Aviation Week and Space Technology

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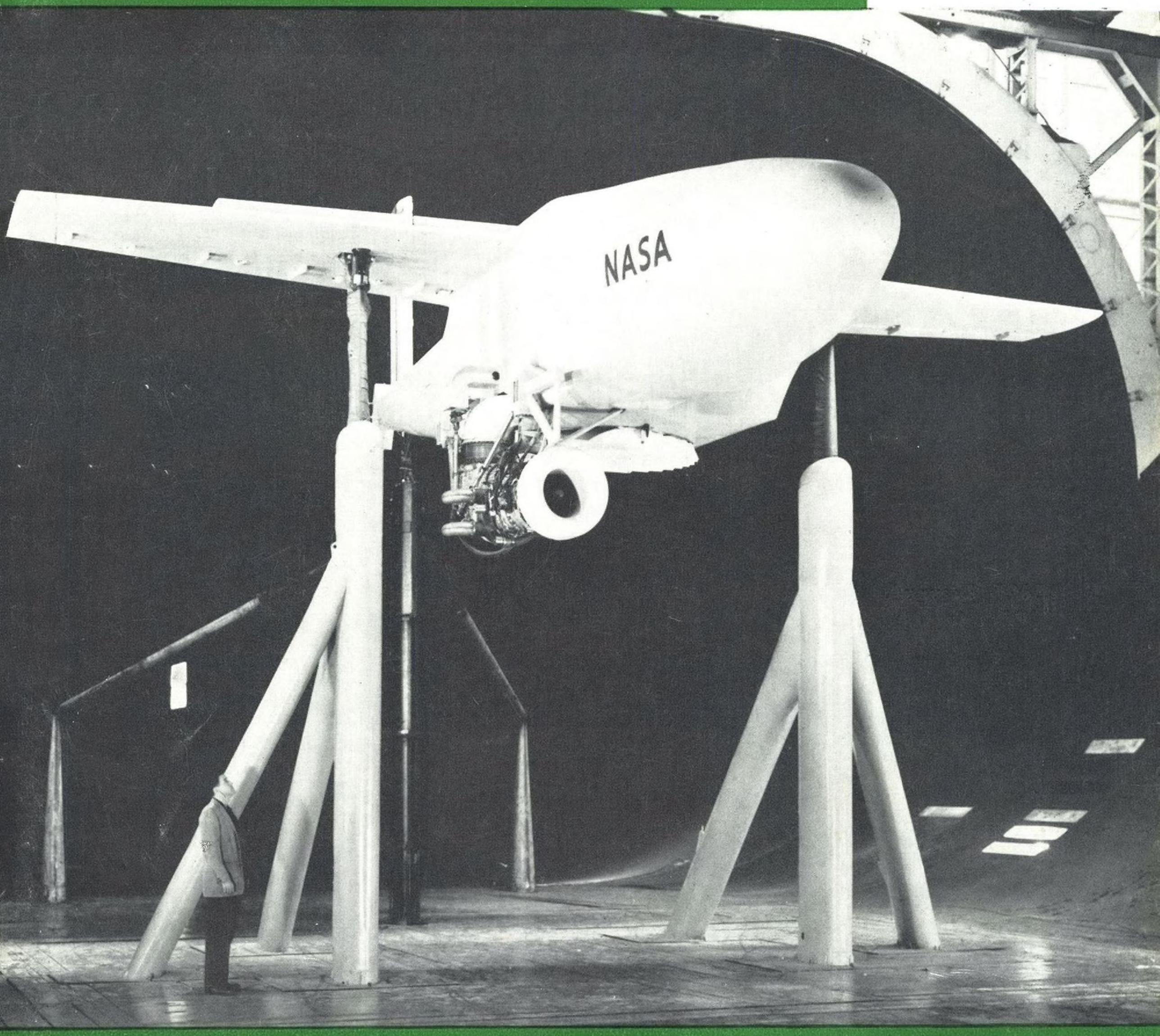
August 8, 1960

Avionic Industry Probes Nuclear Pulse Radiation

NASA Wind Tunnel Tests GE Lift-Fan



Lift-Fan Tests Show VTOL Potential

AVIATION CALENDAR

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

Aug. 16-18—Fourth Annual Tri-Service Conference on Biological Effects of Microwave Radiation, New York University Post-Graduate Medical School, NYU Medical Center, N.Y.C. Sponsor: Air Research and Development Command.

Aug. 18-19—Second International Symposium on Submarine and Space Medicine, Laboratory of Aviation and Naval Medicine, Karolinska Institute, Stockholm.

Aug. 18-19—Electronic Packaging Symposium, University of Colorado, Boulder.

Aug. 23-25—1960 Cryogenic Engineering Conference, University of Colorado.

Aug. 23-26—Western Electronic Show & Convention, Los Angeles Memorial Sports Arena, Los Angeles, Calif.

Aug. 28-Sept. 5—1960 National Air Rally, Municipal Airport, Orange, Mass. Sponsor: National Aeronautic Assn.

Sept. 1—Symposium on Rocket and Satellite Instrumentation, Society of Instrument Technology and British Interplanetary Society, London, England.

Sept. 4-5—Civilian, Closed-Course Airplane Races, Lakefront Airport, Cleveland.

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

Sept. 7-9—Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Mass. Sponsors: Instrument Society of America; American Society of Mechanical Engineers; American Institute of Electrical Engineers; Institute of Radio Engineers; American Institute of Chemical Engineers.

Sept. 8-9—1960 Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 8-10—1960 National Convention, OX-5 Club of America, Tower Hotel Courts, Dallas, Tex.

(Continued on page 6)

AVIATION WEEK and Space Technology

August 8, 1960
Vol. 73, No. 6

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AVIATION CALENDAR

(*Continued from page 5*)

Sept. 12-13—Sixth Annual Titanium Metallurgy Conference, New York University's College of Engineering, Bronx, N. Y.

Sept. 12-16—16th Annual General Meeting, IATA, Copenhagen, Denmark.

Sept. 12-16—Second International Congress, International Council of the Aeronautical Sciences, Zurich, Switzerland.

Sept. 14-16—Annual Meeting, National Assn. of State Aviation Officials, Wort Hotel, Jackson, Wyo.

Sept. 15-16—15th Annual Meeting, Armed Forces Chemical Assn., Sheraton-Park Hotel, Washington, D. C.

Sept. 15-16—Eighth Annual Engineering Management Conference, Morrison Hotel, Chicago, Ill.

Sept. 19-22—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, Shoreham Hotel, Washington, D. C.

Sept. 20-22—13th Annual Meeting & Forum, National Business Aircraft Assn., Ambassador Hotel, Los Angeles, Calif.

Sept. 21-25—National Convention and Aerospace Panorama, Air Force Assn., Civic Auditorium and Brooks Hall, San Francisco, Calif.

Sept. 24—Reunion, 1st Air Commando Group, concurrent with AFA Convention. Contact: Lt. Col. R. E. Moist, USAF, 7025 Havvenhurst Ave., Van Nuys, Calif.

Sept. 25-27—24th Annual Convention, International Northwest Aviation Council, Harrison Hot Springs, British Columbia.

Sept. 27-30—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica. Cosponsors: USAF; U. S. Army; U. S. Navy; NASA; AEC.

Oct. 2-10—Federation Aeronautique Internationale Annual Meeting, Barcelona.

Oct. 3-5—Sixth National Communications Symposium, Institute of Radio Engineers, Utica, N. Y.

Oct. 3-5—Seventh Annual Meeting, Institute of Radio Engineers' Professional Group on Nuclear Science, Gatlinburg, Tenn. Cosponsor: Oak Ridge National Laboratory.

Oct. 3-5—National Midwestern Conference on Air Logistics, Institute of the Aeronautical Sciences, Tulsa, Okla.

Oct. 3-5—First International Air Traffic Control Conference and Fifth Annual Meeting of the Air Traffic Control Assn., Sheraton-Palace Hotel, San Francisco.

Oct. 5-7—Briefing Session on Opportunities in Space-Age Technology, American Management Assn., Hotel Astor, New York, N. Y.

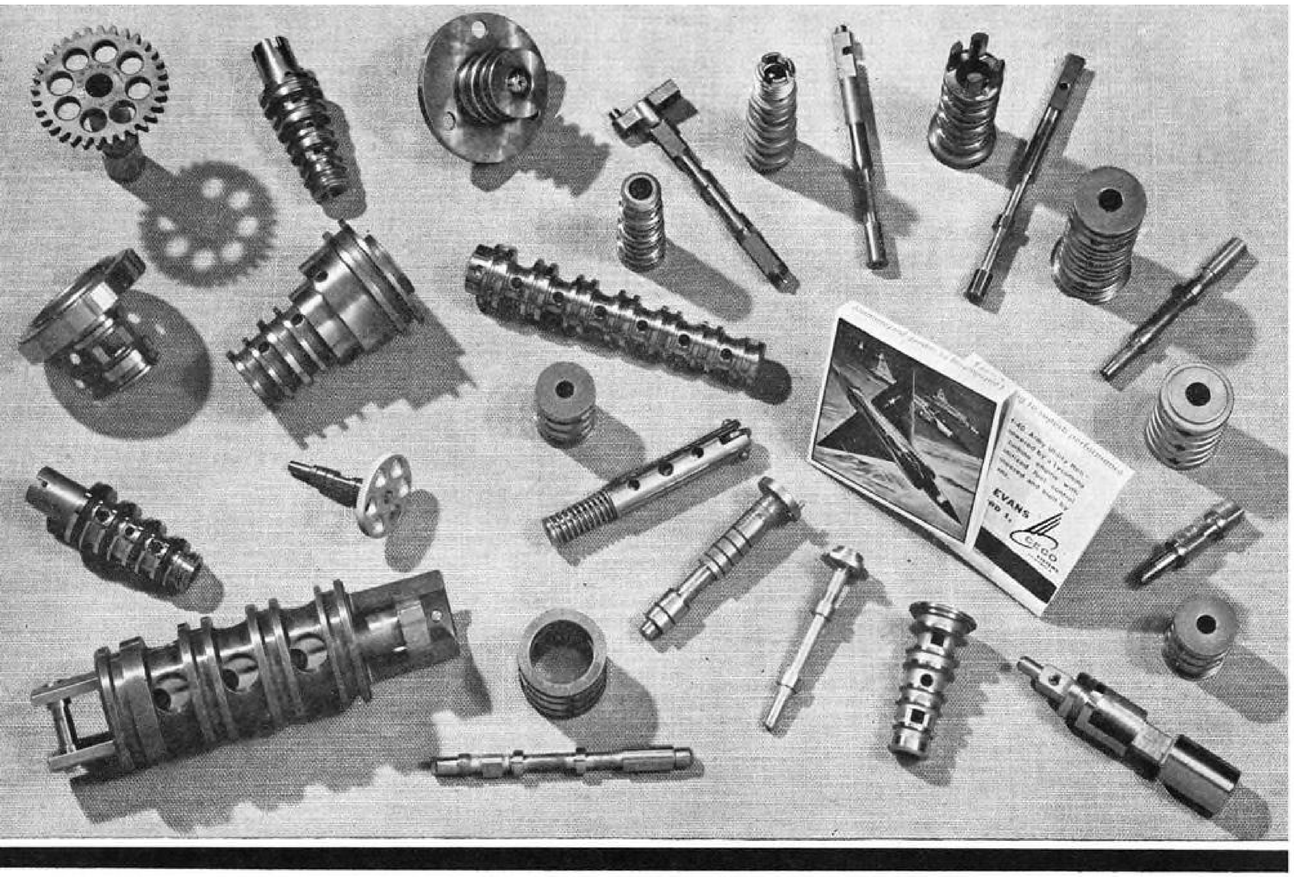
Oct. 6-8—Annual Convention, Airmail Pioneers, El Cortez Hotel, San Diego, Calif.

Oct. 6-9—Annual Meeting, National Pilots Assn., Western Hills Lodge, Wagoner, Okla.

Oct. 8—Third Annual National Aero Club Football Fly-in, Michigan vs. Duke, Ann Arbor, Mich.

Oct. 10-14—Society of Automotive Engineers National Aeronautic Meeting, Ambassador Hotel, Los Angeles, Calif.

Oct. 14-15—Symposium on High-Speed Processing, Society of Photographic Scientists & Engineers, Washington, D. C.



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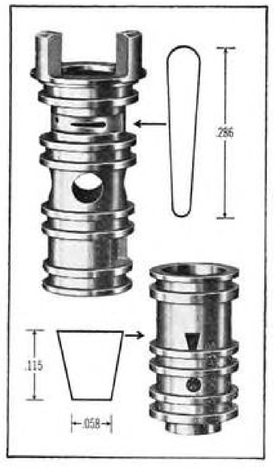

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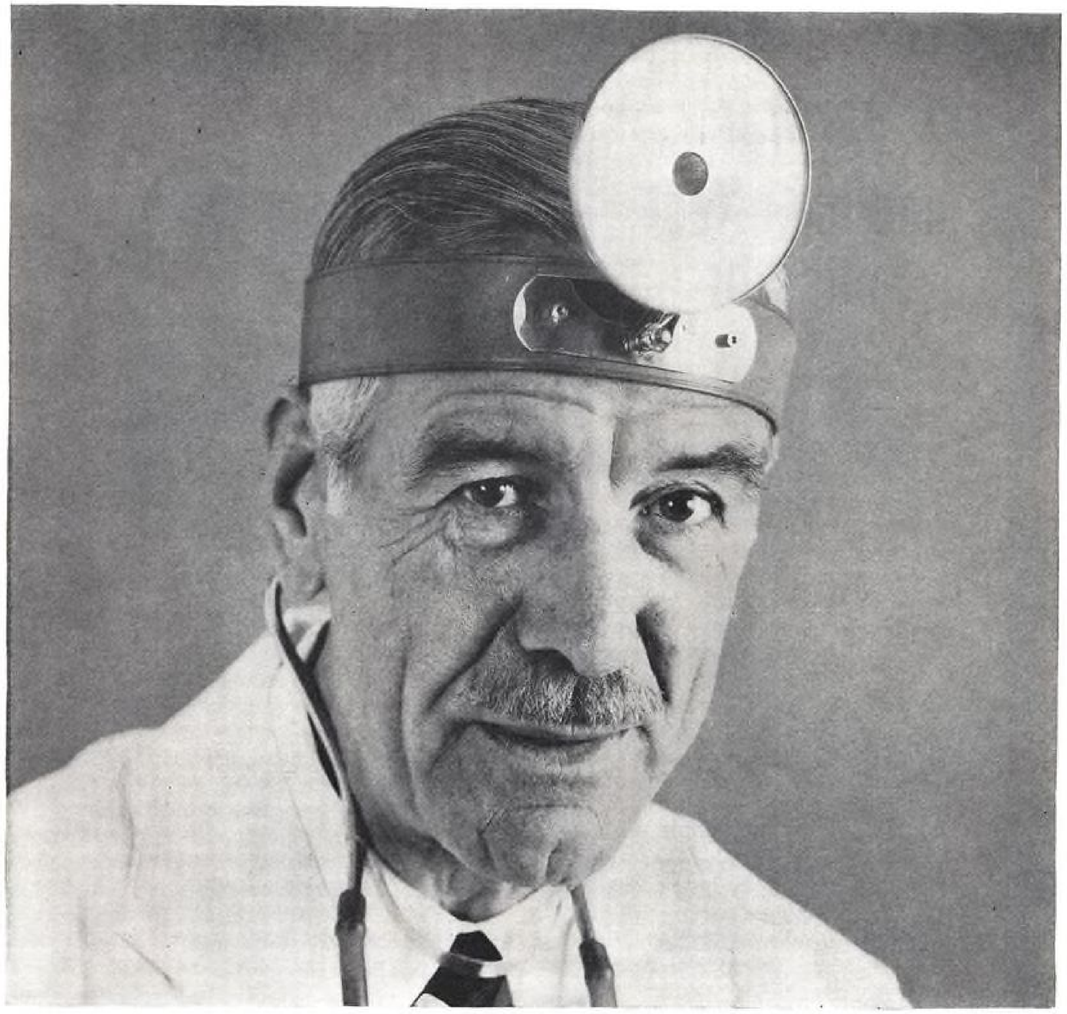

The Extreme Case of Shipmentitis

The most extreme case of Shipmentitis on record dates back to the General who lost the War because during the crucial Battle he couldn't locate the nail for his horse's shoe.

Today, Shipmentitis is a disease that afflicts many electronic component users. Its symptoms are occasional shipments arriving late, or in the wrong place, or incomplete, or with the wrong specifications. Some Companies have a slight case of Shipmentitis without realizing it. In serious cases, Shipmentitis can delay vital defense projects, cause expensive setbacks.

