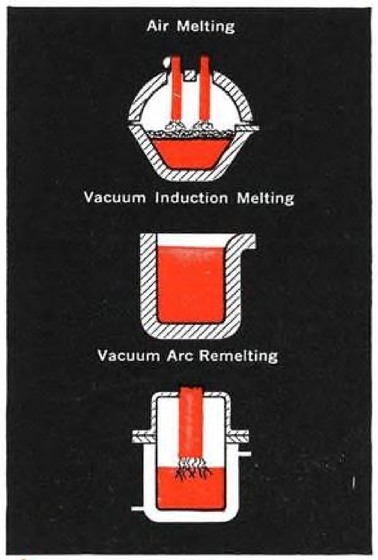


c

Titanium slabs are heated prior to rolling into continuous sheet coils. Crucible's increased capacity for producing high purity metals, in all sizes and mill forms, is substantially reducing costs and delivery times.

Vacuum Melted Alloys are specified for gyroscope balls used in navigational and fire direction systems. The metals' improved properties facilitate miniaturization.

Titanium helium storage bottles for ICBM Atlas. Titanium, which must be vacuum melted, was selected because of its high strength weight ratio, cold-resistant properties and corrosion resistance.



d

Basic Melting Processes. Vacuum induction melting produces "purer" metals than conventional air melting because it eliminates all sources of contamination except the crucible. Vacuum arc remelting eliminates the crucible and permits production of ingots up to 18,000 lbs.



a

VACUUM MELTING CREATES SUPER-DUTY METALS

Marked improvements in properties produced by High-Purity Metallurgy

Behind the development of space-age metals with entirely new characteristics is vacuum melting — a series of processes that produce "purer" metals with better properties.

Why Vacuum Melt? Vacuum melting protects molten metal from contact with air. It also provides closer control of composition, helps eliminate inclusions, and minimizes center porosity and segregation in ingots.

In the field of vacuum melting, Crucible's position is unique. As the leading producer of special purpose steels, Crucible's experience in high-quality steelmaking is unsurpassed. Through formerly affiliated companies, now fully integrated with it, Crucible led in the development and commercial production of vacuum-melted steels, iron, nickel, copper — and titanium. Therefore, Crucible's breadth of experience, together with its extensive facilities, places the company in the best position to provide the "super-quality" metals most suitable for any given application.

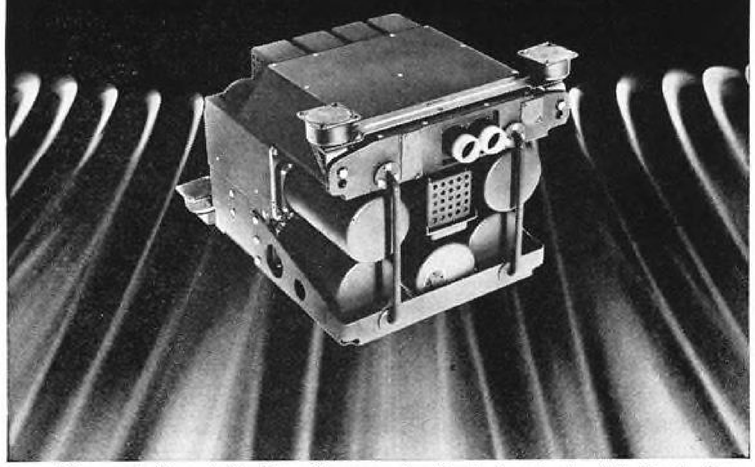
The three vacuum-melting processes — One of the Crucible processes is VIM — *vacuum induction melting*. It starts with very high-purity raw materials, produces extremely pure ingots. A second is VAR — *vacuum arc remelting*, or the consumable electrode process. This process, starting with air-melted electrodes, produces large ingots — up to 32″ diameter x 18,000 lbs. It provides metal with low-gas content and greatly improved uniformity of properties. The third process is VIR — *vacuum arc remelting of vacuum induction melted electrodes*—a double-melting technique. It permits manufacture of super-pure metals in the full range of ingot sizes.

Crucible's experience with all three processes, and its facilities for vacuum arc remelting its own specially air- or vacuum-melted electrodes, provides industry with a complete range of vacuum-melted metals at the lowest possible cost. Only at Crucible is there available this experience, flexibility and the facilities for vacuum-melting titanium, super-alloys, heat-resisting alloys, bearing steels, tool steels, stainless steels, electronic alloys and nuclear reactor materials.

If you'd like to know more about Crucible's work in High-Purity Metallurgy, read: "Quality Aspects and Properties of Vacuum Induction Melted and Vacuum Arc Remelted Steels and Super Alloys" and "Titanium for Aircraft and Spacecraft". Write: *Crucible Steel Company of America, Dept. AJ-17, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

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Expansion in electronics and electromechanical activity is creating excellent openings at all levels for qualified engineers. Diversified programs include Central Air Data systems on the Air Force B-70 and F-108, North American A3J and McDonnell F-4H, as well as other commercial and military aircraft and missile projects.

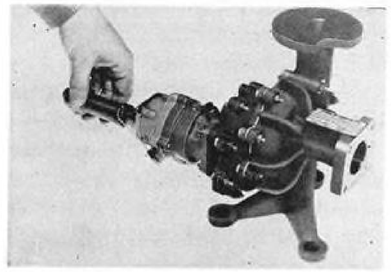
Openings in the following areas:

- **FLIGHT SYSTEMS RESEARCH** General problems in motivation and navigation in air and space; required background in astronomy, physics, engineering.
- **DATA SYSTEMS RESEARCH** Experience with physical measuring devices using electromagnetic, atomic, thermionic and mechanical approaches.
- **CONTROLS ANALYSIS** Work in preliminary design stage involves servomechanisms analysis and analog computer techniques.
- **FLIGHT DATA COMPONENTS** Analysis proposal, design and development work in the following specialties: circuit analysis, servo theory, transducers, transistors, airborne instrument and analog development of high and low temperature problems.
- **ELECTROMAGNETIC DEVELOPMENT** Work with magnetic amplifiers requires knowledge of electromagnetic theory, materials and design methods.
- **INSTRUMENT DESIGN** Electromechanical design of force-balance instruments, pressure measuring devices, precision gear trains and servo-driven positioning devices. Experience in electrical and electromagnetic transducers desirable.
- **AIRBORNE INSTRUMENTATION ANALYSIS AND DESIGN** Work involves solving problems in accuracy, response and environmental effects.

Send resume to:
Mr. T. E. Watson

THE GARRETT CORPORATION
AiResearch Manufacturing Division

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of water at a minimum discharge pressure of 250 psig. and remains unaffected by the presence of large chemicals or minerals in the water. Hydraulic power supply is 7.4 gpm. at 2,650 psig. inlet pressure with motor discharge pressures of 150 psig. Hydraulic oil temperature can range to 275F.

Curtiss-Wright Corp., 6767 Hollister Ave., Goleta, Calif.

One-Man Plane Parker

Aircraft parker for twin engine planes weighs 89 lb., can be handled by one man while negotiating holes, obstructions, etc. Called the Ramp Rascal, the



machine is powered by a 3 hp., four-cycle gas engine with power to tow aircraft on flat or inclined surfaces. Price is $395.

Industrial Products Division, Permanent Filter Corp., 1800 West Washington Blvd., Los Angeles 7, Calif.

WHAT'S NEW

Publications Received:

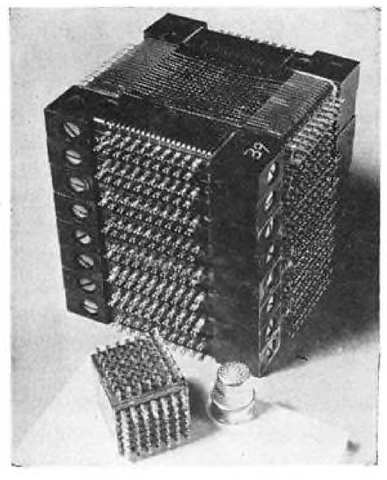
Power Unlimited—by Abraham & Rebecca B. Marcus, Prentice Hall, Inc., 70 Fifth Avenue, New York 11, New York. $3.50; 152 pp. A book on power, which covers electric motors, a nuclear propellant, the solar battery, turbojets, rockets and others.