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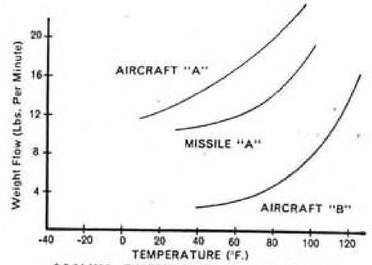

COOLING EFFECT DETECTOR SCHEDULES

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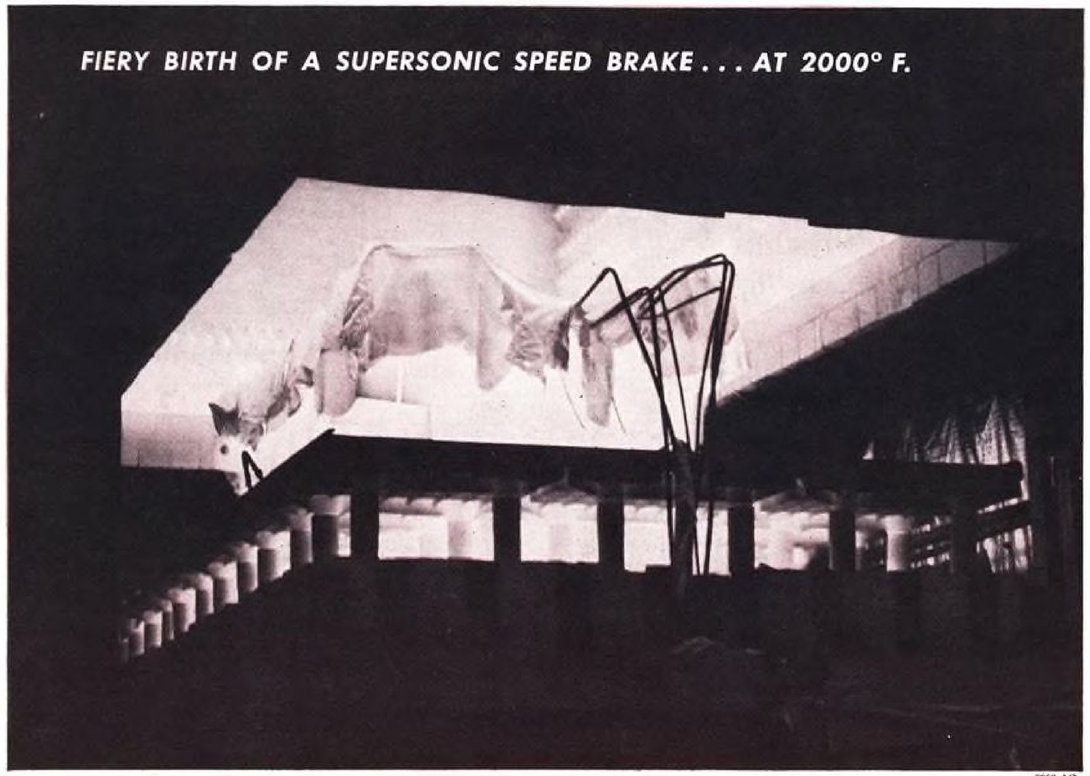

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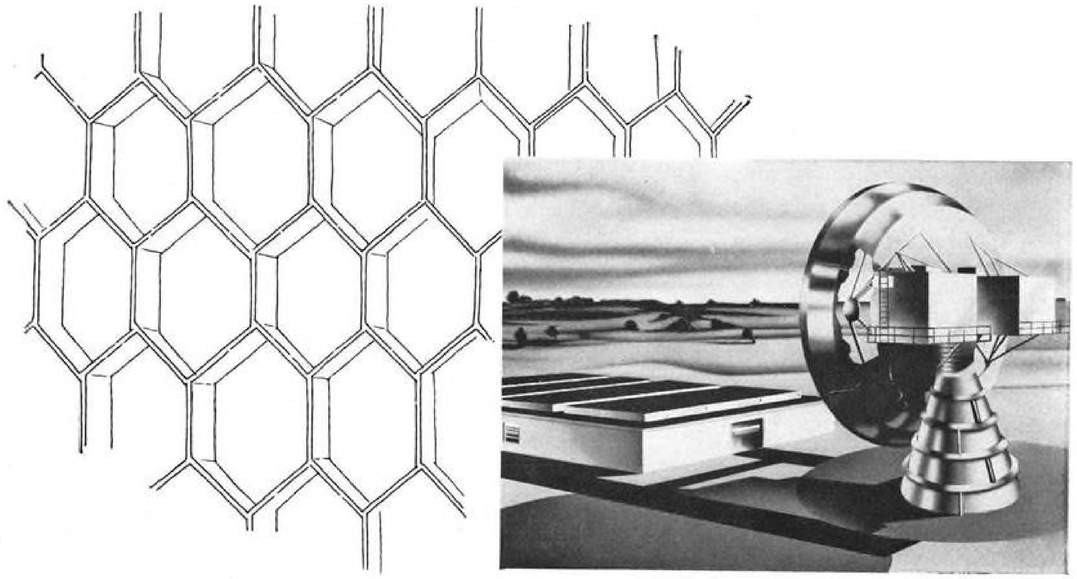
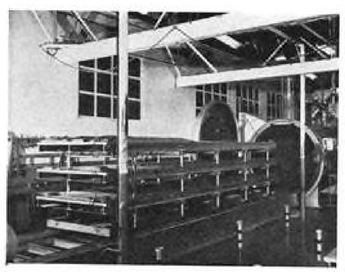
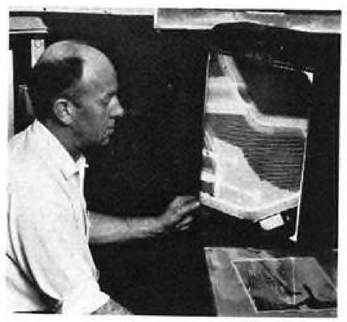


FAIRCHILD

for high-strength, low-weight honeycomb sandwich construction

Fairchild Aircraft & Missiles Division offers industry a unique capability in honeycomb sandwich design and construction. Typical of such competency in this field is a contract award to Fairchild by the Raytheon Company for the design and manufacture of a giant parabolic reflector for use in the five-story-high radar system designated as "Pineushion", a project sponsored by the Advanced Research Project Ageney, Department of Defense, for tracking and identification of intercontinental ballistic missiles. Fairchild





will also fabricate the 30x30x40 ft. room complex which houses more than 30 tons of electronic equipment. Due to the critical dynamics and stringent lightweight requirements, aircraft design and fabrication principles will be utilized.

The reflector, to weigh only 13,000 pounds, will be built of aluminum and its reflector surface will be made of honeycomb panel material which will require the extensive use of another Fairchild capability — bonding. The use of honeycomb paneling imparts rigidity, reduces weight and cost, and also simplifies tooling and replacement.

Raytheon officials state that Fairchild's ability to maintain the rigidity and tolerance requirements and to hold the total weight of the reflector to 13,000 pounds, represents a major technical break-through in the field of large antenna structural design.

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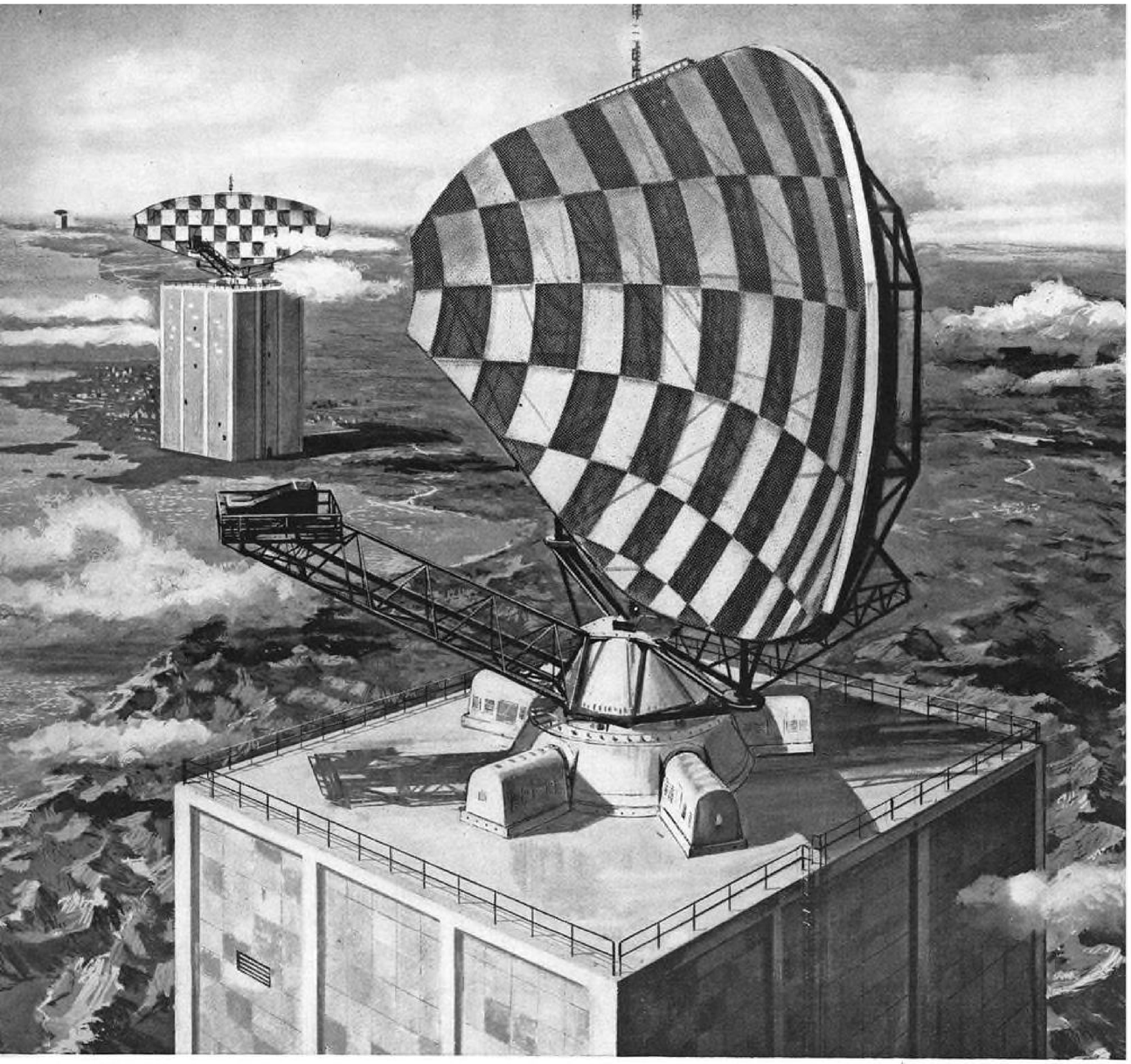

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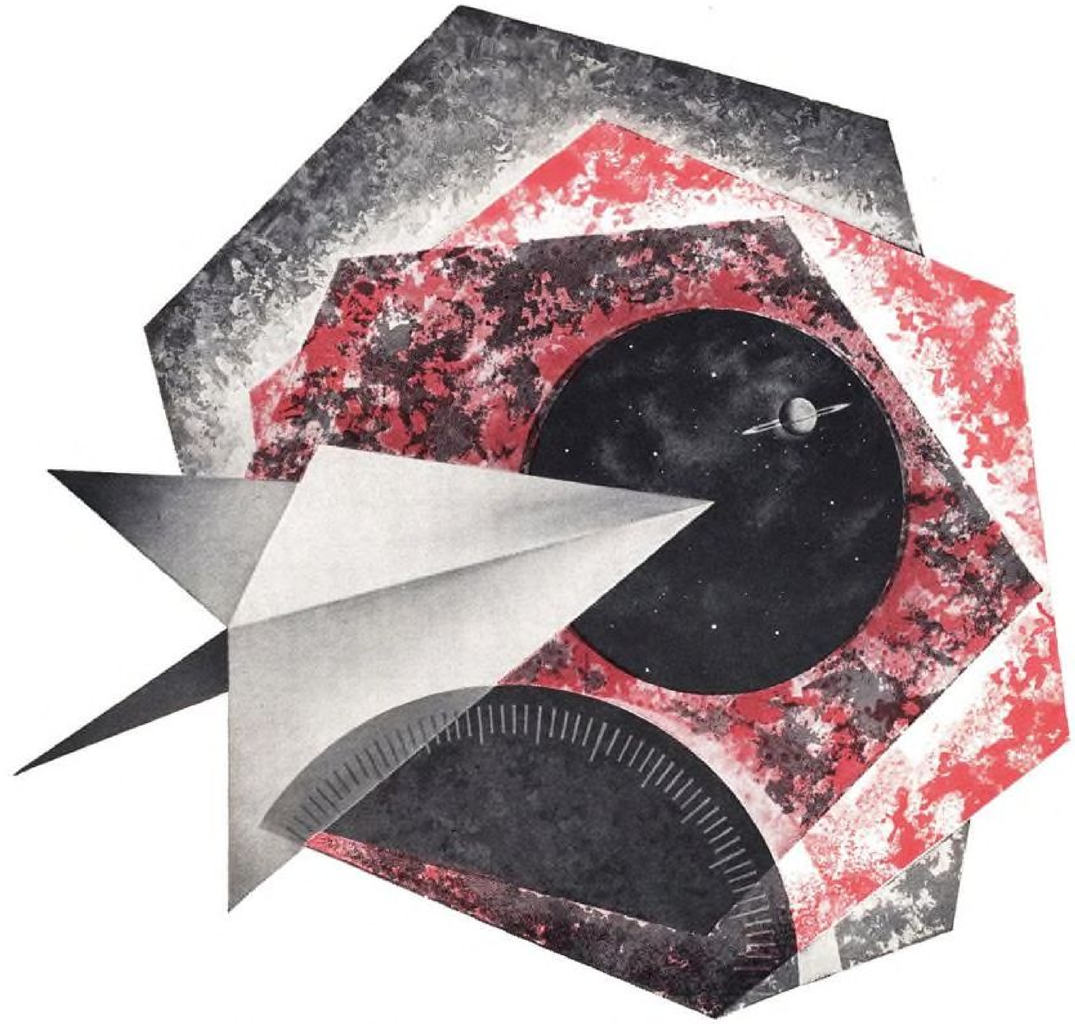

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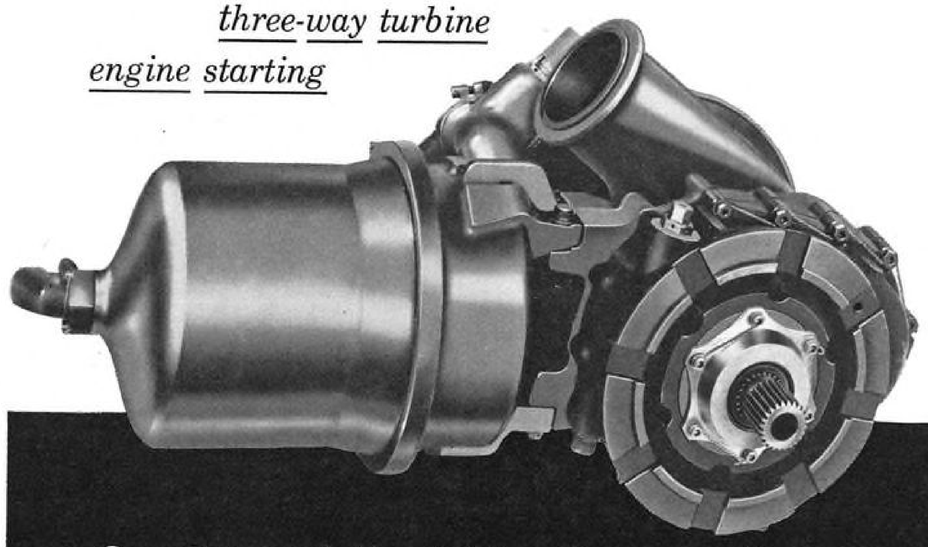
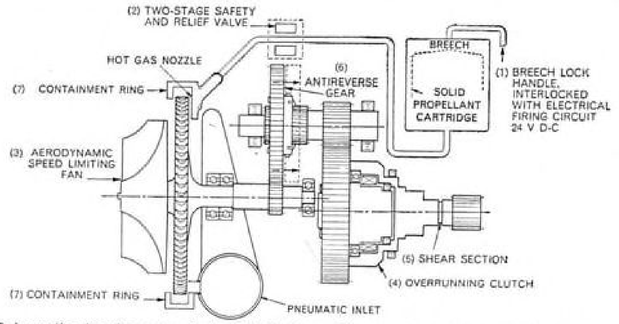


Sundstrand Cartridge-Pneumatic Starter



Schematic showing cascaded safety features. The two-stage safety and relief, (2) above, controls cartridge burn rate and assures consistent starting torques at all temperatures from -65° F to +160° F. The safety stage of the valve resets automatically.

Personnel and aircraft protection against destructive failure during starting and operation

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(5) Shear Section	•	•	•
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(7) Containment Ring	•	•	•
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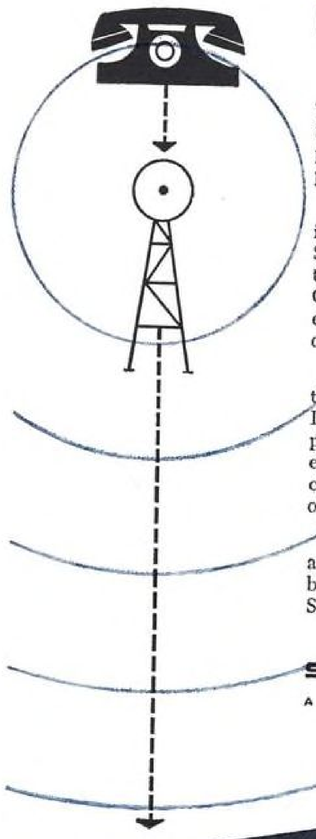

The U.S. Army Corps of Engineers is using Stromberg-Carlson—San Diego's new S-C 3000 High Speed Communications Printer to print 3000 words a minute from remote sources. The equipment can print out over great distances, using standard wire or radio links.

The S-C 3000 is compatible with most available data link systems, including the Collins Kineplex data transmission system and the Stromberg-Carlson Binary Data Link. Printing is accomplished through a unique combination of the Stromberg-Carlson CHARACTRON® shaped beam tube and Haloid Xerox, Inc's., electrostatic printing process. The S-C 3000 prints without impact on untreated paper or lithographic masters.

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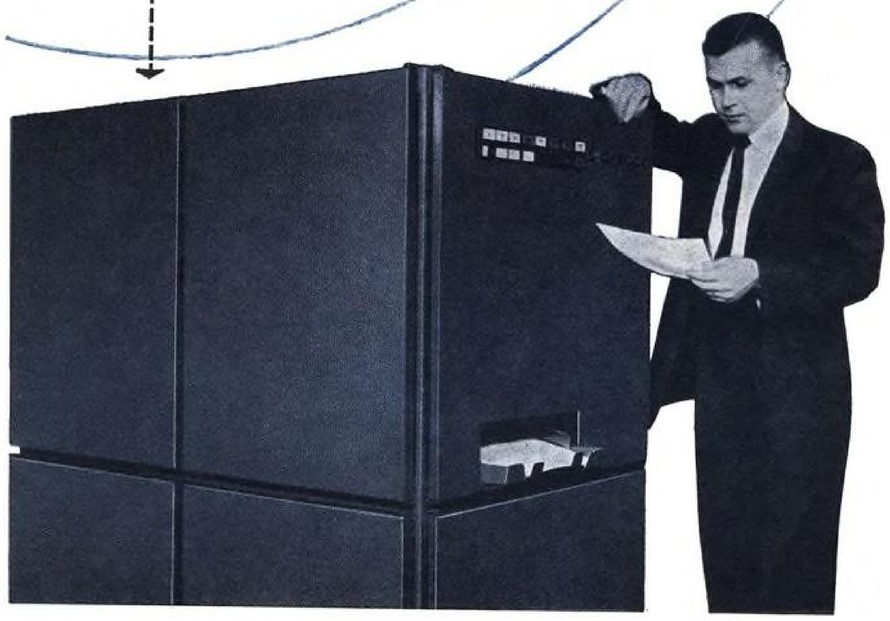

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COVER: First Army-General Electric lift-fan engine mounted in a generalized VTOL aircraft configuration has been tested for 20 hr. in the 40 x 80 ft. full scale tunnel at Ames Research Center of the National Aeronautics and Space Administration. Tests showed that transition from vertical to horizontal flight and back again could be made smoothly.

PICTURE CREDITS

Cover—NASA; 26, 27, 94 (top), 95—NASA; 30—Army-RCA; 31—USAF; 39—Atomic Energy Commission; 41—Aviation Week; 49—Sabena; 51—Sovfoto; 52—Canadair; 61, 67—Collins Radio; 76, 77—Standard Telephones and Cables, Ltd.; 77—U. S. Navy; 79—Corning Glass Works; 80, 81, 82, 83, 84—Rocketdyne; 86, 87—Boeing Airplane Co.; 89—USAF; 94 (bottom), 101—General Electric; 121—Dorado Beach Hotel.

83,431 copies of this issue printed

EDITORIAL

Global Television Program

Within several years, millions of people around the earth will witness the first live global television via communications satellites. Recognizing the powerful political and social influence that domestic television has already demonstrated, global television may well be the most significant peaceful application of space technology for at least the next several decades.

It is not hard to visualize the impact on peoples of the world of being able to watch on-the-spot deliberations of the United Nations, the U.S. Congress, the British Parliament or the Supreme Soviet in hours of crisis. A global television system would also enable a nation to actually show the fruits of its economic system and its culture to millions of people scattered around the globe.

If the United States acts boldly and imaginatively now, the first person to be seen and heard on television screens around the world could be an American President. Otherwise the master of ceremonies at the world's first global television show probably will be Nikita Khrushchev.

There has been a significant lack of official comment by Soviet officials as to their plans for communications satellites, but U.S. scientists who have had private conversations with Soviet space experts report keen interest in this subject and considerable evidence of work in this area. Soviet scientists indicate that they are centering their attention on synchronous (24-hr.) satellites in a 22,000 mi. high orbit, which are particularly suited to global coverage. They also speak of new types of passive reflectors which could be more effective than the metalized balloons that the National Aeronautics and Space Administration plans to launch.

Soviet Awareness

Because the Soviets have shown such a keen awareness of the value of impressing the world with Russia's technical achievements and of the impact of such accomplishments on international politics, it would be foolish for us to hope that they are overlooking these implications in a global television satellite system.

Within several years, the Pentagon's Project Advent may produce a communications satellite that could be used to demonstrate global television on a dramatic one-shot basis. But this satellite is being designed primarily for voice and teletype communications. First priority users will be the military.

Recently the American Telephone and Telegraph Co. (AT&T) disclosed preliminary plans for a commercial communications satellite system capable of providing both television and voice services. AT&T estimates it could put a global system of 50 satellites into orbit and 26 ground stations into operation for about $170 million. A more limited system using about 30 satellites to provide coverage between the U.S., Hawaii and western Europe would cost about $50 million, AT&T estimates.

Industry Activity

Many other companies, including the Astronautics Division of Convair, Space Technology Laboratories, International Telephone and Telegraph Corp., General Electric, RCA, Bendix and Space Electronics Corp., have been working on various technical approaches to a global satellite communications system.

It is apparent that the United States now possesses both the rocket boosters and electronic techniques to proceed swiftly toward the establishment of a commercial communications satellite system above and beyond the purely military requirements of the Pentagon programs. It is also apparent that it will be a long time before such a system could offer sufficient return on investment to be tackled by any individual corporation as a profitable private venture.

Unless some extraordinary effort is devoted to organizing a joint government-industry program in this area, another tremendous opportunity to demonstrate U.S. technical capability will pass by default. It is becoming more and more apparent in many areas of advanced technology, such as nuclear power, supersonic transports, and space technology, that private industry cannot shoulder the whole load of developing the initial useful systems. Nor does government have the technical or managerial resources to do this job properly. We strongly recommend that NASA and the corporations with technical capabilities in this field begin immediately to consider organizing a joint effort to enable the United States to score a truly significant first in space technology and to provide the world with a new communications system of enormous social significance. It is an effort well worth making.

Next week we will explore some of the methods by which it might be done.

—Robert Hotz

WHO'S WHERE

In the Front Office

C. Rhoades MacBride and **W. P. Gullander,** directors of General Dynamics Corp., New York, N. Y. Messrs. MacBride and Gullander are the executive vice presidents of the corporation.

Thomas G. Rutledge and **D. C. Fabiani,** directors of McDonnell Aircraft Corp., St. Louis, Mo. Mr. Rutledge is vice president, secretary and counsel of the company, and Mr. Fabiani, vice president-finance.

Roy L. Ash, president of Litton Industries' newly formed subsidiary, Litton Systems, Inc., Beverly Hills, Calif.

William C. Lawrence, vice president in charge of the recently formed Development Engineering Department, American Airlines, Inc., and **Frank W. Kolk,** assistant vice president in charge of the department's Engineering Research and Development Division.

Richard G. Walsh, vice president-engineering, Titeflex, Inc., Springfield, Mass.

G. L. Stancliff, Jr., Washington (D.C.) Area Manager for General Precision, Inc. Mr. Stancliff continues as executive vice president and chief executive officer of GPE Controls, Inc., a subsidiary of General Precision.

Gene Hopkins, vice president-marketing, Avien, Inc., Woodside, N. Y.

Dr. Joseph W. Wulfeck, West Coast manager and program director for Dunlap & Associates, Inc., Stamford, Conn., named a vice president of the company.

Anwar Chitayat, vice president-engineering, OPTOmechanisms, Inc., Mineola, N. Y.

Vernon M. John, vice president-finance, Idaho Maryland Industries, Inc., Glendale.

Richard P. Gaunt, assistant to the vice president, Space Electronics Corp., Glendale, Calif.

Maj. Gen. Harold E. Watson, Deputy Chief of Staff for Intelligence, Air Research and Development Command, Andrews AFB.

Maj. Gen. W. A. Davis, Commander of Air Materiel Command's Aeronautical Systems Center, Wright-Patterson AFB, Ohio. **Brig. Gen. Robert G. Ruegg** replaces Gen. Davis as Director of Procurement and Production, AMC Headquarters.

Enar B. Olson, acting manager of the Federal Aviation Agency's Aeronautical Center, Oklahoma City, Okla., and **Chester W. Wells,** assistant manager.

Dr. Vincent S. Haneman, Jr., has resigned from the USAF Ballistic Missile Division, Los Angeles, as Chief, Special Projects Division, Guidance and Control Directorate, and has opened an office in Dallas, Tex., to specialize in fields of automatic control and guidance, mechanical, electrical and aeronautical engineering, analog computation and related work.

Honors and Elections

Col. Thurston T. Paul has received the USAF Commendation Medal for his "meritorious service as chief of the Jupiter Project Office and as deputy commander of the Army Ballistic Missile Agency, Redstone Arsenal, Ala."

(*Continued on page 129*)

INDUSTRY OBSERVER

► Air Force interest is shifting from active (repeater) communication satellites to the passive (reflector) type because of greater operational flexibility and lower vulnerability to jamming. Several recent developments may eliminate need for high-powered transmitters and large antennas once considered necessary for passive satellites. These include the reflecting cloud technique using thousands of small, frangible needles developed by Massachusetts Institute of Technology (AW Aug. 1, p. 23) and the extremely high gain array-type antennas being investigated by MIT and Ohio State University.

► **National Aeronautics and Space Administration now plans to have launch capability for its Scout solid propellant launch vehicle at both Atlantic and Pacific Missile Ranges, as well as at Wallops Island, Va. Current cost estimate for Scout is $900,000 per launch.**

► Advanced solid-propellant rocket engine, called Caleb, under development at Naval Ordnance Test Station, China Lake, Calif., probably will receive little or no funding in Fiscal 1961 because it can't be projected for specific space experiments.

► **Air Force-Martin Titan is scheduled for use as a boost vehicle in conjunction with the Lockheed Agena B second stage in projected space experiments.**

► Advanced Research Projects Agency-Army-Philco Corp. Courier 1A delayed repeater communications satellite launch now is set for Aug. 16 at the Atlantic Missile Range. Payload of approximately 475 lb. will be fired in a southeast direction for injection over the east coast of Africa.

► **NASA estimates that it should be possible to manufacture solid fuel rockets which are 96% propellant, a reduction in inert weight which could increase performance as much as 25%. Solid rockets currently can be built with 90% of their weight in propellant.**

► Design of a rocket engine test cell capable of testing 1.5 million lb. thrust engines at simulated altitudes higher than 100,000 ft. is authorized in the Fiscal 1961 construction budget for Arnold Engineering Development Center. Facility is estimated to cost $10.5 million and take several years to build.

► **NASA will spend about $20 million of its Fiscal 1961 $75 million lunar and planetary exploration budget for launch vehicles. An estimated $55 million will be spent for developing and producing space craft and payloads, with 60% of this going to industry and universities on subcontract.**

► Beech Aircraft Corp.'s Aerospace Division has initiated design of a Mach 3 drone, using company funds.

► **Motorola, Inc., has been selected in Northrop Nortronics Division competition to supply three adapter consoles for GJQ-9 automatic checkout equipment for guidance subsystems in the USAF-Douglas Skybolt air-launched ballistic missile. Contract will be slightly under $2 million and work will be done at Motorola's Phoenix, Ariz., division.**

► Martin-Orlando GAM-83A Bullpup air-to-surface missile is scheduled to become operational with USAF in late October or November. Initial squadron of F-100 fighters to be equipped with the missile is now training with it at Nellis AFB.

► **Seventh Saturn C-1 vehicle, scheduled to be launched in 1963, will be the first to have live S-IV and S-V stages and to have orbital capability. On the first three C-1 flights, Rocketdyne H-1 engines in the S-I stage will be operated at 165,000 lb. thrust to provide 1.3 million lb. total thrust. Next three vehicles will develop 1.5 million lb. in S-I stage and will have a live -IV second stage.**

► Boeing Airplane Co.'s Aerospace Division is scheduled to evaluate bids this month for work at Air Force Plant 77, the Minuteman ICBM assembly site at Hill AFB, Utah. Work includes new buildings, rehabilitation of old buildings, roads and services.

Washington Roundup

Defense in Politics

Pattern of defense spending for the rest of the year will depend on how the Republicans decide to handle the defense issue during the campaign. Some increased spending is inevitable. The political problem lies in finding ways of doing it without seeming to repudiate current Administration policies.

President Eisenhower left the door open for a bigger defense effort if events warrant it when he addressed the Republican convention. His planned conference with congressional leaders could produce the decision to ask for more money when he tells Congress what he expects in the way of defense and mutual security action during the August session.

Despite pressure from within the Republican party, the President seems determined to fight any major increases in national spending. But some programs—like Polaris, B-70, Samos—could benefit from funding switches within the present budget. This way, the Administration could spend more money on programs in the public eye without increasing over-all spending.

Democrats are waiting to see what the Administration plans to do with the extra defense money already voted before launching a new push for more money. This was evident last week in Sen. Lyndon Johnson's request for specific spending plans from Defense Secretary Thomas Gates. If the Administration refuses to spend much of it, Democrats may decide they have enough of an issue without voting any more money.

Democrats have some political worries if the President decides to spend much of the defense funds available. Judicious program increases spread over the coming months and tied to logical excuses could possibly blunt the defense issue. The extra money thus pumped into the economy just before election also could blunt some of the domestic economic issues the Democrats plan to use.

New Policy on Bases

Defense Department plans a shift to negotiated contracts to fight construction delays at ICBM bases. Army Corps of Engineers will risk the wrath of the General Accounting Office by establishing a list of best-qualified contractors and asking these firms to submit bids on future Atlas, Titan and Minuteman base construction.

This modified negotiated contract system runs counter to GAO policy, which favors sealed bids for construction jobs. Contract goes to the lowest bidder under GAO policy. The new system is designed to avoid giving contracts to "bid brokers" who subcontract most of the work to other firms. Air Force and Army blame much of the delay in base construction to the confusion rising from this system.

Defense Department accepted part of the blame for base delays in a meeting late last month with top officials of missile and construction companies. Management changes are expected to cure these deficiencies. Brig. Gen. Alvin C. Welling will run all missile site construction for Corps of Engineers. He has direct access to Army Secretary Wilbur Brucker and Chief of Staff Gen. L. L. Lemnitzer. Maj. Gen. Thomas Gerrity, new AMC Ballistic Missile Center commander, is expected to tighten USAF management, although he doesn't have the same direct access to the Pentagon.

Air Force and Air Research and Development Command headquarters will be briefed this week on results of Winter Study Group efforts. This group has spent approximately six months analyzing USAF's present electronic support system programs and its needs in the 1965-75 period. If ARDC Commander Lt. Gen. Bernard Shriever approves, bulk of the Winter Study Group report will be made available to industry.

Director of Defense Research and Engineering Herbert York is not expected to authorize program for development of bombardment satellites. Current view is that such a weapon offers relatively little to justify expense of such a program. York's staff also doubts the Soviets will find bombardment satellites sufficiently attractive, but has asked Air Force to launch a program to develop the basic rendezvous techniques required for satellite interception in case current appraisal of Soviet intentions proves incorrect.

Space Symposium

Air Force Office of Scientific Research is resuming its series of astronautics symposiums with a meeting in October. Third symposium in the series will be held with the Society of Automotive Engineers in Los Angeles Oct. 12-14. Last meeting was held in Denver in April, 1958.

Series is resuming after a 2¼ year hiatus caused by national space politics. A meeting was scheduled for May, 1959, but it was canceled, officially because of a conflict with the World Congress of Flight. The cancellation came at a time when National Aeronautics and Space Administration was striving for the lead role in the national space effort and when Pentagon policy still discouraged any service attempts to develop prominent individual space roles. **—Washington Staff**

Failure Delays Mercury Launch Goals

By Edward H. Kolcum

Washington—National Aeronautics and Space Administration has revised the Project Mercury test schedule to repeat the critical high-angle re-entry experiment which failed completely July 29, dimming chances of a manned Redstone ballistic flight before the end of the year.

U. S. manned satellite program suffered its most significant reversal when an Atlas launch vehicle exploded 65 sec. after ignition. The MA-1 booster was carrying a McDonnell Aircraft Corp. capsule on a mission to qualify the capsule in a severe test of structural integrity. About 36 hr. after launch, salvage crews recovered pieces of the instrumented capsule shell. Although onboard telemetry tapes were recovered intact, NASA said not one basic flight objective was achieved.

Atlas failure casts doubt on announced goal of a manned Redstone ballistic flight before the end of this year, since NASA will not attempt manned capsule flights until the capsule structure with integrated systems is fully flight tested.

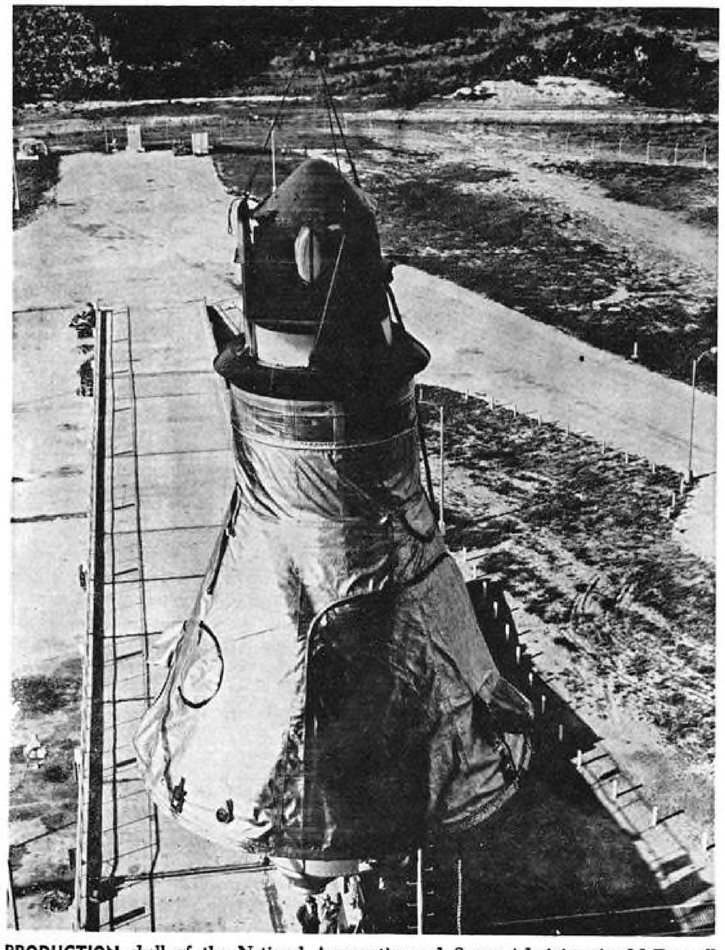
Goal remains possible because the compressed Mercury schedule calls for concurrent Atlas and Redstone flights. In order for manned Redstone flights to take place this year, however, a heavy flight schedule with no serious system failures must be completed during the next five months.

Immediate result of the MA-1 failure was commitment by NASA of the second Atlas launch (MA-2) to a repeat of the high-angle re-entry test. The agency had hoped to obtain full data on high velocity re-entry in three Atlas ballistic flights. Initial test objective remains evaluation of the capsule structure at a re-entry of about 10 deg. This will be followed by either a normal re-entry (two degrees) or simulation of an aborted mission immediately after injection into orbit.

NASA must now shuffle the test program by assigning a backup Atlas and a backup McDonnell capsule to repeat MA-1. The agency has not assigned specific missions to all 24 capsules or 15 Atlas and eight Redstone boosters.

Flight development program will continue with instrumented capsules, followed by chimpanzee flights, prior to manned flight.

Unsuccessful MA-1 had a programed mission profile of 1,500 mi. range, 110 mi. apogee and 20 min. flight time. Capsule was to have been subjected to extreme tests of strength and reaction to afterbody heating such as would occur following an abort during powered flight.



PRODUCTION shell of the National Aeronautics and Space Administration-McDonnell Project Mercury space capsule is lifted to be mated to Atlas launch vehicle. Capsule contained 200 lb. of instruments and a 20 in. stub tower simulating pilot escape system.

Resin and glass fiber heat shield would have reached a temperature of 3,000F, and the afterbody, shingled for expansion, would have experienced re-entry temperature of 1,500F. Structure would have been further tested by 16g load when the one-ton capsule entered the atmosphere at a velocity of 13,000 mph.

Profile was to have been attained by shutting down the Atlas sustainer engine prematurely about four minutes after ignition.

Actual flight, conducted in driving rain, took the capsule to a range of five miles and an apogee of six to eight miles. Telemetry was received from the booster for 65 sec. and from the capsule about 3½ min. Capsule apparently was in the air the full 3½ min., since it burst on impact and did not float. Wreckage was found in 50 ft. of water. Salvage efforts are continuing in hope of finding enough of the launch vehicle to determine the malfunction.