The Upper Atmosphere—H. S. W. Massey & R. L. F. Boyd, Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. $17.50; 333 pp. A detailed account of the phenomena of the upper atmosphere studied in the International Geophysical Year. The techniques used are described along with attention given to radio fadeout, radio absorption, night airglow, aurorae, meteors, cosmic rays, and currents responsible for magnetic variations.

Helicopters & Autogyros of the World—by Paul Lambermont with Anthony Price, $10.00; 215 pp. A newly-compiled reference work designed to provide a catalog of the world's helicopters and autogyros, past and present. With 64 pages of photographs and drawings.

High Altitude and Satellite Rockets—The Philosophical Library, Inc., 15 E. 40 Street, New York 16, N. Y. $15.00; 136 pp. Twelve papers by American and British authors presented at the proceedings of the first symposium in Cranfield, Great Britain, July 1957, dealing with design problems, recovery after re-entry, high temperature materials, etc.

Comprehensive Analytical Chemistry—Cecil L. Wilson and David W. Wilson. Elsevier Publishing Company, Amsterdam. U. S. Distributors: D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. $5.00; 577 pp. This study will be compiled into five vol-



Memory Stack

Miniaturized ferrite core memory stack for coincident-current systems can provide density of about 3½ million cores per cubic foot. Small stack in foreground, with 2,048 cores, measures 1.4 x 1.4 x 1 in., is about 1/50th the volume of conventional stack (background) with same capacity. New miniaturization technique can be applied to stacks of any size. Manufacturer: General Ceramics Corp., Applied Logics Division, Keasbey, N. J.



Carl Baumgaertner, Assistant Chief Engineer, Ground Support Equipment, Honeywell Aeronautical Division

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"Our group at Honeywell is concerned with establishing leadership in a relatively new area of Ground Support Equipment. The requirements for testing complex electronic systems present a challenge for creative approaches. There are currently openings within this group for electrical engineers, preferably having experience in digital techniques, solid state circuitry, and logical circuit design as applied to automatic checkout systems. There are also openings for recent graduate engineers in this field.

"If you are a qualified engineer interested in a rewarding career in this area of Honeywell Aero, send information on your background, interests, and accomplishments to Bruce D. Wood, Technical Director, Dept. 846K".

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To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. D. Eckstrom, Honeywell, Minneapolis 8, Minnesota.



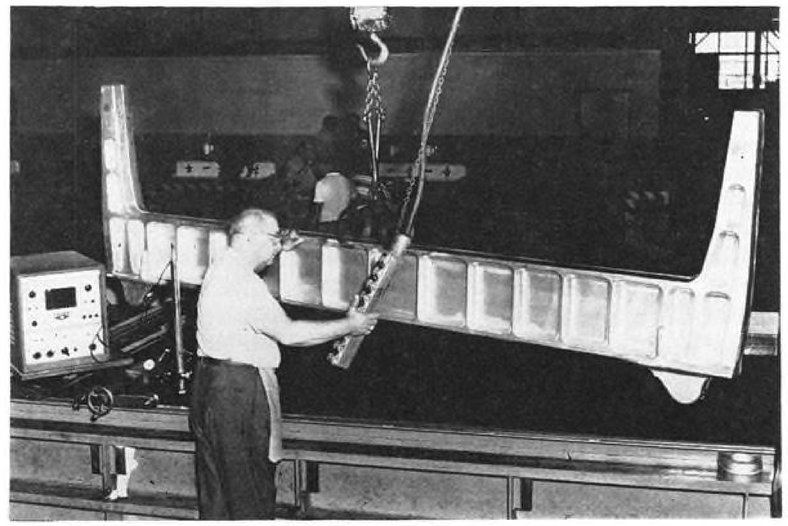
umes, consisting of several parts. The first, Vol. 1A deals with the introductory and general material associated with analytical chemistry.

Traffic Management—by Charles A. Taff, Richard D. Irwin, Inc., Homewood, Ill. $8.70; 631 pp. This book covers such topics as electronic data-processing, scientific research methods and leasing versus owning equipment.

Concise Dictionary of Science—by Frank Gaynor, Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. $10.00; 545 pp. Definitions of terms pertaining to all fields of science are provided along with full coverage to the newer sciences of virology, ensymology, cytogenetics and radio-chemistry.

The following books may be obtained from the USAF Book Program, Office of Information Services, Washington, D. C.:

The Air Force Blue Book—Tom Compere and William P. Vogel, Jr. $4.95 hard cover edition, $1.00 paper-back edition. Reference guide to the USAF, the missions and operations of the various Air Force commands and subordinate units.



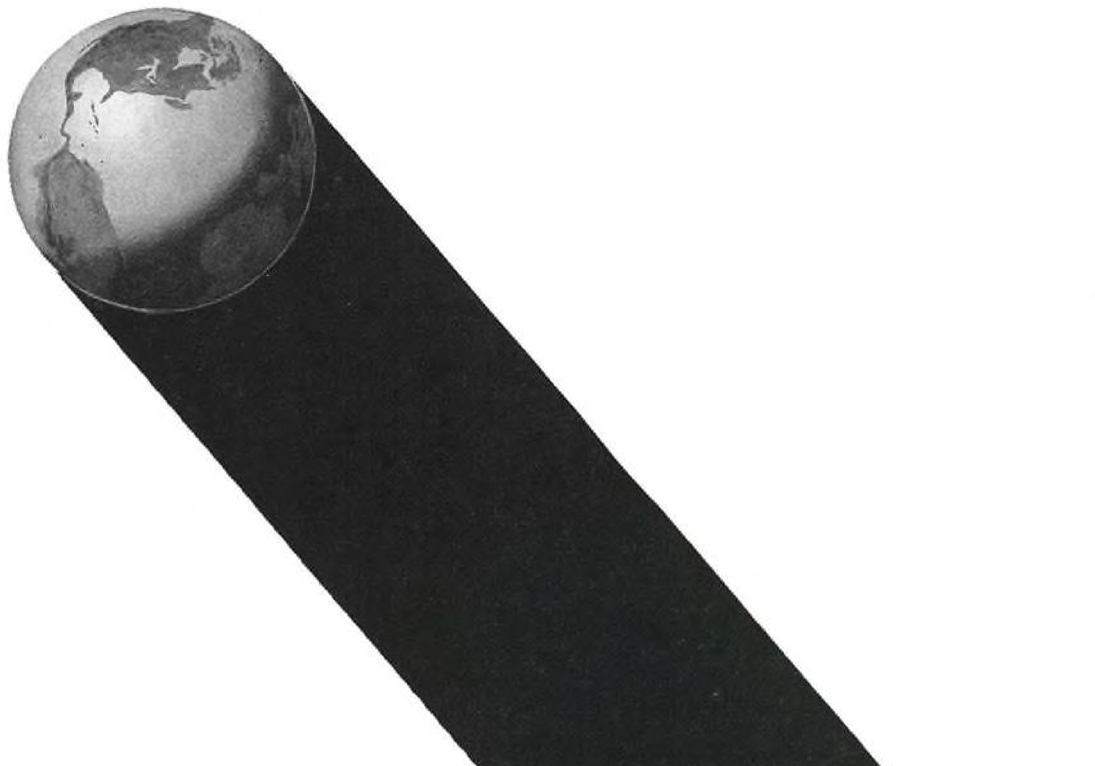
Convair 600 Forging Weighs 800 Lb.

Aluminum bulkhead forging for the Convair 600 jet transport undergoes ultrasonic inspection after closed-die forging at Wyman-Gordon, North Grafton, Mass. Two of the 12 ft., 800 lb. forgings, said to be the largest for a commercial aircraft, will form the main bulkhead of the Convair aircraft.