Capsule was fitted with a 20 in. stub tower instead of the 16 ft. pilot escape pylon. Stub was to have been jettisoned to simulate pylon separation in the flight sequence.

Atlas booster in the MA-1 launch was equipped with an abort-sensing system on an open loop circuit running directly to the telemetry.

George M. Low, chief of NASA's manned space flight program, said the pylon tower was omitted because it has not been flight tested with the abort system on a closed loop. A malfunction of the closed loop abort system could have triggered the escape cycle and prevented or masked reception of data on primary test objectives.

Installation of the escape tower would have cost approximately two weeks delay for additional checkouts plus installation of a more complex flight sequence, he said. Flight sequencer used was programed to activate three minutes after launch.

Normally, abort sensors will monitor engine performance, airframe integrity, circuitry and vehicle motions. Malfunction will cause automatic ignition of the escape rocket any time from before ignition to separation from the burned-out Atlas booster.

Telemetry received during the flight, confirmed by recovered tapes in the capsule, show abort sensors signaled just before powered flight terminated, Low said. Tape will be of some value since it shows capsule behavior in maximum Q (maximum dynamic pressure) maneuver and will provide this data for the first time on a McDonnell capsule. NASA test capsule was flown with Little Joe booster Jan. 21 (AW Feb. 1, p. 22) to quality pilot escape system under maximum dynamic loads.

Low did not minimize the MA-1 setback with its loss of time, money and a backup system. Intelligent assessment of the failure in delay of the over-all program cannot come until MA-2 is flown, he said.

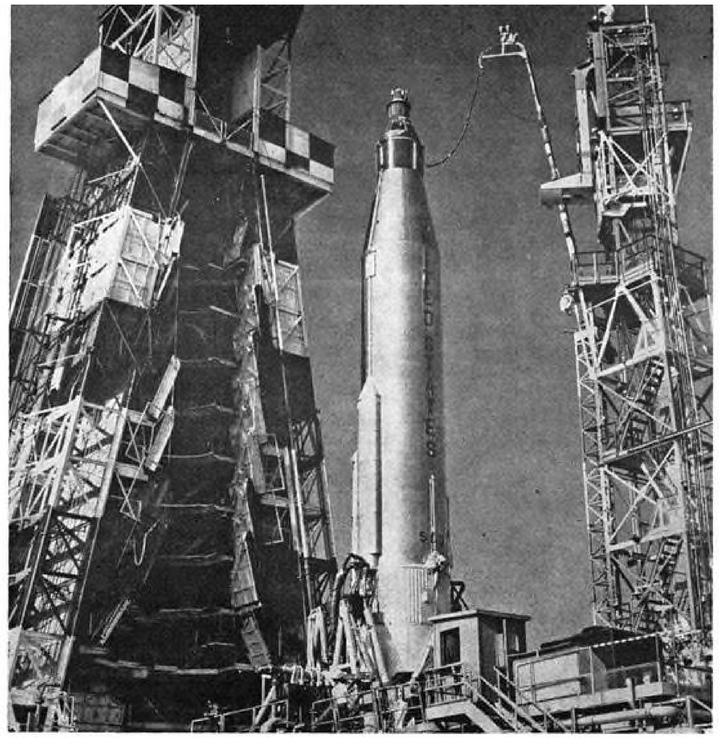
Little time will be lost if the structure proves to be sound during the repeat launch. If the repeat shows structure deficiencies, the minimum loss will be the time between the shots, plus the time necessary to rectify the deficiencies, Low said.

If MA-2 does not result in a good launch, flight and recovery, presumably MA-3 would be another high-angle re-entry test.

NASA has ordered an unspecified number of backup capsules, bringing to 24 the production order with McDonnell Aircraft Corp. MA-1 capsule was instrumented by NASA's Langley research center, but instrumentation of remaining capsules will be done at the McDonnell plant in St. Louis, Mo.

Because instrumentation to record data from all Atlas ballistic tests is similar, no delay will result solely from changing the mission of MA-2 to a high-angle re-entry flight.

Instrumentation consists of a 16-channel telemetry system, two tape recorders, two 16 mm. cameras, heat sensors at 51 points, plus sensors for pitch, yaw and roll rates, accelerations, pressures, vibrations, external noise levels and flight functions, including action of adaptor band release, capsule separation and drogue chute deployment.



ASSEMBLED Mercury-Atlas I is 85 ft. high with a liftoff weight of 250,000 lb. Test failed when launch vehicle exploded 65 sec. after ignition. Objective was to test structure in severe high angle re-entry. Experiment will be repeated in next Atlas-boosted launch.

Life Sciences Coordination Urged

Washington—Opposition to duplication of the nation's space medicine facilities and the need for closer coordination in this field between the National Aeronautics and Space Administration and the Department of Defense was expressed last week by the Senate Committee on Aeronautical and Space Sciences, headed by Sen. Lyndon Johnson (D.-Tex.).

The report expressed doubt that NASA's Office of Life Science Programs has a well conceived plan for future coordination, noting that the Civilian-Military Liaison Committee, which met 13 times between November, 1958 and December, 1959, failed to achieve general coordination between NASA and Defense.

On the working level, the Senate group noted that there is close and continuing cooperation between civilian and military agencies in the field of space biological and medical sciences, due mainly to the dedication and broad outlook of the individuals involved.

Many of life scientists serve the government on a variety of advisory boards and committees. The report pointed out that these groups meet infrequently, however, and they lack day-to-day participation in the operating decisions of the organizations they advise.

The report questioned whether, as the NASA effort increases and the services commit substantial proportions of their biomedical personnel and facilities to NASA without adequate reimbursement, the services could justify future budget requests on the basis of work performed for NASA.

NASA told the committee it would reimburse Defense Department for programs carried out in military biomedical laboratories which are specifically for NASA projects.

The report said ". . . there is a need for issuance of a policy statement or suitable set of guidelines by life science organizations showing how they may conduct business on a systematic basis."

NASA Office of Life Sciences, established Mar. 1, 1960, will have a staff of 32 professional and supporting personnel for Fiscal 1961 and a total program expenditure of $5 million. Future professional staff will be 60, not counting supporting personnel.

Dr. S. J. Gerathewohl, an expert on weightlessness in space flight and formerly with the Army Ballistic Missile Agency, recently joined the space agency life sciences staff to direct operational development. Dr. Richard S. Young, also formerly with ABMA, will be chief of flight biology.

Military Sees Firm Need for Aircraft

By Irving Stone

San Diego, Calif.—Manned aircraft have a firm place in advanced planning requirements of U. S. Air Force, Navy and Army, but increasingly steep costs threaten to reduce quantities and cut types from the broad spectrum of vehicles the three services are projecting.

Paring of frills and embellishments was one solution proposed to the almost 1,000 members of the military and industry at the national summer meeting of the Institute of the Aeronautical Sciences conducted here in closed sessions. But determination of these unnecessaries was deemed a tough chore, with the more probable solution being a close screening of aircraft types.

Despite the extreme emphasis on cost factors, impressions at the meeting indicated these highlights:

- **Air Force-North American** B-70 Mach 3 intercontinental bomber, considered to be the last of the very large manned "atmospheric weapon systems," will get substantial support before the upcoming presidential election.
- **Follow-on projects** are contemplated for aircraft to operate in the fringes of the atmosphere—hybrid vehicles with multi-mission capabilities.
- **Navy's Missileer** will prove an effective point-defense weapon, strongly upgrading the combat potential of carriers (AW Aug. 1, p. 33).
- **Strategic airlift** capability will be bolstered.
- **VTOL and STOL** development will be pushed.
- **Variable sweep wings** are receiving close study for future multi-mission aircraft.
- **North American F-108** long-range interceptor has not been scrubbed completely from the Air Force "possibilities"—the international situation may work to reinstate this vehicle or a similar type.
- **Army funds for aircraft** are expected to rise gradually, but appreciably, within the next decade.

B-70 Step-Up

Air Force observers feel confident that the Office of the Secretary of Defense (OSD) is looking more favorably at a step-up in the B-70 program, hope that the plan recommended will be approved to expand low present development to include sufficient quantities to prove operational capability of the weapon system. They don't hope to be given all the money this year that Congress has appropriated for the B-70 weapon system. The two prototypes now authorized under the cutback will not include detail weapon subsystem components, essential to make the aircraft a true weapon system.

Estimates of slippage in the program vary from one to two years, if development tempo is authorized to be boosted immediately to an optimum rate.

With authorization to proceed with development and stay on schedule, the cost per B-70 including spares and equipment would be about $17 million—on the basis of a total run of 200 aircraft which the Air Force contemplates it will need for effective strategic strength. But another estimate puts the figure as high as $35 million per airplane. It is admitted, however, that the way budget thinking has been channeled, the military funding pie would have to be cut another way to provide for payment of 200 B-70s.

Air Force observers also advanced the argument that if the B-70 isn't developed, there will be a long lag in the introduction of the commercial supersonic transport, a vehicle envisioned as a distinct aid to military operations. But feeling in commercial transport circles doesn't support this contention unanimously. One extreme view considers it "foolish" to go ahead with B-70-type aircraft because many of the unknowns involved are not resolved yet, that a military plane which involves compromises won't necessarily make money for commercial operators.

On the other hand, a design which does make money for an airline will meet Air Force emergency requirements, and "we must not jump every time the Air Force cracks the whip," in the opinion of William Littlewood, vice president-equipment research, American Airlines, who was a participant in an open panel discussion at the meeting.

It is essential that the B-70 development be carried forward, according to Dr. Hugh L. Dryden, deputy administrator, National Aeronautics and Space Administration. "If the Russians develop this type of aircraft first, we would have an atmosphere like that of Sputnik all over again," he predicts.

Air Force officials revealed that the B-70 is designed to attain supersonic speed at an altitude of 30,000 ft. in a climb, could loiter at altitude at the subsonic speed or Mach 0.68 (about 440 mph.).

Means also have been found to reduce substantially the aircraft's radar reflectivity by changing the fillet radii at intersections of vertical surfaces and wing with the fuselage and by the incorporation of radar absorbing material.

Indications are that although there is nothing definitive with regard to specific requirements, projections envision development of a hybrid-propulsion multi-mission manned vehicle which would operate in the "fringe" zones of the atmosphere where there would be sufficient air to provide marginal, yet valid, use of wings for controlled flight and re-entry. It is unlikely that the concept could be proved adequately and become operational before at least a decade, considered an optimistic goal by many industry observers. Operation is seen applicable to the mission of many Air Force segments, perhaps Strategic Air Command, Tactical Air Command, and Air Defense Command.

Dual Powerplants

Industry observers foresee for this type of vehicle a dual powerplant installation, one of which might be a ramjet which would take over to boost the vehicle's speed to the region of 17,000 to 20,000 mph. at altitudes in the region of 50 mi., to attain flight capabilities encompassing an orbiting-decay path, or porpoising to provide wing-lift for fast rise for a long glide over a specific area before re-entry under controlled flight conditions.

Navy's presentation on manned aircraft included requirements and employment of carrier-based attack planes, anti-submarine warfare aircraft in land-based and carrier-based categories, Marine attack and defensive aircraft, and helicopters, according to Vice Adm. R. B. Pirie, deputy chief of naval operations. Citing the effectiveness of Navy aircraft, he declared that 50 nuclear weapons can be placed on target with the first launch from carriers. Starting from scratch, all of the carrier-based aircraft could be off in a "couple of hours."

The carrier-based subsonic Missileer, new Navy point-defense aircraft which will be built by Douglas Aircraft Co., is a prime example of design with an eye on costs and high effectiveness. Toting six Eagle air-to-air missiles having a speed exceeding Mach 4, Missileer is designed to defend against low-level attackers—a difficult combat job. It will go into service under a schedule aimed to equip all of the Navy's attack carriers within a 10-year period. For a force of 14 attack carriers, approximately 20 squadrons of Missileers will be deployed. First Missileer is expected to be phased into operation in 1965 if development plans proceed according to schedule.

Development costs will run about $200 million. Allocation may run $75 million in Fiscal 1962, and cost per plane may run $5 million without spares—an estimate appearing low, according to industry observers.

Missileer was developed under the concept of avoiding the problems inherent in the development and operation of a carrier-based Mach 3 (or better) fighter and putting the sophistication into the aircraft's missiles, while using a subsonic plane as a launch platform. This approach is cheaper than using a supersonic aircraft for the job, Pirie said. The six Eagle air-to-air missiles will be capable of being launched simultaneously each at different targets. In operational procedure, Missileer will start out about 150 mi. from the carrier force, launch its Eagle missiles out another 1,000 mi., from sea level to high altitude, to hit approaching missiles or aircraft. Manned by a crew of four, Missileer will gross about 50,000 lb., will function as a small CIC (combat information center), and will be capable of remaining on station for about 4 hr.

Navy's Grumman A2F Intruder is another example of specifying subsonic operation to keep costs down where supersonic operation wasn't considered necessary. This 50,000-lb.-gross plane will range out very far, exploiting low-level attack. It is capable of "a terrific load," Pirie said, for conventional warfare. Capable of flying at 86 kt., it will carrier-land at 100 kt., compared with usual 125 kt. speeds. Its droop type tailpipe functions for better control at low speed by contributing a lift component, Pirie added.

The aircraft has an integrated instrument system—a radar-presentation top scope referred to as a "pathway in the sky" and likened to flying visually, teamed with a bottom scope affording information on range and endurance.

P3V Modifications

Navy doesn't contemplate any delays in the introduction of its turboprop Lockheed P3V Electra ASW aircraft as a result of the modifications being cranked into the structure of the basic Electra configuration following investigation of structural failure in aircraft service, according to Rear Adm. Paul D. Stroop, chief of Bureau of Naval Weapons. Navy doesn't expect to receive its first P3V before March, 1961, and will incorporate the greater strength of the Electra's modified structure.

Development of strategic airlift, in the form of approximately 150 large turbofan-powered cargo transports, convertible for hauling personnel, is planned by the Air Force, and funds for the project already are earmarked, according to Maj. Gen. Bruce K. Holloway, Air Force's director of operational requirements.

Design competition is expected to be held within the next year and operational date is projected for 1964. Considered particularly responsive to the Army's needs, the transport could support any military mission, could haul a Minuteman intercontinental ballistic missile to an airfield for ground transportation to the missile's silo site. Cruise speed would be about 400 kt., top speed close to 500 kt. Projection is to fly it nonstop across the Pacific with reduced load (25,000 lb.), and across the Atlantic nonstop with 50,000 lb. load or better.

Air Force's tactical airlift requirements are being tailored to the concept of VTOL aircraft. Although the broad needs of the service are fairly defined, specifics have not yet been funneled into concrete requirements. Army and Navy, as well as Air Force, also have requirements in the VTOL field. Big gap in the tactical VTOL regime is considered to be in propulsion development.

Indications are that in the STOL field, the Air Force will circulate requirements for aircraft sometime next month, with a possibility that a Phase 1 contract may be let early next year. Specifics probably will be left for industry to supply in detailed proposals within certain fixed maximums set by the military.

Air Force thinking envisions an STOL type of aircraft for operation on a 2,000 to 3,000 ft. runway of very soft construction. This plane will be quite versatile, will carry atomic weapons, be suitable for a Korean-type theatre of operations. In the interim, the Republic F-105 would be the backbone of the tactical forces.

Variable sweep wings to fit the entire flight envelope from sea level to very high altitude and from low speeds to high speeds are being given concentrated in-house study by Air Force to fit the category of multi-mission aircraft. NASA also is reported to be strongly supporting research efforts in this regime at its Langley laboratories. Industry reaction is favorable to the aerodynamic advantages of variable sweep, but designers are concerned about operational hurdles such as extreme reliability required for wing retraction and extension mechanism, under fast-changing flight conditions, as well as the high costs this additional complication will introduce.

Some 10 to 12 companies are conducting company-funded research on variable sweep, anticipating military competitions which will introduce this flight requirement.

F-108 Chances

Military observers close to the requirements and operational phases of the service feel that the North American F-108 long-range interceptor "is not completely out of the window" even though the weapon system program long has been canceled. Feeling is that the F-108 system concept may still have to be revived if international tension increases.

Meanwhile, development of the F-108's fire control and associated weapon still is being supported by Air Force on the premise that these can be adapted to another aircraft if required by operational emergency. Opposed to the possibility of F-108 revival is the $2.3 billion reportedly estimated for an original procurement of 300 planes, with the cost being considerably higher in today's market.

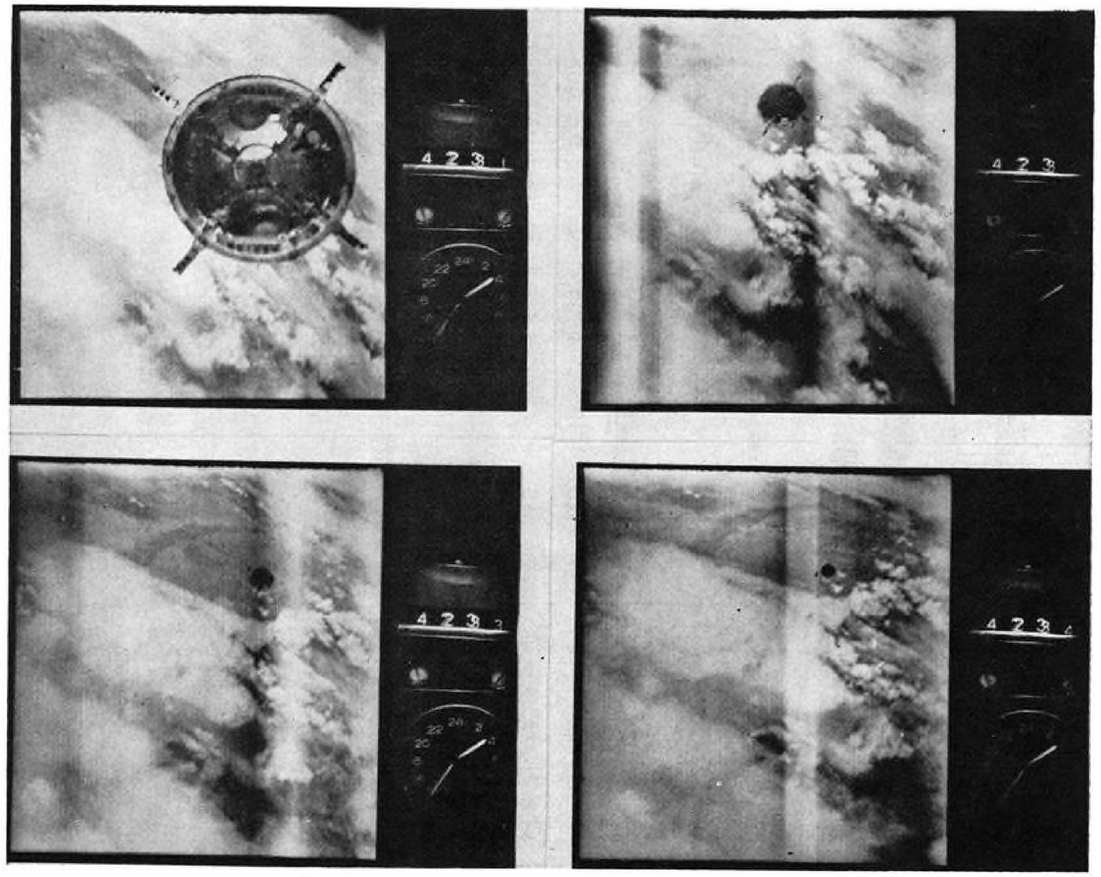
Army aviation is expected to get additional, concentrated support. Industry observers feel that a natural progression will be that this service will require twice its present aviation-activity manpower by 1970 and at least one-third more than its present complement of aircraft. Expectation is that Army bill for manned aircraft by 1970 will be $350 million as an upper limit and $250 million as a lower limit, with strong emphasis on light observation, surveillance and transport type aircraft.

Under present evaluations, helicopters powered by turbines and capable of performing the entire light observation mission are needed. Configurations would accommodate four seats, cruise at about 110 kt., carry 100 lb. of communications and avionic gear.

Army Aircraft Requirements Review Board has recommended development, contingent on prior studies, of new manned high-performance surveillance aircraft, compatible with the ranges of Army missiles, according to Lt. Gen. Arthur G. Trudeau, Army chief of research and development.

Minuteman Control

Washington—Firing of Minuteman ballistic missiles buried in underground silos from remotely located control-launch centers may employ jam-resistant radio control instead of using land-line connections as previously planned. Change is intended to eliminate possibility of sabotage and false triggering. Ten avionics manufacturers will submit proposals this week for such a radio control system to Boeing. System will employ complex coding to prevent false triggering. Boeing plans to complete evaluation by the end of this month and hopes to have Air Force approval to begin contract negotiations late in September. Companies expected to submit proposals include: Bendix, Collins Radio, General Electric, Hughes Aircraft, International Telephone & Telegraph Corp. Motorola, Philco, Raytheon, Radio Corporation of America and Stromberg-Carlson.



Redstone Tests Missile TV System

First pictures of new Army videcon system shows inert Redstone warhead in terminal phase of its ballistic flight. Radio Corporation of America instrument package contains slow scan camera with narrow angle lens ejected pneumatically at an altitude of about 40 mi. High-drag video package follows re-entry body, transmitting high resolution pictures to ground station. Instrument capsule is several miles above warhead at impact, which Army says permits real-time assessment of missile performance and damage. Ground station has direct view monitors, two receivers, video tape recorder and 35 mm. photo monitor. This sequence, taken over a 20-sec. interval, is video tape reproduction of a Redstone nose cone traveling at Mach 4 to target on the White Sands Missile Range.

Defense Pressed for Budget Plans

Washington—Senate majority leader Lyndon Johnson (D.-Tex.) put pressure on Defense Department last week to release $1.7 billion in unrequested funds for key projects added by Congress to the Administration's Fiscal 1961 defense budget.

Sen. Johnson, the Democratic vice presidential nominee, also challenged Defense Secretary Thomas S. Gates, Jr., to say whether any new funds voted for defense in the August session of Congress would be spent.

The Administration has already released some of the funds for construction of five new fleet ballistic missile submarines. The Administration budget fully financed three submarines, and Congress added money for two more.

In a letter to Gates, Sen. Johnson in his capacity as chairman of the Senate Preparedness Subcommittee, noted that Congress made additions to the Fiscal 1961 budget "after careful consideration." He requested that Gates furnish the subcommittee "with a clear-cut statement concerning current Department of Defense policy with regard to immediate and full utilization of the additional funds provided by Congress. This statement should cover each of the individual items or programs for which Congress provided funds in excess of the budget request."

Other information requested by Sen. Johnson:

- " . . . **the specific steps** that have been taken, as well as those planned to be taken, in order to eliminate wasteful contracting, supply mismanagement, and other procurement deficiencies in order to achieve the economies called for by the Congress in making a 3% over-all reduction in procurement funds.
- ". . . **A complete accounting** of the apportionment actions taken to date with respect to funds available for FY 1961."
- **"The specific 'shopping lists'** submitted for approval by the military departments, as well as changes made by the Office of the Secretary of Defense and the Bureau of the Budget and the reasons for such changes."
- **Whether a June 9 memorandum** issued by Gates to the three services "has since been repudiated or rescinded." According to Sen. Johnson, it read: "If the Congress makes available more funds for FY 1961 than are requested, and where the law does not require expenditures, agencies should reserve the increases and carry them forward to the maximum practical extent to FY 1962."

Avro Continuing VTOL Wind Tunnel Tests

Washington—Continued U. S. Air Force and Army support of the Avro VTOL research aircraft hinges on wind tunnel tests now under way at National Aeronautics and Space Administration's Ames Research Center.

Disk-shaped VTOL research aircraft built for the U.S. Army and Air Force by Avro Aircraft, Ltd., of Canada (AW Dec. 7, 1959, p. 154), has been tested extensively in the full scale 40 x 80 ft. wind tunnel at Ames. These wind tunnel investigations have been in progress for several months, and the current test results have been favorable enough to warrant a continuation of the program after modifications to the aircraft. Stability of the vehicle at low speeds both in and out of ground effect has been a major problem. Flight tests of the vehicle outside of ground effect have not been scheduled.

Vertical Takeoff

Aircraft is designed to move rapidly along the ground and achieve a vertical takeoff by operating in a strong cushion of air when it is within one wing diameter of the ground. The air cushion is created by discharging an annular jet of air downward from the rim of the circular wing. Primary air from this annular jet is pumped by the large fan located in the center of the vehicle.

This primary flow is augmented as it is exhausted around the circumference of the wing by passing it through a nozzle which creates a jet pump effect and draws in a large volume of relatively low speed air. Large opening at the edge of the wing is the inlet for the augmentation air flow. A boundary layer bleed for air drawn into the intake is just inside the secondary air inlet.

Fan for the primary air is driven by a tip turbine and is similar to the GE lift fan described below. Three Continental J69 turbojets produce the hot air to power the fan.

Horizontal thrust for level flight is provided by deflecting the annular jet of air to the rearward. The annular jet can not be turned through a 90 deg. angle, so that it always contributes to the total aircraft lift. Several systems are being studied to find the most efficient means of turning the jet to achieve horizontal flight. Aircraft stability depends upon keeping the flow smooth as it turns rearward.

Configuration shown in these photographs has wing edges and an inlet for annular jet augmentation flow which are designed for subsonic flight. Supersonic version of this same general test vehicle has been considered which has sharp wing edges and a modified inlet system for annular jet augmentation flow.

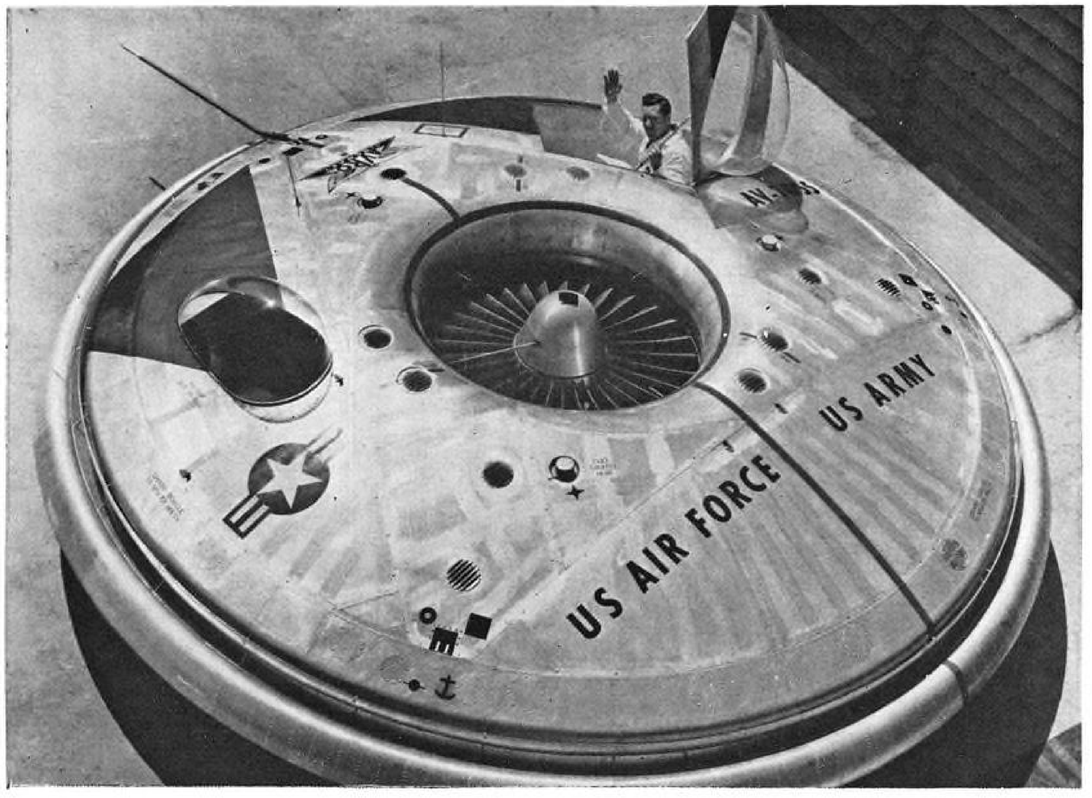
Circular wing planform has potential for military aircraft because it is structurally compact and light and because it is an ideal shape for very high speed flight at low altitudes, if its stability problems can be corrected. Studies by NASA, Avro and several other aircraft companies have indicated that the most efficient aircraft for flight near sea level at transonic and supersonic speeds probably will be wingless. It will operate at very low lift coefficients and will not benefit from a long, narrow, high aspect ratio wing. Reduction of wetted area is a primary design consideration for low drag with a low level aircraft, and the circular aircraft is ideal on this point.

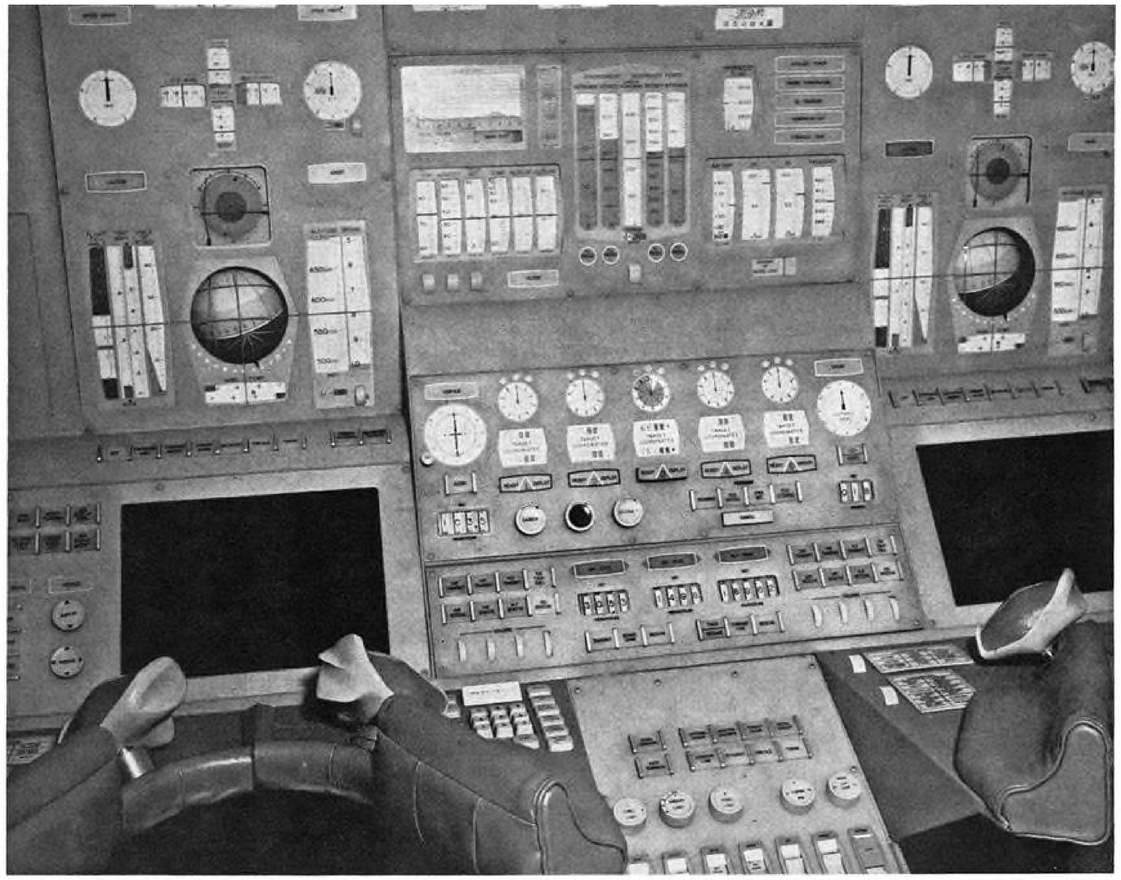
Circular Aircraft

Circular aircraft will be relatively inefficient below 500 mph., however, because its aspect ratio is only 1.28 and its drag due to lift will be very high.

Current test work has not been completely successful but it has shown that the stability and transition problems with the circular aircraft are not insurmountable.

HIGHLY ROUNDED wing edges characterize subsonic configuration of the Avro disk-shaped research vehicle for USAF, Army.





ORBITAL BOMBER cockpit mockup, designed by Lear for USAF, is first attempt at control and display system for space weapon system. Flight group instruments for launch and re-entry, extreme left and right, are directly in front of pilot and copilot. Center display provides instruments for orbital flight and control of five ballistic weapons. Hand grips are used to introduce vehicle maneuvers.

USAF Shows Orbital Bomber Cockpit

By Philip J. Klass

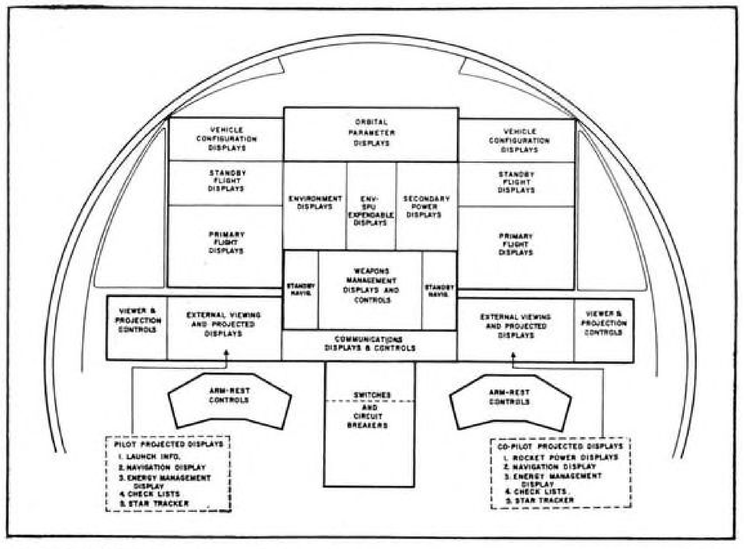
Grand Rapids, Mich.—Cockpit control and display system mockup for a four-man orbital bomber, designed to remain in a 300 mi. high orbit for up to 30 days, is being demonstrated here to representatives of the aerospace industry and will be shown to Dyna-Soar project personnel early in September.

The orbital weapon system cockpit, developed by Lear under Wright Air Development Division sponsorship for a hypothetical vehicle, represents the first detailed analysis of the displays and controls required for an orbital bomber.

Equally significant is the approach, or methodology, which the WADD/Lear program has developed for the design of aerospace vehicle cockpits, based on a detailed, step-by-step analysis of each operation required of crew members throughout the mission. This methodology is equally applicable to all types of aerospace vehicles.

The orbital bomber control and display system, identified as the Mark IV, is largely a static mockup. Instruments are pictorial paste-ups, but some indicating lights and a pictorial display are semi-operational.

Lear is fabricating operational models of the primary flight instruments and expects to produce instruments required for vehicle attitude and energy management functions during critical re-entry portion of mission under a forthcoming contract extension. Extension also is expected to include funds for conducting simulator tests on re-entry and fuel management to evaluate instrument displays. Program to date has cost approximately $400,000.



BASIC LAYOUT of cockpit for hypothetical orbital bomber, developed from detailed analysis of mission profile from launch to re-entry, contains atmosphere operation displays at extreme left and right, while orbital operation instruments are at center.

Display Area

The four-man orbital bomber selected by WADD as the guinea-pig vehicle for the Mark IV has a crew of two pilots and two technicians. The vertical display area is divided into three nearly equal sub-areas. Two of these, one each in front of the pilot and the pilot, contain the basic flight instruments required during launch, re-entry and landing. The pilot and copilot displays are identical. The third sub-area between the other two is devoted to instruments which display orbital (cruise) conditions, vehicle environment and controls for weapons management.

The flight group displays, directly in front of the pilot and copilot, contain several familiar instruments, such as a three-dimensional moving globe which indicates vehicle attitude and heading relative to earth coordinates and vertical moving-tape indicators for altitude, airspeed and angle-of-attack.