What Every Air Force Wife Should Know—by Ester Weir. $3.95. A reference guidebook on all aspects of Air Force life which are of concern to Air Force-wives in their activities.

Jet Navigator: Strategic Air Command—Rutherford Montgomery and Lt. Col. Grover Heiman, USAF. $2.75. A novel about jet navigator training and crew duty and the role of the naviga-

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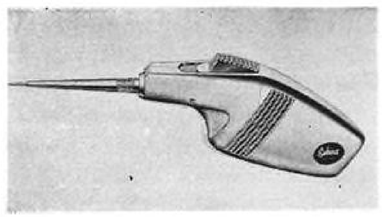
Optics
Light Transmission
Basic Phosphor Chemistry
Electroluminescent Panels
Insulating Materials
Human Factors Engineering
Thin Dielectric Formulation
Electrical Measurements and Evaluation

Graduate scientists and engineers with applicable backgrounds are invited to submit a resume to:

Mr. R. A. Martin, Supervisor
Professional Placement Staff
HUGHES RESEARCH AND DEVELOPMENT LABORATORIES
Culver City 79, California

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Solder Dispenser

Solder dispensing tool, for holding and feeding solder into deep chassis and other difficult-to-reach locations. Knurled knob is used to eject solder to required length. Tool is now available from International Electronic Research Corp., 145 Magnolia Blvd., Burbank, Calif.

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tor on combat-ready B-52 Strategic Air Command crew.

Man in Space: The USAF Program for Developing the Spacecraft Crew—Lt. Col. Kenneth F. Gantz, USAF. $4.00. Story of Air Force research, development and test in the fields of aerospace medicine and human factors. Air Force authorities analyze and discuss individual aspects of the Air Force program to prepare man for space flight.

Tiger in the Sky—Brig. Gen. Robert L. Scott, Jr., USAF (Ret.) A collection of air adventure stories based on the author's 30 years of flying in the USAF. $.35, paperback edition.

Reports Available:

The following reports were sponsored by the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.:

Catalog Lists All Reports of Battery Research — by the Army, Navy, Air Force, Atomic Energy Commission, other agencies of the U. S. Government and German documents captured during World War II. $10. (CTR-372 Batteries, 1953-58).

Navy Survey Provides Background Data for Use of BioElectronics in Human Engineering—by A. Ford of the U. S. Navy Electronics Laboratory. April, 1957. $2.75. (PB 151291).

Translated Russian Textbook on Aerodynamics—by I. V. Ostoslavskiy, professor at the Moscow Aviation Institute. Translated by the Technical Information Center, Wright Air Development Center, U. S. Air Force. Three volumes contain the translated version of 808 pp. Part 1—59-11993-1, $5.00; part 2—59-11993-2, $5.00; part 3—59-11993-3, $3.50.

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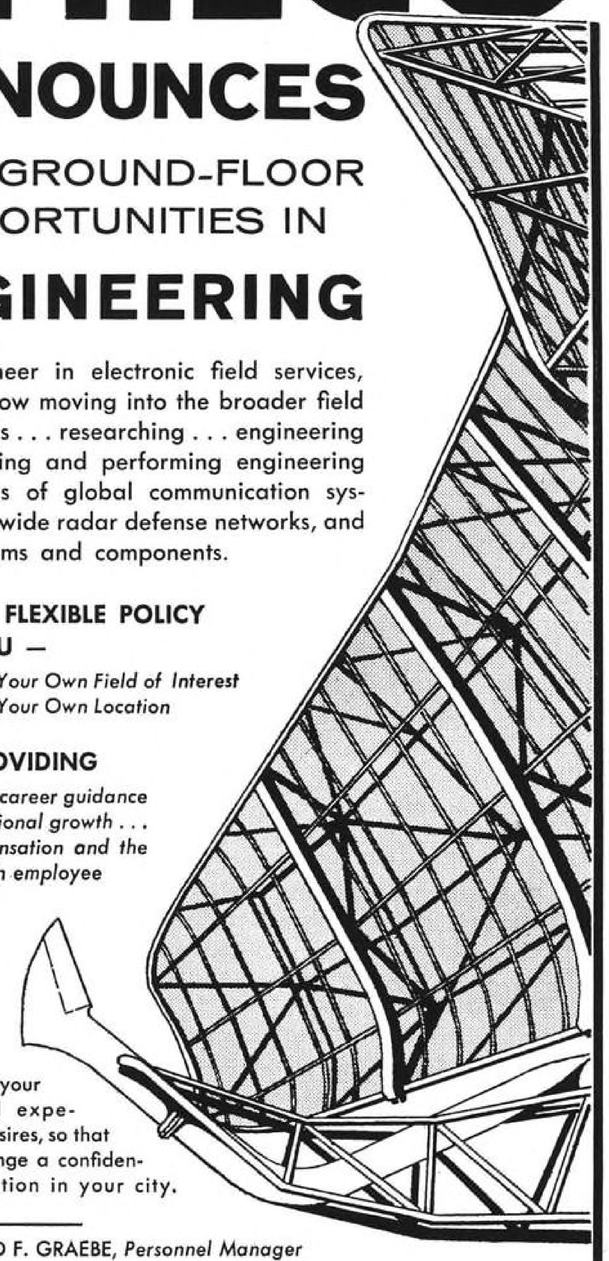
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P.S. Please Enclose Resume.

These R&D Projects for Future Decades in Space

typify Lockheed's vast program of Air/Space Science

■ New programs and study contracts awarded to Lockheed's California Division are planned to solve America's future exploration projects into space. The new multimillion-dollar Research Center in nearby San Gabriel mountains is further evidence of Lockheed's determination to support and supplement its already extensive research and development activities.

As a result of this markedly expanded program, there is urgent need for engineering and scientific personnel with high-level technical skills.

Long a leader in advancing the science of flight, Lockheed is placing vast resources and accumulated knowledge into programs designed to provide major break-throughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Some of these important research and development programs are:

High Altitude Flight Vehicles with speed ranges between Mach 8 to 25. Problems associated with landing **Manned Space Vehicles** capable of hypersonic glide or orbit about the earth. **Infrared System** studies as an advanced method of detecting ultrasonic missiles and high-speed aircraft. **Solar Radiation** studies. **Vertical Take-Off and Landing** and "air recovery" vehicles. **Helicopters. Supersonic Transports.**

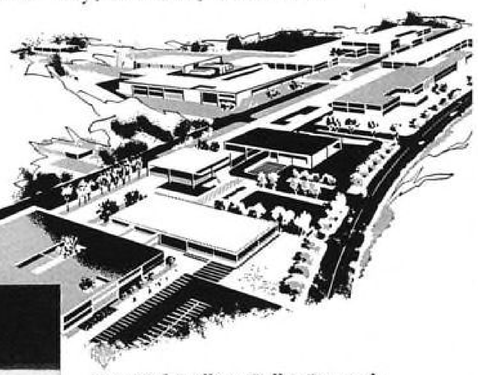
High caliber scientists and engineers are invited to investigate Lockheed's outstanding career opportunities. Openings now exist in: Aero-thermodynamics; propulsion; armament; electronics—research and systems; servomechanisms—flight controls; sound and vibration; operations research; physics; antenna and telemetry; and underwater sound propagation.

Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 11101, 2400 North Hollywood Way, Burbank, California.