New Instruments

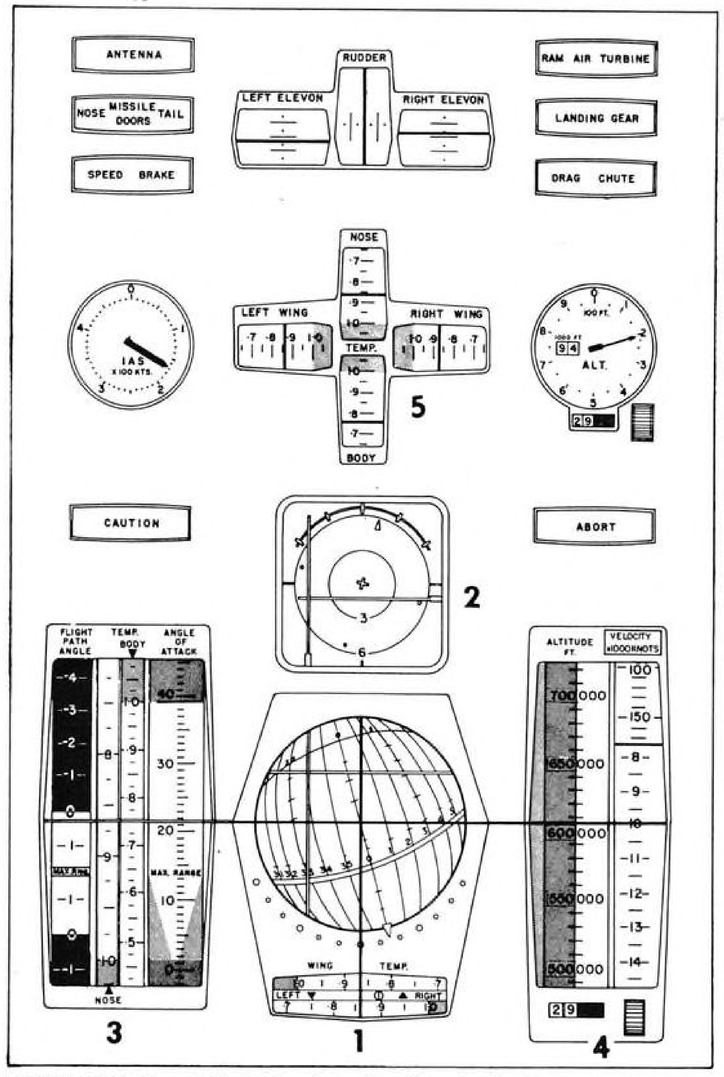
New instruments, required because of the vehicle's orbital mission, include:

- **Rate indicator,** which displays rate of rotation of vehicle about each of its axes. Simulator tests indicate that rate-of-change of attitude display is required to permit human pilot to stabilize vehicle with minimum consumption of reaction jet fuel. Rate indicator is positioned directly above moving globe attitude display.
- **Temperature indicator,** showing body and nose temperature during re-entry, consists of moving-tape type vertical displays contained alongside of indicator showing angle-of-attack and flight path angle. Additionally, there are standby indicators to show temperature of body, nose and each wing during re-entry.
- **Viewing screen,** directly in front of the pilot and copilot and underneath the flight group, can be used to display a variety of things, ranging from checklists to navigational maps. Because the cockpit has no windows, the display screen can be also used for external viewing using optical periscope or closed-circuit television. Particular display shown on the screen can be selected individually by pilot and copilot, depending upon their operational needs of the moment.

During the critical re-entry phase, the pilot or copilot can select an energy planning display for screen viewing which shows predicted landing position of the vehicle relative to its desired base, vehicle's underbody temperature, angle of attack, bank angle position and distance to go.

At the top of the center display, or orbital group, which can be viewed jointly by the pilot and copilot, are located digital indicators which show vehicle's altitude, velocity, orbit inclination and period and ascending node. To the right of these present-situation indicators are others which display computer-predicted information, such as time to go to re-entry or to bomb release.

Below the orbital parameter displays are located instruments for showing the vehicle and cabin environment. A radiation display shows the amount of radiation dosage accumulated since the mission began as well as a warning light to show if high intensity peak radiation is being encountered. Other instruments show the remaining supply of nitrogen and oxygen for crew supply as well as rocket engine fuel remaining. Also displayed are electrical and



FLIGHT GROUP for orbital bomber shows three-dimensional ball-type attitude indicator (1), three-axis rate indicator (2), moving tape indicators for flight path angle, body and nose temperature and angle-of-attack (3), moving tape indicators for altitude and airspeed (4), and standby indicator for body, nose and wing temperatures (5).

hydraulic power system performance.

The weapons control and display panel is located in the midsection approximately at the same level as the viewing screen in the flight group and contains a provision for setting in target coordinates for five ballistic missiles as well as lights to indicate weapon readiness.

Immediately below this section is the control and display panel for vehicle communications. Located on a console situated midway between pilot and copilot seats are miscellaneous switches and circuit breakers.

Primary controls for maneuvering the vehicle are handgrips with padded rests to support the pilot's and copilot's arms. Grips are oriented so that palm is angled downward, inward and toward the pilot. The right-hand grip is used for all three axes, with maneuvers generated by the application of force about the appropriate axis without actually rotating or moving the grip. Left hand grip provides switches for critical vehicle controls.

In designing the Mark IV cockpit control and display system for an orbital bomber, Lear's Advanced Engineering Division was able to work without the usual constraints forced upon designers of conventional airplane cockpits who cannot depart too radically from long-used cockpit configurations and instruments, according to Edward Warren, WADD's project engineer for the Mark IV program.

Time Line Analysis

The "time line analysis" concept used by Lear's Advanced Engineering Division in the Mark IV was developed originally by WADD's Flight Control Laboratory. The current mockup represents its first major application.

Under the time line analysis methodology, both the vehicle configuration and its mission are analyzed in detail before any attempt is made to design the required instrumentation. A detailed flight profile, from launch through orbit to re-entry is prepared, listing every task that must be performed during the mission. These are then analyzed on a time scale to determine which should be assigned to each crew member or whether they should be performed automatically, according to Edward Krug, associate manager of Lear's Advanced Engineering Division. Krug formerly was employed by Convair and worked on B-58 cockpit instrumentation.

Each task is then analyzed to determine what information the assigned crew member requires to perform the function and how such information can best be displayed. In many instances, simulation is employed to evaluate relative merit of different display and/or control configuration.

Polaris Test Vehicle Destroyed After Flying Off Planned Course

Washington—Erratic flight following a normal launch resulted in destruction by a range safety officer last week of the fourth submarine-launched Navy-Lockheed Polaris test vehicle.

In three earlier tests firings from the nuclear submarine USS George Washington, Polaris test vehicles flew 1,000 naut. mi. and Navy said they met all test objectives.

Fourth test began with a good ejection from the launch tube and programed ignition. After 25 sec. of flight, the vehicle spiraled to the left of its planned path. It corrected itself but immediately afterward appeared to lose control about all three areas. It was destroyed 47 sec. after launch.

Following the shot, the George Washington left the Atlantic Missile Range for its home port at Charleston, S. C. Later in the week, the Navy fired a Polaris test vehicle from the Ships Motion Simulator and planned to fire another from the flat pad. The vehicle launched from SMS carried a warhead trigger in the first flight test of the Polaris nuclear warhead arming and fusing mechanism. The second fleet ballistic missile submarine, USS Patrick Henry, will arrive at Port Canaveral later this month for a series of Polaris test vehicle launches and shipboard system checkouts.

Meanwhile, the Navy has established the framework for further development of its Polaris system during a period when the system has become the subject of diplomatic discussion.

Under present plans, Lockheed will produce three tactical versions of the solid-fuel missile, the first of which will be used only on the George Washington, Patrick Henry, Theodore Roosevelt, Robert E. Lee and Abraham Lincoln. Called the A1, the initial Polaris will have a range of 1,200 mi. and will be identical to the four test vehicles fired by the George Washington, with instrumentation removed.

The 1,500-mi. A2 will be 30 in. longer than the 28-ft. A1. All FBM submarines under construction or planned in the remanider of the 45-boat program will be built with longer tubes for the A2. In addition, the five submarines in commission or outfitting will be retrofitted with longer tubes when they return to shipyards for periodic overhaul.

There are five FBM submarines in the George Washington class and five in the second generation Ethan Allen class. Ethan Allen class ships displace 6,900 tons and are 410 ft. long. Third generation will be the Lafayette class, four of which Congress financed in the Fiscal 1961 budget (AW July 25, p. 32). They will displace 7,000 tons, and the Navy says they will be the largest submersibles ever built.

The 2,500-mi. A3 will have the same external configuration as the A2. Range increase will come from higher energy fuel and lighter weight airframe and component materials.

The question of general acceptance of Polaris by North Atlantic Treaty Organization nations remains unsettled (AW Aug. 1, p. 27). French President Charles de Gaulle apparently is seeking a more attractive formula than dual U.S.-French control of nuclear-armed Polaris missiles before committing his country either to acceptance of Polaris or rejection in favor of French development of a medium range missile.

In Britain, the Polaris situation has developed into two separate considerations. One is the broad question of NATO acceptance of the missile for land-based installations. The other involves negotiations on British port use.

The British deny that U.S. use of British ports for submarine provisioning is tied in with a general re-examination of U.S. use of British bases. Negotiations are under way concerning a separate agreement for use of British ports by U.S. submarines.

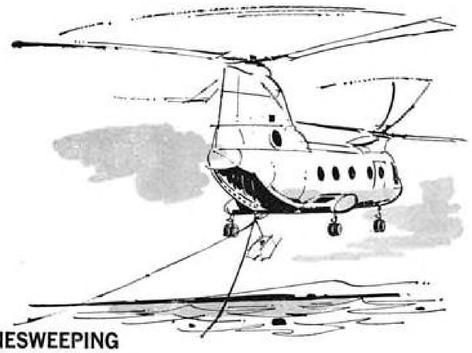
Thorneycroft Succeeds Sandys

No change in the government support policy for the British aviation industry is expected as a result of the ministerial changes announced last week, despite the fact that Peter Thorneycroft, who succeeds Duncan Sandys as minister of aviation, resigned from the government two years ago because of his contention that the government was over-spending public funds.

The industry believes that Thorneycroft will accept both qualitatively and quantitatively the commitments initiated by Sandys, but is braced for tougher financial and contractual arrangements.

It is believed that the new minister may even enhance the prospects of treasury backing for the supersonic airliner and a space program. Sandys was known to be in favor of both projects, but failed to push them through or recommend them.

the VERTOL 107 – the all-service, all-mission helicopter



MINESWEEPING

AIR-SEA RESCUE

ANTI-SUBMARINE WARFARE

AIR-LAND RESCUE

PARATROOP TRAINING

MISSILE SITE SUPPORT

TROOP TRANSPORT

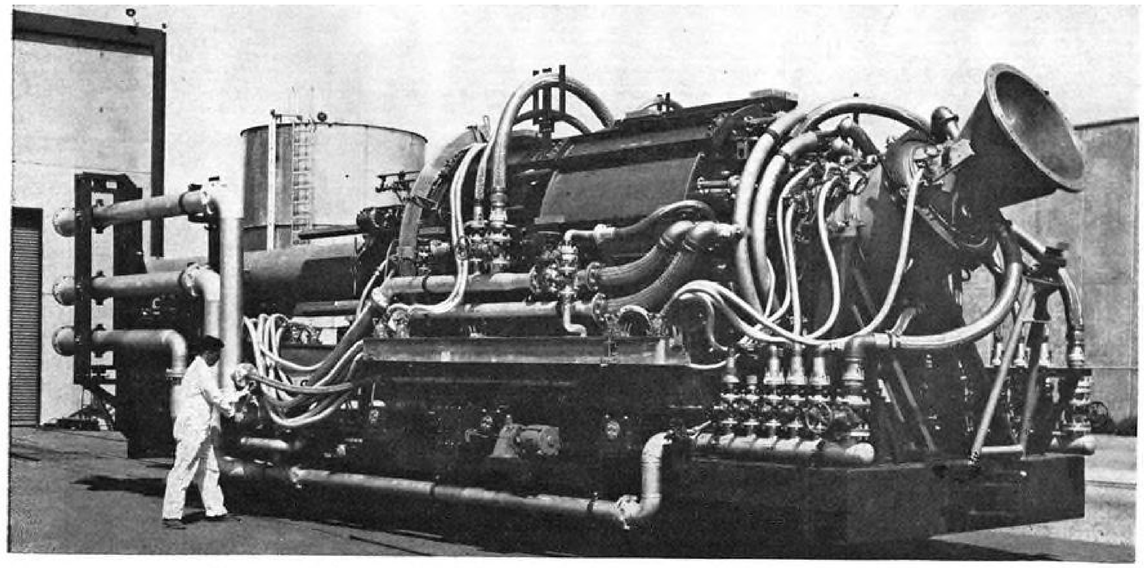
GROUND TROOP FIRE SUPPORT

MEDICAL AIR EVACUATION

AMPHIBIOUS OPERATIONS

FLYING CRANE

TOWING



Tory IIA Reactor Scheduled for November Test

Tory IIA experimental reactor, the first to be tested in the Air Force Project Pluto nuclear ramjet program (AW June 20, p. 206), is mounted on a railroad car for test scheduled in November at the Atomic Energy Commission's Nevada test site. Exhaust nozzle for air passing through the reactor is angled up 54 deg. at right. Air will flow through the radiator-like reactor at about 1,000 lb./sec. and at pressures up to those encountered during Mach 3 flight at sea level. Tory IIA is rated at 140 megawatts, and the follow-on feasibility goal of the Tory IIC reactor will be 600 megawatts. Tory IIC is in the design stage and is scheduled for test in the summer of 1962. It will have many characteristics of a flight-weight reactor, with provision made for maneuvering and acceleration loads.

Defense Department Revises Security Rules

Washington – Defense Department has revised standards and procedures for clearing contractors and their employes to handle classified material.

New regulations cover more than one million defense contractor employes, and for the first time, coverage will extend to National Aeronautics and Space Administration and Federal Aviation Agency, which will have their classified contracts handled under the Armed Forces Industrial Security Regulations.

Changes stem from a Supreme Court decision which held that the Defense Department lacked authority to withhold classified information from contractors and their employes in certain cases because the procedures used had not been authorized by the President or Congress. A presidential executive order was issued requiring detailed regulations.

New rules require that all testimony and evidence must be submitted to a Field Board in the applicant's presence, and the applicant will have a chance to cross-examine witnesses and examine documents.

Field Board makes a recommendation, but the final decision rests with a Central Board, which has power to hear written or oral arguments and to refer cases to the Defense Secretary or the National Aeronautics and Space Administration or FAA administrator.

News Digest

Lockheed Aircraft Corp. passed its third quarter dividend last week. First half results and details of the Electra modification financing will be revealed this week when Chairman Robert E. Gross appears before the New York Society of Security Analysts. Lockheed, which has been paying a $1.20 annual cash dividend, paid its second quarter dividend in stock to conserve cash.

Cutback in production of Handley-Page Victor Mark II bomber was made last week by British Air Ministry after analysis of the V-bomber strategic deterrent factor using Douglas Skybolt missiles. Ministry apparently canceled 12-25 bombers, which cost $3 million each. Cutback may have been caused by modification problems in fitting Skybolt, and because Victor's reconnaissance role has not materialized.

Maj. Gen. John B. Medaris, former chief of the Army's missile program, has been elected president and a director of the Lionel Corp., historically the leading manufacturer of model trains and accessories. Lionel recently expanded its activities by developing new electronics applications based on a 35-year research program.

X-15 set an unofficial new speed record of Mach 3.3 (2,150 mph.) at 66,000 ft. last week, preliminary flight record analysis indicated. Aircraft was X-15 No. 1, fitted with interim XLR-11 engine. X-2 hit Mach 3.195 (2,094 mph.) on Sept. 22, 1956.

Lockheed Aircraft Corp. and Martin Co. have been awarded $100,000 six-month contracts by the National Aeronautics and Space Administration to study nuclear rockets flight test program concepts for Project Rover.

Pratt & Whitney JT12 turbojet engine, now flying in Lockheed JetStar and the North American Sabreliner, last week was certificated by Federal Aviation Agency at 3,000 lb. thrust and 436 lb. total weight after a 30-month development period.

Federal Aviation Agency ordered an emergency inspection last week of all Sikorsky S-58 main rotor blades following the crash of a Chicago Helicopter Airways S-58C. Order requires that all main rotor blades with 1,400 hr. of service time be withdrawn from service and that all blades with 1,000 hr. be X-ray inspected daily.

Defense Department and National Aeronautics and Space Administration will award Mrs. Robert H. Goddard and the Guggenheim Foundation $1 million in settlement of a patent claim covering rights to more than 200 of the late Dr. Goddard's inventions in rocket and space research fields.

Long-Forecast Merger Trend Crystallizes

United-Capital plan viewed as beginning of series; regrouping of competitive routes termed inevitable.

L. L. Doty

Washington—Proposed merger of Capital Airlines into United Air Lines (AW Aug. 1, p. 34) is being viewed generally by the airline industry as the first step in an inevitable regrouping of competitive routes.

Initial reaction to the proposed alliance suggests that opposition by carriers operating east-west routes will be slight, but that airlines serving the already glutted Florida market (AW Jan. 18, p. 36) can be expected to protest the plan. In most east-west markets, competition generally would be reduced by the merger, but the introduction of well-equipped United with its strong resources into Florida will serve to intensify the current hot race for traffic in that area.

Nevertheless, most top officials feel there is no alternative to Capital's fiscal plight, which has led the airline to the brink of foreclosure (AW June 27, p. 36). Chances that the consolidation will meet the approval of the Civil Aeronautics Board are viewed as good. Although Capital stockholders and bond holders will suffer an initial loss, potential gains are greater through the merger route than they might have been had the carrier been forced into receivership. Thus, they are expected to support the plan.

The inevitability of merger as a means of shaving costs, controlling excess capacity and leveling competition has been acknowledged by industry leaders for many months (AW Dec. 28, p. 26). W. A. Patterson, United's president, in what now proves to be a prophetical statement, told AVIATION WEEK early this year that the need for mergers will be felt as "early as next September" (AW Feb. 29, p. 43).

More Mergers

If it is completed the United-Capital consolidation, coupled with the proposed Northeast-TWA merger (AW May 23, p. 38), will cut the number of trunklines from a total of 12 to 10. And not a few airline officials feel that the total will drop even farther as more carriers are driven into mergers through economic necessity.

Net result will be a complete reshuffling of present routes which will tighten competition to a degree that will permit the operation of high-capacity turbojets at an efficient utilization rate. In the process of readjustment, a number of regional-type routes will be passed off to local service carriers to provide that group with new strength.

If the United-Capital merger materializes, United will be substantially strengthened by gaining an entry into the Florida market and by linking its transcontinental route with virtually every major city in the lucrative eastern market. At the same time, competition in Eastern markets presently served by both airlines will be cut.

Number of carriers in the Washington-Chicago market will drop from four to three. There will be four carriers instead of the present five in the New York-Chicago and New York-Detroit markets. The number will be reduced from three to two on the Philadelphia-Chicago route, a market that has grown in importance in recent years.