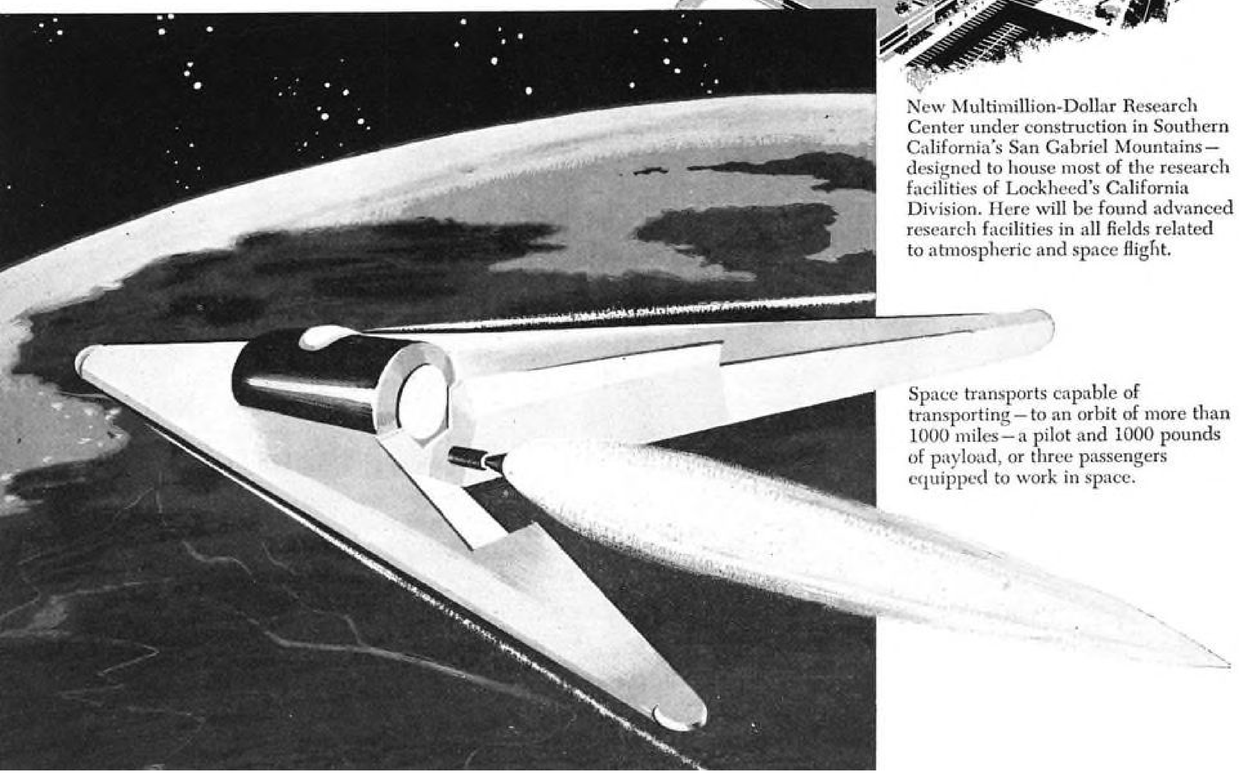
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New Multimillion-Dollar Research Center under construction in Southern California's San Gabriel Mountains—designed to house most of the research facilities of Lockheed's California Division. Here will be found advanced research facilities in all fields related to atmospheric and space flight.



Space transports capable of transporting—to an orbit of more than 1000 miles—a pilot and 1000 pounds of payload, or three passengers equipped to work in space.

SAFETY

CAB Accident Investigation Report:

EAL DC-7 Damaged After Hitting Localizer Shack on Final Approach

At 1657,[1] May 6, 1959, following routine preparations, Eastern Air Lines Flight 609 originated at Newark, N. J., as scheduled. Its destination was Jacksonville, Fla., with three intermediate stops, one of which was Washington, D. C. A flight crew of six, under the command of Capt. C. J. Smith, and 63 passengers were aboard the Douglas DC-7B, N824D.

Capt. Smith, in the left seat, flew the entire flight segment to Washington. The flight operated at 10,000 ft. in clear weather and in accordance with an IFR (Instrument Flight Rules) flight plan and clearance. Approaching Washington, the flight was assisted by radar vectoring and was advised that Georgetown approaches were in effect for landing on Runway 18. The weather conditions at the airport were also clear and the reported surface wind was south at five knots. The speed brake was used to facilitate descent and before reaching the Georgetown beacon the before-landing checklist was completed.

Flaps Extended

Capt. Smith said that he followed the Potomac River to the right turn for the final approach. The turn was made about 500 ft. above the river at 120 kt. and with approach flap extended. Following the turn, runway alignment was established and landing flap was extended.

Capt. Smith said that approaching the shoreline of the river at approximately 115-120 kt. indicated airspeed the copilot said, "Snuffy, it looks a little low." Recognizing this, and seeing the ILS (Instrument Landing System) localizer shack just ahead, Capt. Smith applied nose-up control pressure. Almost simultaneously the main gear tore through the shack. Capt. Smith said he felt the impact and as the right side of the aircraft settled he held it off as long as possible. When airspeed dissipated the aircraft settled and slid to a stop. The occupants then left the aircraft quickly and in an orderly manner.

The localizer shack is located on the extended runway centerline about 175 ft. from the runway threshold. Its roof is about 10 ft. above the ground and runway elevation.

The shack houses the localizer antenna and its location is necessary to the efficient function of this portion of the ILS.

The main gear tore through the roof of the shack about eight feet above the ground and then contacted the ground about 80 ft. short of the runway. The aircraft then skipped, touching the runway 105 ft. past the threshold. At this location the right main gear was already badly damaged as shown by castering tire marks on the runway.

Shortly thereafter the right wheel assembly and strut piston came off and bounced to the right side of the runway. About 1,600 ft. from the runway threshold the right side of the aircraft settled on the strut cylinder and collar which formed a "ski-like" platform. The aircraft gradually veered off the runway to the right, slid across a grass area onto taxiway 2-2A, and stopped on the taxiway about 3,400 ft. from the threshold. During the final 250 ft. the right strut collapsed.

At the time of this accident Capt. Smith had flown nearly 14,000 accident-free hours, of which about 1,000 were in the DC-7B. He had been employed by Eastern Air Lines since 1942 and was captain for the past 14 years. His training record was entirely satisfactory and he was currently certificated for his position according to regulatory requirements. His latest physical examination, including one shortly after the accident, showed he was in good condition and his eyes were normal in every respect. He was off duty 50 hr. before the flight.

Capt. Smith stated that he intended to land on the first portion of the runway and had misjudged the altitude of the aircraft during the last portion of the final approach. He said he knew the aircraft was low but felt it would adequately clear the localizer shack which he saw ahead. Capt. Smith indicated that weather, traffic, and operation of the aircraft were not factors. He said there were no extenuating circumstances and the investigation found none.

ANALYSIS AND CONCLUSION

Examination of the right gear conclusively showed that the damage to it was the direct result of the inflight contact with the ILS localizer shack and subsequent landing on the damaged gear. All other damage to the aircraft such as to the flaps, right wing and stabilizer surfaces, and propeller blades was the result of the wheel assembly separation and final collapse of the remaining portion of the strut assembly.

It is the Board's analysis and conclusion that Capt. Smith misjudged the altitude of the aircraft just prior to a landing which was intended on the first portion of the runway. It is believed that his misconception of altitude was the result of a lack of attention and concentration necessary to produce the most accurate sensory responses required during the phase of flight just before landing.

As corrective measures the Board has recommended that the company periodically reemphasize to its pilots that the highest degree of concentration is necessary to produce the most accurate sensory responses; also,

[1]All times herein are Eastern Standard based on the 24-hr. clock.

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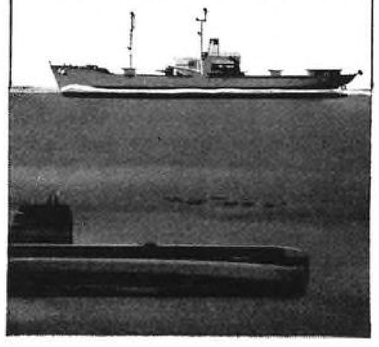
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To help meet the urgent and continuing problems of national security, RCA has created an *Advanced Military Systems Department* at Princeton, New Jersey. There, in an atmosphere of complete intellectual freedom, men of a very special kind are engaged in the analysis and study of our national defenses—present and future—and how they can be made most effective to meet any future enemy capability.

THE MEN—The men who form the technical staff are a group of mature scientists and engineers. They are accustomed to responsible positions in industrial research, advanced development, or systems planning. Most of them have an extensive background in the broad fields of electronics, vehicle dynamics (space, marine or terrestrial), physics (astro, nuclear, or plasma), or operations research (military science). All are temperamentally suited for performing highly sophisticated, comprehensive analysis and planning. They are men who enjoy seeing the fruits of their work create a far-reaching effect on the defenses of the country.

THE WORK—Studies by this group are of the broadest scope and cover such diverse areas as physical and engineering sciences, military science, economics and geophysics. Accordingly, each member of the technical staff operates either independently or as a consultant in interdisciplinary groups. He is generally free to select his own area of work, but results must have a direct application to problems of national defense.

As a staff member, he is provided with every opportunity, facility and detail of environment to use creative and analytical skills to maximum advantage and at the highest level. He has no responsibility for administrative details. He can call in any specialists he may need. He has full access to all available information—military, academic and industrial. Furthermore, specialized research projects and laboratory work can be carried out at his request by other departments of RCA.

THE LOCATION—Princeton offers unique civic, cultural and educational advantages. The RCA Advanced Military Systems Department itself occupies a new, air-conditioned building on the quiet, spacious grounds of RCA's David Sarnoff Research Center. Working in individual, well-furnished offices, staff members find their associates and surroundings highly conducive to creative activity, and the community ideal for gracious living in a university atmosphere.

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that it caution its operational personnel against apathy which can occur unconsciously from an ideal and nonstimulating flight environment.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the captain's misjudgment of altitude during final approach.

By the Civil Aeronautics Board:

JAMES R. DURFEE
CHAN GURNEY
HARMAR D. DENNY
G. JOSEPH MINETTI
LOUIS J. HECTOR

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident shortly after it occurred. An investigation was made in accordance with the provisions of Section 701 (a) (2) of the Federal Aviation Act of 1958 and the Board's regular investigation procedures.

Eastern Air Lines, Inc., is a Delaware corporation with corporate offices in New York City. The air carrier is engaged in the transportation of persons, property, and mail by virtue of current certificate of public convenience and necessity issued by the Civil Aeronautics Board. It possesses an air carrier operating certificate issued by the Federal Aviation Agency for various routes including the one involved.

Capt. C. J. Smith, age 44, was employed by Eastern Air Lines Mar. 16, 1942, and was promoted to captain Sept. 20, 1945. He had flown 13,972 hr., exclusive of military time, and about 1,000 hr. in the DC-7. He held a currently valid airman certificate with airline transport, Martin 202/404, and Douglas DC-3, 4, 6, and 7 ratings. He had satisfactory physical examinations prior to the accident and immediately after it.

Pilot R. W. Sidletski, age 32, was employed by the company on May 2, 1955. He had flown 6,603 hr., exclusive of military time, and 779 hr. in the equipment involved. The pilot was currently certificated and trained for his flight crew position.

Flight Engineer R. H. Headland, age 36, was employed by Eastern Air Lines Dec. 7, 1953. He had flown 5,366 hr., of which 1,415 were in DC-7B equipment. The flight engineer was currently certificated and trained for his flight crew position.

Flight Attendants Victor Quinones, Rosemary McBorley, and Sally Richard were currently qualified for their positions.

Douglas DC-7B, N824D, at the time of the accident had accumulated 4,938 hr. since new. It was equipped with Curtiss-Wright engines and Hamilton Standard propellers.

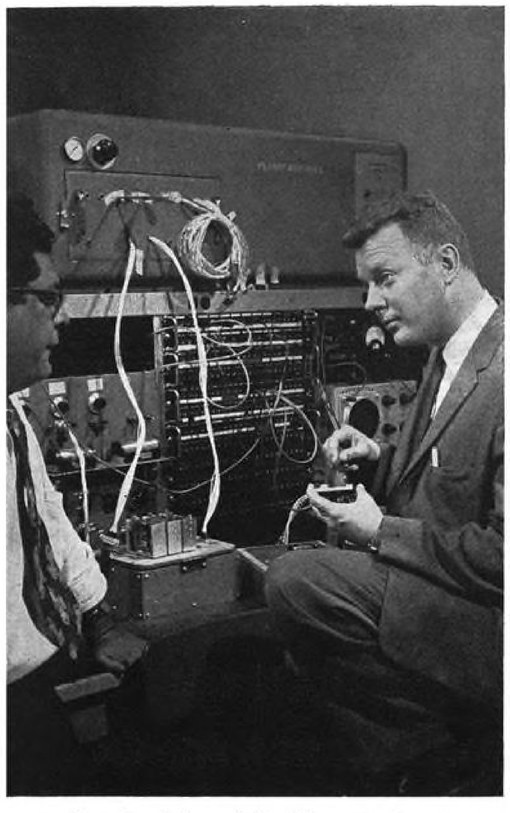
Air Force Establishes NAFEC Field Office

Atlantic City, N. J.—U. S. Air Force has established a field office at the Federal Aviation Agency's National Aviation Facilities Experimental Center here.

The office, headed by Maj. R. L. Arnsdorf, will work with NAFEC in the development of a common system of air traffic control, navigation and landings, as the mission pertains to Air Force requirements.

FLIGHT CONTROLS

Expanding the Frontiers of Space Technology



Transistorizing missile flight control systems by Lockheed scientists has meant significant reductions in weight and space requirements.

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Flight controls programs include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment, and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

In the flight controls simulation laboratory, mathematical representations of elements in a control system are replaced one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems designs.

Lockheed Missiles and Space Division is systems manager for such major, long-term projects as the Navy POLARIS FBM; DISCOVERER, SENTRY and MIDAS; Army KINGFISHER; Air Force Q-5 and X-7; and other important research and development programs.

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One of Lockheed's test stands with dynamic thrust mount to simulate flight environment.

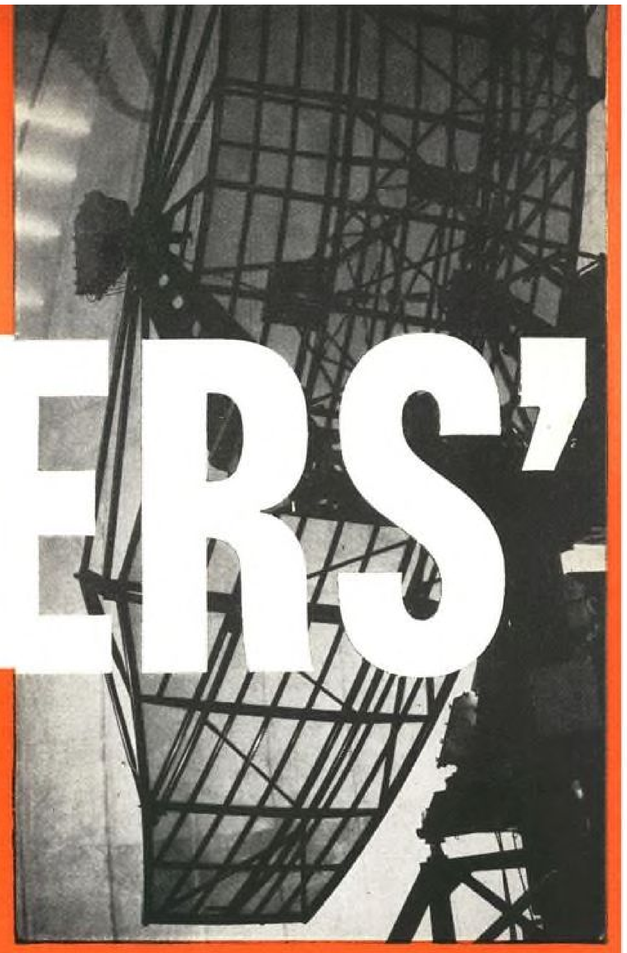
Lockheed / **MISSILES AND SPACE DIVISION**

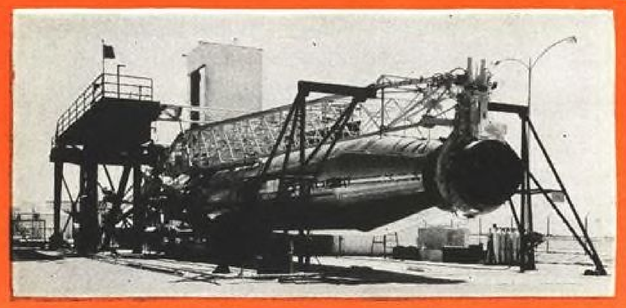
Systems Manager for Navy POLARIS FBM; DISCOVERER, SENTRY and MIDAS; Army KINGFISHER; Air Force Q-5 and X-7.