At the same time, assuming that the CAB will not enforce new operating restrictions on the merged carrier, United will augment its Chicago-Toledo-Washington and Chicago-Columbus-Dayton-Washington routes with the highly profitable Chicago-Detroit-Cleveland-Pittsburgh-Washington route now operated by Capital. It will gain access to Minneapolis-St. Paul with nonstop rights from the twin cities to eastern markets.

United will win nonstop rights between Milwaukee and New York and will inherit the important Chicago-Detroit-Buffalo-New York route. It will also absorb the heavily traveled Washington-Norfolk route from Capital's structure.

New Competition

None of these route amalgamations creates new competition for carriers already serving eastern markets. United, however, will offer American Airlines new competition on the route between Buffalo and Rochester, N. Y., and the West Coast. And because of Capital's strong identity in the Pittsburgh market, it will bring about a new competitive impact against TWA in the Pittsburgh-West Coast market which United has not yet fully developed on its own.

United will receive a substantial volume of new route mileage when it takes over Capital's certificates to operate between Cleveland, Pittsburgh, Buffalo and Miami and between New York, Pittsburgh and Atlanta and New Orleans. The merged airline can be expected to bid for the elimination of light traffic points by transfer of a number of routes to local service carriers (AW July 4, p. 44).

Beyond the effect the TWA-Northeast and United-Capital mergers will have on competition, other areas will be significantly influenced at least temporarily. Since the basic purpose behind any merger is to consolidate economic strength while cutting operating costs, some constriction within the industry must be expected.

Patterson said at the time the proposed merger was announced that no plans had been developed for the absorption of the more than 7,000 people now employed by Capital. However, there can be no doubt that there will be fewer positions available in the merged airline than there are presently within the two separate companies. As a result, some unemployment within the trunkline industry is an inevitable outcome of the merger.

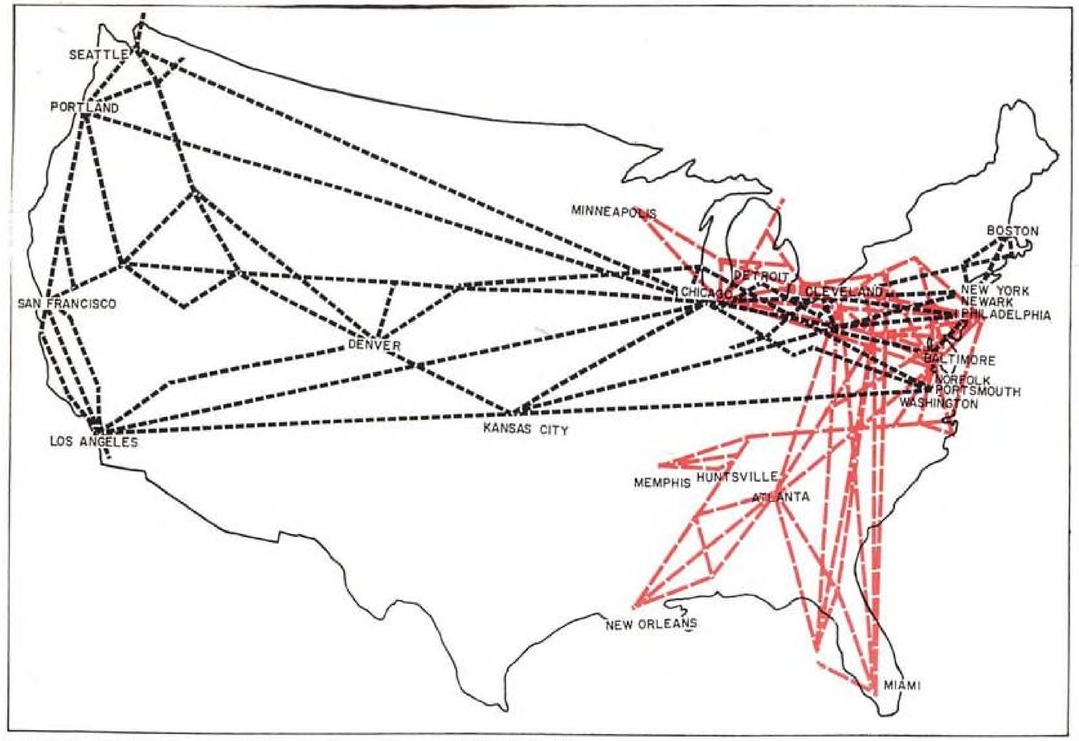
TWA 880 Delay

Delivery timetable for Trans World Airlines Convair 880s still is uncertain as TWA prepares to send the only airplane it has—an unpainted 880 used for training at Kansas City—back to the factory for modification.

A dozen unpainted TWA 880s can be seen parked on the ramp at Convair's San Diego plant coated with a green preservative to protect against salt water corrosion.

In the wake of the resignation of TWA President Charles S. Thomas, closing of the airline's $340 million jet financing program was postponed 30 days. Whether the financing delay is related to 880 deliveries is unclear.

TWA directors last week were discussing an interim management for the airline. E. O. Cocke, senior vice president and system general manager, took over operating control of the airline after the Thomas resignation.



CAPITAL AIRLINES routes (color) superimposed on a United Air Lines route map indicates duplicating routes of the two carriers and new routes United would gain. The latter include Cleveland, Pittsburgh and Buffalo to Florida routes, and New York to New Orleans and New York Atlanta service. Capital also serves numerous intermediate points in the south. United also gains a Chicago to Minneapolis route. Principal Capital-United duplication is on Chicago-New York and New York-Washington service.

At the same time, vendors, suppliers, caterers and manufacturers will temporarily feel the pinch of cutbacks in the volume of purchases of goods and services. As one airline official put it: "A general regrouping of the industry is shaping up that will bear a definite influence on suppliers' business until such time as the over-all adjustment works itself out. From that time on, the industry will start a new period of growth as it expands from its new base."

Stockholder reaction to the proposal is best illustrated by the activity of Capital's common stock listings on the New York Stock Exchange. Following the official announcement of the merger, Capital stock plumeted 2⅜ points to a new 1960 low of 6½ on the total of 32,100 shares traded. High for the year was 13¾. United stock held relatively firm and had settled to its recent average of 30-31 as of late last week. United's stock has reached a 1960 high of 37⅞, a low of 25¾.

Under the proposed plan, Capital stockholders will receive for each seven shares of common stock they hold one share of United common stock plus a five-year warrant to purchase 1½ shares of United at $40 per share. Annual reports of the two companies as of Dec. 31, 1959, showed United with 3,946,000 shares outstanding and Capital with 909,659 shares outstanding.

On this basis of the exchange, Capital stock is valued at approximately $4.25 a share.

A simple majority of United's shares is needed for approval of the merger. A two-thirds vote of Capital's common shares and over 85% of the bond holders' vote must be obtained before the merger can be approved. Vickers-Armstrongs, British manufacturer of the Viscount turboprop transport, has approved the program. The concern has filed a foreclosure suit against Capital for failure to pay $38.8 million due on notes covering the Viscount fleet.

Merger Approval

In addition to the stockholders of both airlines and Capital bond holders, Civil Aeronautics Board and Securities and Exchange Commission must approve the merger before it can be consummated.

The merger undertaking will cost United about $28.8 million, excluding the costs of the warrants, according to Patterson. United will issue to Vickers-Armstrongs $15.9 million of its 5.5% cumulative preferred stock, 60,000 shares of common stock, 7½-year warrants to buy 200,000 shares of United common stock at $45 per share and 15 Viscount airplanes not required in the operations of the merged companies.

The merger agreement also calls for the offer of 20 shares of common stock for each $1,000 principal amount of Capital's 4¼% convertible subordinated debentures.

In the merger, which may be finally approved as early as February, Capital will be completely absorbed by United and lose its identity entirely. The airline will continue with corporate name of United Air Lines, and Capital's headquarters facilities here will be closed.

The merger was negotiated largely by Thomas D. Neelands, who was named chairman of the Capital board last spring (AW June 6, p. 41). Neelands was brought in for the prime purpose of working Capital out of its financial dilemma.

Capital is the product of a merger: a merging of Pennsylvania Airlines with Central Airlines in 1936 to form Pennsylvania Central Airlines. The corporate name was changed to Capital in 1948.

FAA Negotiates Sharp Reduction In Military Airspace Restriction

Washington—Federal Aviation Agency has brought about a sharp reduction in the prohibited airspace around the Los Alamos, N. M., nuclear installation in the latest phase of its drive to open military restricted areas to public travel.

The action brings to a total 12,206 sq. mi. the areas that have been released by the military services from restricted classification in the past 14 months since FAA first launched its program to eliminate all restricted and prohibited airspace that could not be fully justified. As a result of the program, there are now only seven U. S. areas from which civil aircraft are barred.

The Los Alamos airspace, from which civil aircraft are prohibited from operating, has been reduced from 346 sq. mi. to 45 sq. mi. In an earlier action, the entire 171 sq. mi. prohibited area at Oak Ridge, Tenn., was revoked and is now open to civil air traffic.

For a number of years, large sections of airspace blocked off by military services as restricted or prohibited areas have been the target of much airline criticism. The carriers have charged that much of the reserved airspace was unnecessary and forced carriers to undertake costly deviations from established routes in order to avoid the prohibited areas.

Prohibited areas are normally established by presidential order and restrict civil aircraft from entering the area for reasons of security. Restricted areas are blocked off to permit unusual aerial activity or gunnery practices.

Responsibility for the allocation of airspace was granted to FAA on May 15, 1959. In July of that year, FAA issued a special regulation calling for a detailed utilization report by the controlling agency of each restricted area. A large volume of restricted airspace was voluntarily freed following issuance of the regulation. In addition, surveys and consultations with the controlling agencies of the airspace under question resulted in further reductions.

In some areas, time of restriction has been reduced permitting public use of the airspace on a part-time or seasonal basis. In some areas, the joint use concept was introduced.

At the same time, FAA has established certain additional restricted areas in order to meet military requirements. For example, during June and July, military climb corridors, about 89 sq. mi. in size, have been set up at Minot, N. D., Klamath Falls, Ore., Grandview, Mo., Mt. Clements, Mich., Limestone, Me., and Victorville, Calif.

As of July 31, FAA has revoked 36 restricted areas and two prohibited areas. Total of 25 new restricted areas have been established, 12 restricted areas were reduced in size and four increased in size. Time designation of 12 restricted areas totaling 2,459 sq. mi. has been reduced, and 20 restricted areas totaling 6,886 sq. mi. have been reduced in vertical size.

Here are a few of the actions taken by FAA during the past two months:

- **In the southwest portion** of the large eastern California complex, a major source of controversy between the airlines and military services or manufacturers operating test flights, a 112 sq. mi. section was released. In the same general area, a 20 sq. mi. reduction was made in the northwest corner of the Bullion Mountains restricted area. The reductions have accelerated the movement of traffic between the Los Angeles-Long Beach areas and from Los Angeles to points east.
- **Restricted military climb** corridor was revoked in Burlington, Vt., releasing 133 sq. mi. of space.
- **Entire restricted area** releasing 864 sq. mi. to civil air traffic, was revoked in upper Lake Huron, Mich. Lake Huron region was modified and reduced for a savings of 135 sq. mi. of free airspace.
- **Chincoteague Inlet,** Wallops Island, Va., has also been modified and cut from 142 to 99 sq. mi.
- **Restricted ceiling** at Ft. Leonard Wood, Mo., has been lowered from 50,000 ft. to 6,000 ft.

As a means of facilitating the public use of restricted airspace, FAA has designated itself controlling agency of 17 of the present restricted areas. It will assume control of eight additional restricted areas Aug. 25. Over the 14 month period, FAA has reduced the total restricted and prohibited airspace from 148,814 to 136,000 sq. mi.

CRAF Moving Toward Turbines

Washington—Civil Reserve Air Fleet contract and large piston-driven aircraft will not guarantee an air carrier major military contracts in Fiscal 1961 and 1962, the Air Force warned here last week.

Speaking to eight industry spokesmen representing the Air Transport Assn., the Independent Airlines Assn. and the Supplemental Air Carriers Conference, Assistant Secretary of the Air Force Philip B. Taylor pointed out that over-all Department of Defense requirements for commercial airlift are decreasing.

Taylor's comments were interpreted by the industry as a "go slow" signal to supplemental and contract carriers that might be on the verge of buying Lockheed 1649 Constellation or Douglas DC-7 equipment to qualify for CRAF standby contracts.

These agreements represent a premium, for when Military Air Transport Service negotiates more than $40 million worth of commercial airlift contracts this September, CRAF participants will be accorded preferential consideration (AW Aug. 1, p. 42). As of July 1, there were 19 carriers in the program, including six of the 12 domestic trunklines in the United States.

Even though about 55% of MATS passenger traffic and 10% of its overseas cargo will be moved by civilian carriers in Fiscal 1961, Taylor said here that military transportation requirements as a whole have decreased 100,000 ton-miles in the last fiscal year. This decline, he said, was forecast to continue.

Taylor emphasized that the 1649 and the DC-7 will be "removed from the CRAF program as soon as Boeing 707-300s and Douglas DC-8s are available to satisfy remaining passenger requirements. Procurement of this type aircraft in passenger configuration . . . by any carrier will only enable it at best to acquire business for a short period of time," Taylor added.

Taylor said that this reasoning also could be applied to purchases of DC-7 and 1649 freighter conversions for, with the Canadair CL-44 "right around the corner," carriers would be risking their investment if they relied upon less modern aircraft to capture MATS business.

Actually, the number of CRAF carriers recently has been decreasing. As of Nov. 1, 1959, 23 had pledged their air fleets to the Air Force in the event of national emergency. Last year's list was made up of AAXICO, Alaska Airlines, American, Braniff, California-Hawaiian, Capitol Airways, Continental, Delta, Flying Tiger Line, Hawaiian Airlines, National, Northwest, Overseas National, Panagra, Pan American, Resort, Seaboard & Western, Slick, Trans-Caribbean, Transocean, TWA, United and United States Overseas Airlines.

Last month, AAXICO, Continental, Delta, Panagra and Transocean no longer were participants. And even though World Airways had executed a contract, the roster of CRAF carriers decreased about 17% and failed to include, among the trunklines, the names of Eastern, Capital, Continental, Delta, Northeast and Western.

La Guardia Safety Survey by Pilots May Determine Cutback Demands

By David H. Hoffman

New York—An airline pilots' survey of possible flight hazards arising out of La Guardia Airport's $56 million construction program may result in a demand for significant traffic cutbacks at the terminal here.

Questionnaires, distributed last month to about 1,500 Trans World Airlines pilots, will determine whether Air Line Pilots Assn. headquarters recommends further operational restrictions for La Guardia, the nation's fifth busiest airport in 1959.

Preliminary returns in the poll indicate that, at the very least, pilots are overwhelmingly in favor of raising La Guardia's present minimums (600 ft. ceiling and 1.5 mi. visibility), which govern circling approaches to the airport's only usable runway.

Meeting last week in Boston, TWA's Master Executive Council considered these other pilot recommendations, which, if adopted, would slow the pace of arrivals and departures at La Guardia:

- **Restricting** the airport to day operations only during the period of peak construction.
- **Ruling out IFR** (instrument flight rules) operations until the airport's ILS runway, 4-22, is reopened in November.
- **Reducing the maximum crosswind** permitted for landing and eliminating all downwind takeoffs and landings.
- **Urging the six scheduled airlines** operating into La Guardia to reschedule more of their flights to nearby Idlewild and Newark airports until the construction program is complete.

The six carriers—American, TWA, United, Eastern, Capital and Northeast—already have shuffled their La Guardia flight patterns to minimize traffic snarls on the airport's obstructed taxiways and congested parking areas.

In addition, traffic through the terminal has been cut back to the extent of about 80 plane movements per day. In January, 1959, to illustrate, there were 12,457 landings and takeoffs at La Guardia. Last January there were 11,525. During June, 1959, the airport recorded 16,292 plane movements as opposed to 13,891 in June, 1960.

Many airline pilots feel that La Guardia's vast face-lifting project is compromising flying safety at the airport (AW Apr. 18, p. 41). Their complaints center on the shortness of Runway 13-31, which was reduced from 5,914 ft. to 4,900 ft. shortly after Runway 4-22 was shut down.

Pilots maintain that Lockheed Super Constellations and Douglas DC-7s, even though weight limited to 105,000 lb., cannot operate safely from a 4,900 ft. runway unless all other factors—wind, weather and airport facilities—are favorable. At La Guardia such is not often the case.

Rather than shielding Runway 13-31, the 15 ft. embankment that parallels the runway's northwest edge creates a burble effect that actually exaggerates the impact of crosswinds, according to some pilots. Moreover, poorly lighted or unlighted taxiways complicate night ground operations. The same applies to the old yellow centerlines that no longer mark the center of La Guardia's reshaped ramp areas.

Most instrument approaches to the airport follow the La Guardia ILS localizer to the northeast until visual contact with landing Runway 13-31 is made at or above the 600 ft. altitude minimum. At this point, pilots landing to the northeast turn sharply to a downwind heading of 130 deg. before reversing course over Flushing Bay.

Aircraft landing to the southeast, however, overfly La Guardia on the ILS and then execute a gradual 270 deg. left turn around Rikers Island that, the pilots contend, takes them dangerously close to a 422 ft. fuel storage tank and five 293 ft. smoke stacks in the Bronx.

The Federal Aviation Agency, which approved the 600 ft. circling approach, agrees that standard obstruction clearances are not provided. Pilots, on the other hand, point out that an altimeter, incorrectly set by .2 in. could lead to a collision with the Bronx tank when coupled with marginal visibility on the circling approach to Runway 13.

ALPA will first present its recommendations to the FAA, the carriers and the Port of New York Authority. ALPA officials feel discussion will dissolve whatever differences of opinion exist among the parties concerned with La Guardia.

Eastern Orders 720s

Washington—Eastern Air Lines placed a $44 million order for 10 Boeing 720 medium range turbojet transports last week. Delivery is scheduled to be completed in 1961, and the carrier said it will have nonstop turbojet service on all main trunk routes at that time. Eastern plans either to buy the 720s, equipped with Pratt & Whitney 13,000 lb. thrust JT3C-12 engines, directly or lease them through a separate corporation formed for the purpose.

Aeroflot Begins Flying Second Siberian Route

Moscow—Aeroflot has started proving flights over its new northerly trans-Siberian route between Moscow and the Soviet Far East.

First transport to make the run was a four-turboprop An-10A. It flew from Moscow to Khabarovsk via Syktyvkar, Norilsk and Yakutsk.

The new route represents the frequently-delayed "double tracking" of the existing trans-Siberian airway from Moscow to Khabarovsk and Vladivostok via Sverdlovsk, Omsk, Novosibirsk, Krasnoyarsk and Irkutsk.