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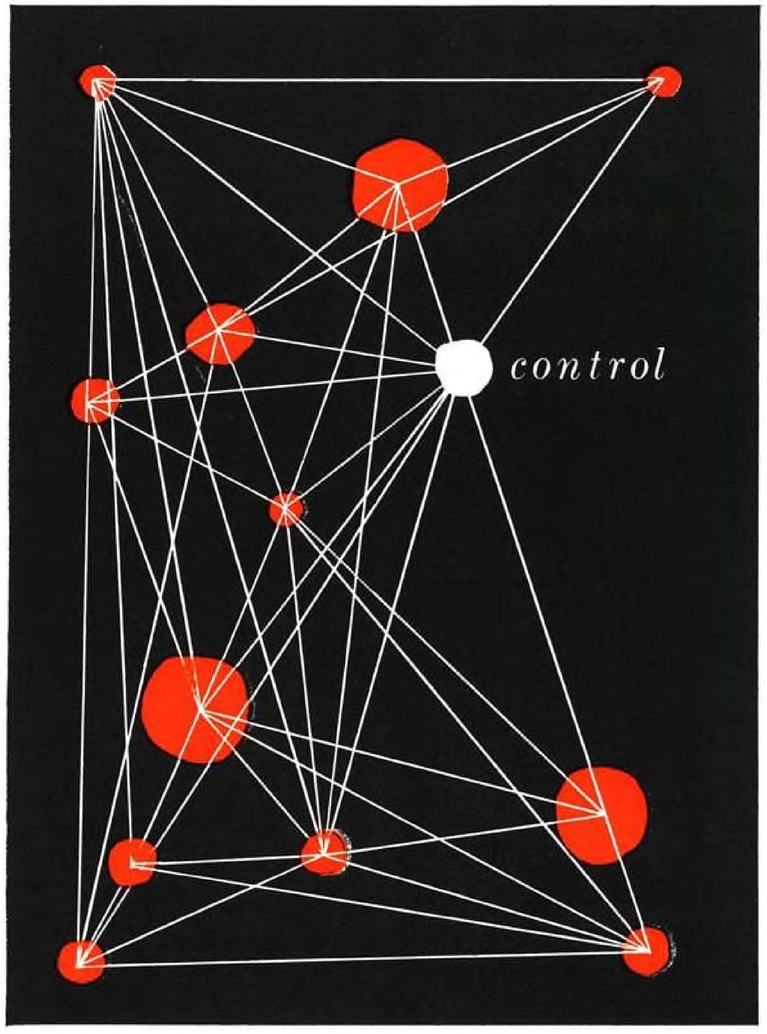
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WHO'S WHERE

(*Continued from page 23*)

Changes

John W. Rane, Jr., director of military relations, Ryan Aeronautical Co., San Diego.

J. R. McGowen, director of commercial sales, Douglas Aircraft Co., Santa Monica, Calif., succeeding **Nat Paschall**, resigned. Mr. Paschall will continue as a consultant and a board member.

L. M. Limbach, corporate director of manufacturing, Aerojet-General Corp., Azusa, Calif.

John H. Baker, manager-marketing operation, Special Programs Section, Defense Systems Department, General Electric Co., Philadelphia, Pa.

Dr. Lewis Larmore, chief scientist, California Division, Lockheed Aircraft Corp., Burbank, Calif.

Robert S. Turner, head of flight testing, The Martin Co.'s Baltimore, Md., Division, succeeding **George A. Rodney**, now manager of Test Complex, Martin's Denver, Colo., Division.

Bertram A. C. Udovin, manager, DuMont Point Mugu Facilities, Pacific Missile Range, Military Electronic Operations, Allen B. DuMont Laboratories, Inc., Clifton, N. J. Also: **Robert F. Feland, Jr.**, assistant division manager, West Coast Division, Military Electronic Operations.

Harold G. Learned, Jr., assistant manager-aircraft bearing sales, Fafnir Bearing Co., New Britain, Conn.

Louis J. Sculley, manager, Central Sales Division (Dayton, Ohio), Cook Electric Co., Chicago, Ill., and also in charge of the Dayton branch of Inland Testing Laboratories.

James C. Callaghan, manager, Organization Planning Department-Administrative Staff, Aeronutronic, a division of Ford Motor Co., Newport Beach, Calif. Also: **William L. Vandal**, manager, Central Environmental Test; **Dr. Barlane R. Eichbaum**, manager, Magnetic Technique Department, Computer Operations.

Paul E. Ritt, manager of the newly formed Physical Sciences Laboratory, Melpar, Inc., Falls Church, Va., a subsidiary of Westinghouse Air Brake Co.

William H. Knowles, sales manager, Defense Division, The Budd Co., Philadelphia, Pa.

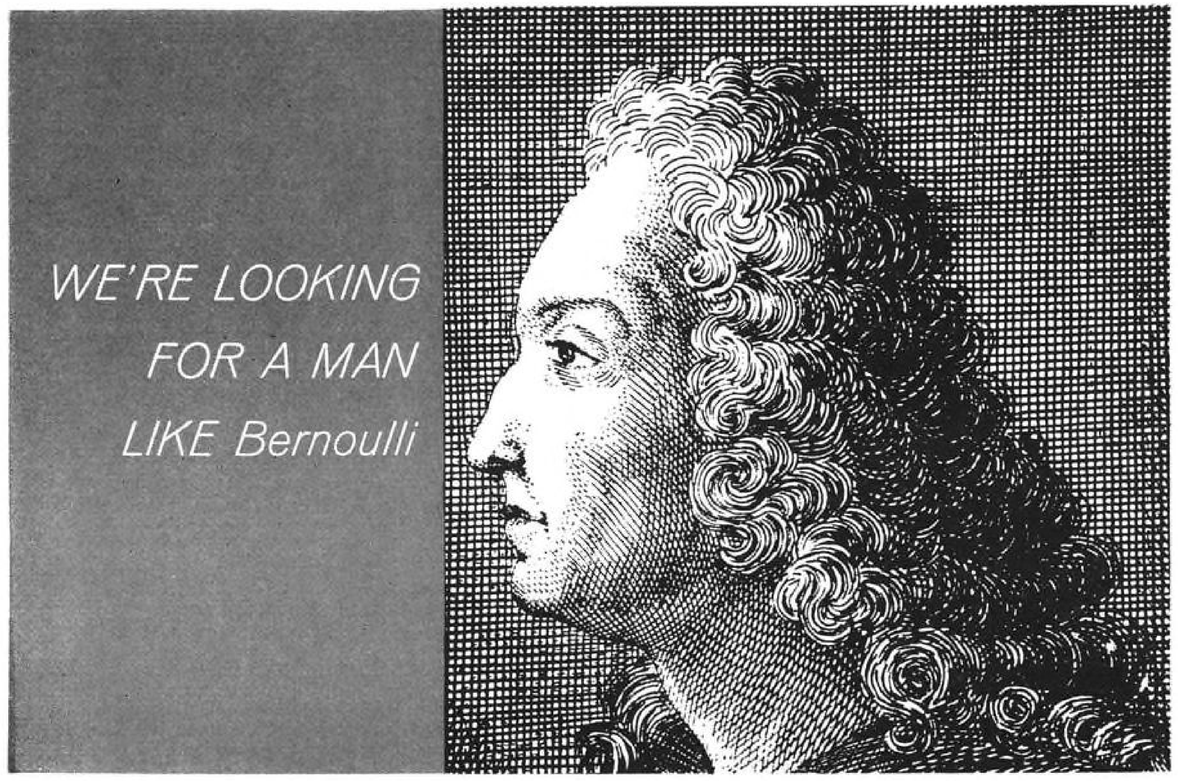
V. F. Knutzen, manager, and **V. J. McCrohan**, assistant manager, program financial controls, Aero-Space Division of Boeing Airplane Co., Seattle, Wash. Also: **Martin L. Schuehle**, manager, and **V. A. Dornes**, assistant manager, the Aero-Space Division's newly organized Manufacturing Research Section.

Col. Louis L. Frank (USMC, ret.), manager of electronic countermeasures programs, Sanders Associates, Inc., Nashua, N. H. Also: **Kenneth Dollinger**, project manager-Target Seeker development for the Eagle missile program.

Leonard K. Schwartz, executive director-special projects, Kaiser Industries Corp., Oakland, Calif.

Irving Stokes, chief engineer, Space Electronics Corp., Glendale, Calif.

Milton V. Ratynski, director of engineering, Craig Systems, Inc., Lawrence, Mass.



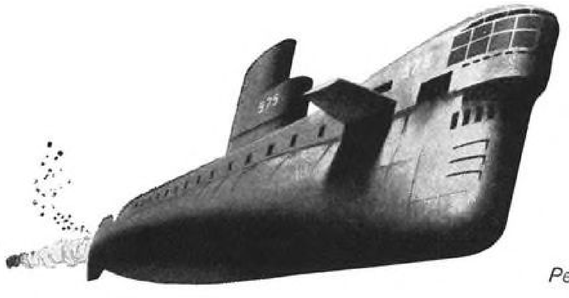
$P_a v_1 + h_a d_a v_1 g + \frac{1}{2} d_a v_1 V_a^2 = P_b v_1 + h_b d_b v_1 g + \frac{1}{2} d_b v_1 V_b^2$

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P-2714, Aviation Week
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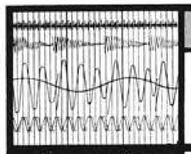
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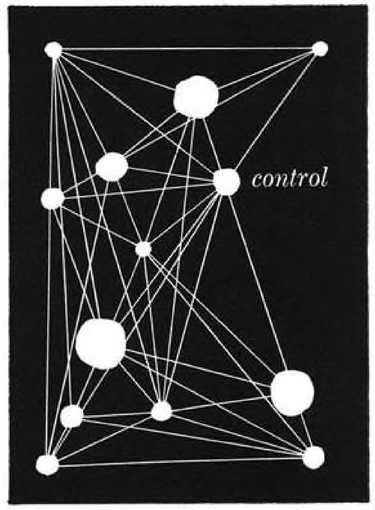
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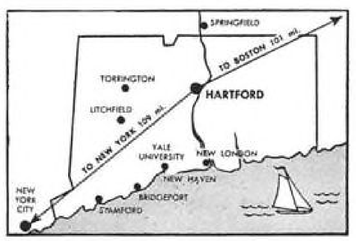
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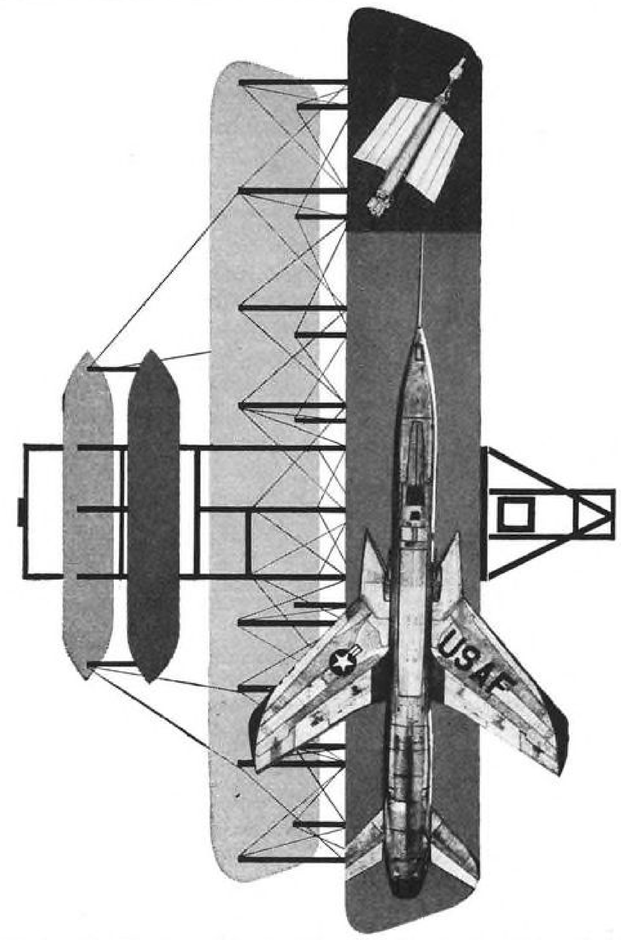
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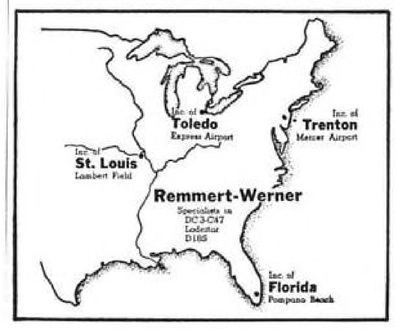
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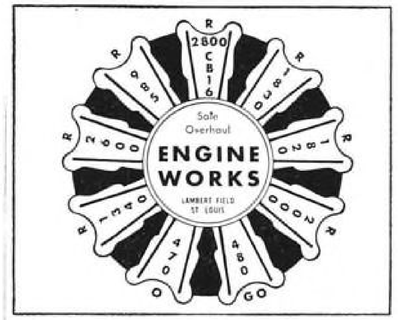
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LETTERS

Important Measure

Congratulations for your fine editorial of Sept. 14 ("Growing Pressure for Real Unification"). Don't give up the struggle; go ahead and strike while the iron is hot. The battle for the unification of our military services will be a hard one, but I am sure that every American will back up such an important measure.

J. Hochu
Boeing Airplane Co.
Seattle, Wash.

The Seven Days Of Farnborough

On the first day of Farnb'rough
I really hoped there'd be
Something new from the S.B.A.C.

On the second day of Farnb'rough
All there seemed to be
Were two purple Doves
Nothing new from the S.B.A.C.

On the third day of Farnb'rough
All there seemed to be
Were three Yes Men,
Two purple Doves
Nothing new from the S.B.A.C.

On the fourth day of Farnb'rough
All there seemed to be
Were four Whirlybirds,
Three Yes Men,
Two purple Doves
Nothing new from the S.B.A.C.

On the fifth day of Farnb'rough
All there seemed to be
Were five cold Pimms,
Four Whirlybirds,
Three Yes Men
Two purple Doves
Nothing new from the S.B.A.C.

On the sixth day of Farnb'rough
All there seemed to be
Were six peasants paying,
Five cold Pimms,
Four Whirlybirds,
Three Yes Men,
Two purple Doves
Nothing new from the S.B.A.C.

On the seventh day of Farnb'rough
All there seemed to be
Were seven salesmen swanning,
Six peasants paying,
Five cold Pimms,
Four Whirlybirds,
Three Yes Men,
Two purple Doves

Nothing new from the S.B.A.C.

Claud and Pamela Powell

(In an editor's note appended to the Powell's letter, the editor of Flight magazine, a British aviation publication, noted that his journal's report on Farnborough discredited the sentiments expressed in the poem. Both authors are staunch supporters of the British aircraft industry.—Ed.)

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Operation Fishhook

I have always been amazed at the way Aviation Week gets not only the news ahead of everyone but the fact that you get photographs of actual tests before the people in charge of the tests are permitted to release them. I was shocked by your recent release showing the Polaris Test Missile recovery apparatus Fishhook (AW Aug. 17, p. 69). As engineer-in-charge of the development tests on its predecessor Skycatch (AW May 25, p. 69) and the development tests you show of Fishhook, I was pleased that you were so current but disappointed in your accuracy. In giving credit for the apparatus, which has saved our taxpayers many millions of dollars, you did not mention the Naval Air Engineering Facility, the government agency responsible for its successful operation. Lockheed and Westinghouse are excellent companies, but we were pushing the program as hard as they were. To cap the whole thing off, you misspelled Fishhook.

Forrest Knecht
Development Engineer
NAEF, Naval Air Material Center
Philadelphia, Pa.

(Fishhook pictures that "shocked" Engineer Knecht were cleared for public release by the Department of Defense security review section on June 13, 1959, and distributed by Lockheed's Missiles and Space Division on July 14.—Ed.)

In two recent issues of your magazine (May 25, p. 69 and Aug. 17, p. 69) you published photographs of two recovery systems for Polaris dummy missiles. I am a member of the engineering group at the Naval Air Engineering Facility, Philadelphia, involved with the design and development of both recovery systems. Some background information about this equipment might be of interest to your readers.

One phase of the development program for the Navy's Polaris submarine weapon system is to determine by test the effect of launching and hydrodynamic forces on the Polaris missile being developed by Lockheed. For this test, simulated test vehicles are used which are in all respect similar to the Polaris missile except for the omission of a propellant ingredient essential for combustion. It was anticipated that the test vehicle would suffer close to total destruction after fall-back impact. Because of this it was expected that the cost of the test would be very high and anticipated returns rather low, in spite of considerable telemetered information. In this type of development one good look is worth a thousand strain gage channels. The obvious necessity here of a recovery system was the mother of "Skycatch" and "Fishhook." "Skycatch" refers to the recovery system developed by the Naval Air Engineering Facility for the surface launching test site at San Francisco Naval Shipyard, and "Fishhook" was developed by the Naval Air Engineering Facility for the underwater launching test site at San Clemente Island.

The requirements for "Fishhook" are more stringent than for "Skycatch." For example, "Fishhook" must make a recovery without interfering with the underwater dynamics of the test vehicle and without applying forces which might overload the necesarily low strength test vehicle. The system devised for this job is basically a hydraulic ram engine, reeved 22:1 with 1,100 ft. of 1⅛ in. non-rotating steel cable. The mechanism is housed on a catamaran barge built by Long Beach Naval Shipyard. The barge also supports a boom 200 ft. high built by Pacific Bridge Corp. The steel cable runs from the nose of the test vehicle over a head sheave at the top of the boom, then through fairlead sheaves down to the engine house where it is anchored after being reeved through the engine.

When the test vehicle is ejected, the "Fishhook" cable is paid in by the main engine so as to duplicate very accurately the position-time history of the missile. As an indication of the degree of accuracy required, the cable stroke must not lead the vehicle at any time and must not lag the vehicle by more than 0.05 sec. at the point of maximum velocity. Furthermore, this accuracy must be maintained when moving a mechanism that has a mass of about 45,000 slugs. A programed pay-in control system triggered from the launcher powerplant is provided for this purpose. When the missile starts its descent, the "Fishhook" control changes its function from cable pay-in to snubbing action, and "Fishhook" brings the missile to a gentle stop in midair.

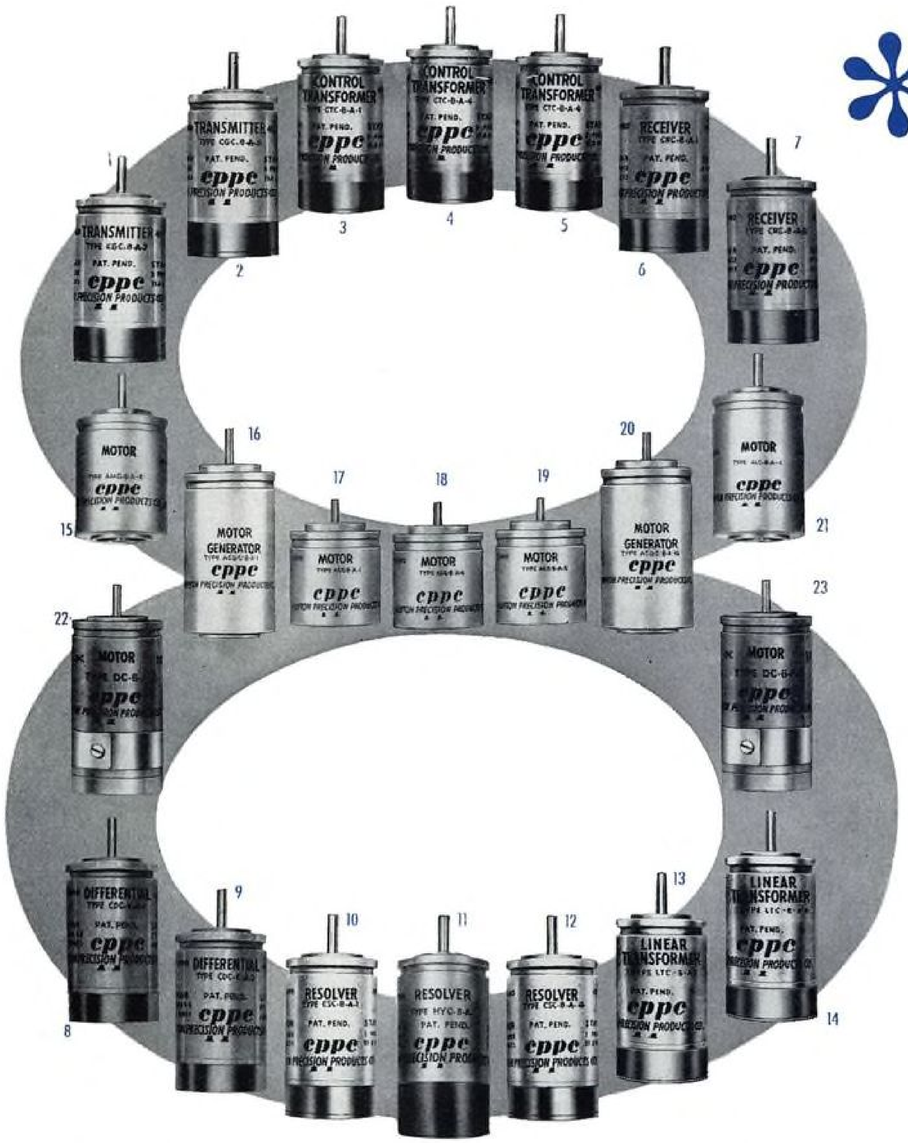
The maximum load applied during the arrestment stroke is only about one third greater than the missile weight. It would appear that this type of recovery equipment, which is saving so much money and time for the Navy's Polaris program, could find similar applications in other misisle projects.

Alvin R. Berger
Staff Engineer
Naval Air Engineering Facility
Philadelphia, Pa.

Two-Engine Landings

After reading about the recent 707 mishap (AW Aug. 24, p. 39 and p. 43), it occurred to me that two-engine-out landings could be performed safely and economically by "landing in the sky." Simply hire a skywriter to lay out the desired landing strip at some safe altitude, then simulate approaches and landings on it. The strip would most likely dissipate after each landing, but could easily be rebuilt after a short wait. If this worked, its value would be obvious: a means for practicing emergency landings without jeopardizing the crew or airplane.

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