With the alternate route available, planes flying across Siberia on either track can shift north or south via interlinking corridors to bypass closed airports.

When in full operation, the northerly route will extend beyond Yakutsk to Magadan. At Magadan some planes will continue eastward to Petropavlovsk, Kamchatka, and others will go south to Khabarovsk.

Aeroflot estimates that the northerly route, which goes above the Arctic Circle at Norilsk, will cut "almost 1,000 kilometers" (621 mi.) from the present 3,600-mi. air route between Moscow and Yakutsk. Distance saved between Moscow and Petropavlovsk—longest USSR air route—will be over 1,000 mi.

TWA Florida Route Confirmed by Board

Washington—Civil Aeronautics Board upheld Trans World Airlines' authority to serve Florida from St. Louis and Kansas City last week, but the Board added a restriction against through service from the West Coast as the result of a court decision.

CAB originally granted TWA authority to operate through service from the West Coast to Florida with a stop at Kansas City or St. Louis. Complaints from Delta Air Lines and Eastern Air Lines to the U. S. Court of Appeals led to a decision that TWA be required to change aircraft at Kansas City, St. Louis or Nashville, Tenn.

Court said the Board might "impose such a restriction upon the route awarded to TWA via St. Louis as to ensure that it would not be an effective competitor with any single-plane, single carrier transcontinental route which might result from the Southern Transcontinental Case."

CAB Vice Chairman Chan Gurney dissented from the Board decision to uphold TWA's authority, saying he was "convinced that this route does not warrant an additional nonstop carrier."

Seaboard and Western Creditors Participate in Refinancing Plan

New York—Creditors of Seaboard and Western Airlines last week agreed to participate in a refinancing plan for the airline that includes a voice for them in its management.

Creditors are Canadair, Ltd., from whom Seaboard has ordered five CL-44 turboprop transports; Esso Export Corp., for fuels, and Caldwell-Wright Division of Curtiss-Wright Corp. for piston engines for its Constellation aircraft. Also involved are two aircraft lessors, Air-World Leases and International Aviation Corp.

New Directors

Richard M. Jackson, former associate of Laurance S. Rockefeller, was elected general manager and acting chairman of the board, and Peter J. Aird, chartered accountant with Canadair, was elected a board member, increasing the board from six to eight members. Both Jackson titles are new in the company. Raymond A. Norden remains as president.

The financing plan calls for:

- **Issuance of $3.3 million** of 10 year nonconvertible debentures to major creditors, who will make additional advances to the carrier.
- **Sale of $1,570,000** of 6% 10 year Series A debentures to the public on a best-efforts basis by Carl M. Loeb, Rhoades & Co. The debentures are convertible into new common stock at $3 a share and also carry five year warrants to purchase at $3 a share 166⅔ shares of stock for each $1,000 principal amount of debentures.
- **Reverse 1-for-3 split** of the present 1,080,000 shares of stock issued, reducing outstanding shares to approximately 350,000.
- **Offering to present stockholders** of two new shares for each new share held at a price of not less than $3 a share.

Purchasers of the Series A debentures agree to purchase an additional amount of another series of debentures, classed as Series B, if the offering of new stock to stockholders fails to raise $2 million—the Series B bonds to provide the difference. The Series B debentures are convertible to stock at $3 a share, but carry no warrants.

To provide immediate funds to meet Seaboard's critical financing demands, Canadair, Esso and Curtiss-Wright and a small group of private investors have purchased $2 million in temporary debentures which are exchangeable for Series A debentures and warrants.

Series A and B debentures will carry voting rights equal to the number of shares into which they are convertible, which might give the creditors considerable voice in selection of management in addition to its influence on policy through board members.

At the end of 1959 Seaboard had about $9.5 million in short and long term debts (AW May 2, p. 183). Some but not all of this debt, which includes unsecured notes payable to suppliers, will be retired.

If all the offerings are fully subscribed, Seaboard would raise $6.8 million—$2 million for new stock, $3.3 million for the non-convertible debentures and $1,570,000 on the convertible debentures.

Since the debenture offering is on a best-efforts basis, the company is not assured of receiving the full amount as it would be where an underwriting syndicate brings out an issue on a commission basis.

Authorized capitalization of the company would be raised to 4,500,000 shares to cover possible future debenture conversion and warrant purchases.

Seaboard is party to three aircraft leases. Five Super Constellations and 15 spare engines are leased from Airborne Carriers, which is not a party to the financing proposal as it stands now. This lease expires next year. Two Super Constellations are leased from Air-World Leases, one of the signers, and one Super Constellation and four spare engines are leased from International, another signer.

Jackson is not a creditor's representative in the Seaboard management. As a management consultant, he is regarded more as bringing a neutral, outside viewpoint to the company.

British Shift Jet Noise Emphasis

London—Major switch in emphasis in Britain's jet engine noise research program from jet efflux to intake noise suppression has been made to meet the growing noise threat during airfield approaches.

Work at the National Gas Turbine Establishment now is wholly concentrated on the suppression of upstream noise propagation from the compressor intakes by the use of variable geometry hubs.

Various engineering arrangements currently are being evaluated whereby during part-throttle operation the intake is choked by the hub, making the relative velocity of the air sonic with respect to the blade.

Compressor noise is a function of blade frequency, so that by creating sonic flow conditions in the compressor, forward (upstream) noise propagation is effectively inhibited, without increasing engine speed.

Annoyance Levels

Annoyance levels from the compressors during the long, low approaches under part-throttle conditions of large jet transports could be as objectionable as the current takeoff noise which is produced by the jet efflux, British experts warned.

Opinion at the Establishment is believed to hold the view that suppression of jet efflux noise by current techniques has been stretched as far as it can go without imposing severe flight performance penalties. Noise reduction on a jet centers largely on reducing the relative velocity of the efflux with respect to the outside slipstream, the noise being generated by the shearing of these two flows. It is whine noise, with the most obnoxious contribution occurring in the spectrum around 60,000 cps.

Suppression is consequently effected by slowing the jet speed or accelerating the pod slipstream. A slow jet is the feature of the fan engines and fast local slipstream velocities is the principal mechanism of most suppressors on existing straight jet engines.

Combination of jet suppression on a high fan ratio engine could effect a maximum noise reduction of about 30 db, and no more according to Establishment investigations. On this basis, suppressor-equipped fan engines would be much quieter than piston engines.

Drag Penalties

But, according to some operators, the drag penalties of suppressors have been underestimated and reports suggest that on the Sud Caravelle direct operating costs have increased by as much as 5% by the addition of suppressors.

For this reason, suppressor for fan engines are viewed as unlikely.

The Establishment, in an experiment with 1,600 persons and using refined techniques, has confirmed the empirical methods of assessing perceived noise levels established by Bolt, Beranek, and Newman in experiments for the Port of New York Authority. Measurements here agreed within a decibel with those postulated by the methods and officials concede that although the distinction between loudness and disturbance is thin, it is a valid one. In addition the Establishment report notes, the superimposition of discrete frequencies to a random noise for equal sound pressure level has no effect on apparent loudness but was judged to be 2 db. more disturbing.

SHORTLINES

► **Aerolineas Argentinas** has taken delivery of the sixth and final de Havilland Comet 4 turbojet airliner in its order. The Comet 4, powered by four Rolls-Royce Avon engines, has been in operation on the Argentine state airline since May, 1959, on European runs and since June, 1959, in U.S.-South American service. The carrier reports a 90% increase in revenues in the first six months of Comet 4 operation.

► **East Coast Flying Service, Inc.**, a contract carrier and fixed base operator in Martinsburg, W. Va., has received the largest of three contracts from the National Aeronautics and Space Administration for air service between Langley AFB, Va., and Patrick AFB, Fla. East Coast's contract is for $218,763.16 and calls for four weekly one-way trips. Capitol Airways received a similar contract from NASA for $160,913.28 and South East Aircraft Corp. received a contract for $116,698.

► **Federal Aviation Agency** has increased the time between overhaul on the Pratt & Whitney Aircraft R-2800 piston aircraft engine from 2,400 hr. to 2,500 hr. The engine is used on Convair 240s, 340s and 440s, all versions of the Douglas DC-6s and Martin 404s.

► **Iberia Air Lines** of Spain has reduced its domestic fares by approximately 15 to 20% by adjusting the official International Air Transport Assn. exchange rate, which stands at 60 pesetas to $1.

► **KLM Royal Dutch Airlines** reports operating revenues for the 12 month period ending June 30, 1960, of $150.3 million, an increase of 12% over the previous fiscal year. Net earnings for the period were $3.9 million, compared with $3.5 million for the previous year.

► **Linea International Aerea, S. A.,** has been recommended for a temporary foreign air carrier permit by a Civil Aeronautics Board examiner to operate air service from Guayaquil and Quito, Ecuador, to Havana, Cuba, and Miami, with flag stop authority at Panama City and San Andres Island, and from Guayaquil and Quito to Bogota and Miami with flag stop authority at Jamaica.

► **Mohawk Airlines** has asked for authority to operate a new nonstop route from Elmira, N. Y., to Washington, D. C. The route would extend from Utica/Rome, N. Y., to Washington via Ithaca, N. Y., and Elmira, eliminating the change of airlines now required for passengers flying between Washington and Utica and Ithaca.

AIRLINE OBSERVER

► British government is ready to place a detailed design contract with British manufacturers for the development of a supersonic transport plane but will seek collaboration with foreign companies in undertaking the project. Ministry of Aviation will select one of the two airframe groups and one of the two engine groups to pursue the work of design detail. At the present time, the government is discussing with the four groups financial and other terms under which the project will be developed. Feasibility studies have included a Mach 2 light alloy project and a Mach 3 stainless steel aircraft. Chances are strong that design studies will be concerned with both types until the program reaches a stage where a firm decision can be reached.

► **Soviet airline Aeroflot says it handled 38% more passengers during the first half of 1960 than in the same period last year. The carrier says it exceeded its passenger traffic goal for the six months by 1%. Gain in number of passengers carried was the largest for any half-year period in Aeroflot history, although percentage increases are declining. The 38% gain for the first six months of 1960 compares with a 45.8% increase in the first quarter of 1960, a 48% gain for the entire year of 1959, 56% in 1958 and 69% in 1957.**

► Resignation of John Brancker as traffic director of International Air Transport Assn. is stirring industry-wide attention because of the implications behind the action. The resignation was not voluntary but was requested by Director General Sir William P. Hildred, who urged the IATA Executive Committee to ask for Brancker's resignation. Brancker holds the strong support of a wide number of airline officials who feel his ability has done much toward maintaining stability and promoting compromises in controversial rate and fare issues that have plagued the IATA Traffic Conference in recent years.

► **No-show problem on overseas flights is growing at New York International Airport because of difficulty in making close connections between widely scattered terminal buildings at the airport.**

► Negotiations between the U. S. and Philippines and Mexico on bilateral air transport agreements have been resumed. Meanwhile, Douglas is pushing its DC-8 in the Mexican market with chances strong that an order for three may be placed shortly by Aeronaves de Mexico. Mexican market now stands as largest U.S. foreign travel market, with U.S. tourists spending more money annually in Mexico than any other country. Travelers from Mexico account for 18% of all U. S. income from foreign visitors, a total second only to receipts from Canadians.

► **Federal Bureau of Investigation has arrested 25 individuals charged with false bomb hoaxes since Apr. 1. Approximately 1,000 bomb hoax threats have been investigated by the FBI since July, 1956, when the Destruction of Aircraft or Motor Vehicles Statute was approved.**

► Delegation of 11 Soviet civil aviation specialists arrived in Washington last week for a three-week visit of airline and airport facilities in Washington, New York, Boston and Miami. Tour is under the direction of the Federal Aviation Agency. A similar U. S. delegation, headed by FAA Administrator E. R. Quesada, will visit the Soviet Union for a reciprocal three-week tour beginning Sept. 19.

► **Japan Air Lines will cut passenger rates on domestic routes 10% by early fall. Carrier will begin Douglas DC-8 turbojet service between Tokyo and San Francisco Aug. 12 and will gradually move Douglas DC-7s and DC-6Bs from international routes to domestic operations.**

► Northwest Airlines is leasing back the five Douglas DC-7s it traded to Douglas Aircraft Co. as part payment on five DC-8s. The leaseback contract is effective through March. Retirement of nine Northwest Lockheed Electras for retrofit (AW Aug. 1, p. 37) and increased traffic projections made the move necessary.

BELGIAN Red Cross workers, Boy Scouts and police gather in rain to aid refugees in debarking from Sabena DC-6.

Sabena Faces Route Crisis After Airlift

By Cecil Brownlow

Brussels—Sabena Belgian World Airlines may face a severe crisis for the future above and beyond the substantial revenue loss stemming from its emergency Congo refugee airlift that drained away aircraft from its most lucrative markets.

Sabena's attempts to find a solution to its problem also may mean increased competition for other carriers over routes that already are highly competitive.

If the present Congo leadership wins out in its determination to erase all traces of Belgian rule, both economic and military, a vital link in Sabena's network will be severed, one that over the years has accounted for approximately 40% of the carrier's annual revenue.

Before the Congo uprising, the Belgian carrier served a total of 43 cities and towns within Africa, 37 of them in its former protectorate, with a network totaling approximately 51,200 mi. Other Sabena routes linking Brussels and Africa amounted to another 136,000 mi.

Possible irretrievable loss of these routes, which represent about one third of the airline's total route structure, is a matter of major concern to top Sabena officials who, at the same time, must cope with the day-to-day problems of providing an airlift to the Congo and maintaining a semblance of commercial service.

These officials hope that somehow, some way, the Lumumba government will be replaced by a pro-Western—more-importantly, pro-Belgian—regime. Barring this, they hope that the province of Katanga, with its mining interests and modern jet airport at Elisabethville, can remain friendly and open.

They are under no illusion, however, that either of these aspirations will be easily attained. If all else fails, Sabena will turn its efforts to other areas, notably the South American market which already has a history replete with rate wars and severe competition. The carrier also probably will move to strengthen its hand in the Far Eastern market and within Europe.

Sabena also knows that, should it be forced from the Congo, there will be no lack of willing heirs. Possible successors include Western carriers already operating extensively within the African network as well as politically-motivated Iron Curtain airlines, particularly Czechoslovakia Airlines, which apparently is searching for a strong foothold in the area.

Intensive Effort

Intensive airlift effort by Sabena spanned 20 days between July 9 and July 28 when the relative calm in the Congo and the halt in flow of Belgian troop reinforcements to the area permitted the carrier to put almost all its aircraft back into commercial service.

Because of the suddenness with which it came, the shifting patterns from day to day and the lack of complete information on flights within the interior of the Congo, no comprehensive estimate is yet available on the financial loss the refugee airlift has, or will, entail for Sabena and the Belgian government as a whole.

But there is no doubt that it will be staggering. Between July 9 and July 22, when Sabena began shifting some of the airlift planes back into commercial service, the airline had committed its full fleet of five Boeing 707-320 turbojet transports and eight Douglas DC-7Cs plus 12 DC-6 and -6Bs and one DC-4 into the emergency operation (AW July 25, p. 38).

Within the Congo, the carrier also turned its fleet of four DC-4s, four Convair 440 Metropolitans and 13 DC-3s and C-47s to the task of shunting refugees from the interior to such major evacuation points as Leopoldville, Elisabethville and the Belgian military base of Kamina in the central Congo.

Prior to the airlift, Sabena on the North Atlantic alone had been scheduling a total of 13 round trips per week with its 707s between Brussels and New York, with two of the flights stopping at Montreal.

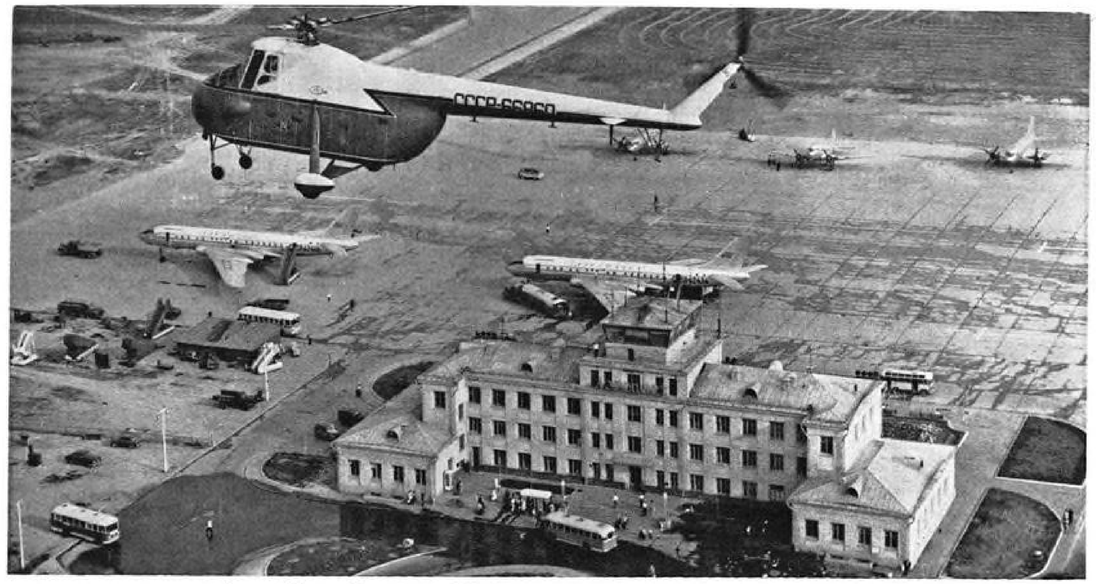
Combined east and westbound passenger load factor for these flights—each with 18 first-class and 126 economy seats—had been averaging 65% during the summer tourist season now in full swing.

Considering only the 11 direct round trip flights between Brussels and New York and applying the basic $290 economy fare to all 93 seats occupied during an average one-way flight, the airline lost over $500,000 per week in potential gross passenger revenue fares on this route between July 9 and July 22.

Over-all, Sabena's five 707s had been following a schedule of 24 round trips per week—eight to Leopoldville, with two via Elisabethville and two via Johannesburg, South Africa; three to Moscow, and the 13 North Atlantic flights.

The DC-7Cs, DC-6s and 6Bs used in the airlift were pulled back from scheduled service within Europe and to Moscow, Leopoldville and the Near East, including Cairo, Ankara, Athens and Teheran.

In addition to the loss of its own revenues and the burden of the airlift itself, Sabena has been forced to supplement its efforts by chartering aircraft from other airlines to aid in the evacua-



Aeroflot Begins Helicopter Service at Moscow

Aeroflot has inaugurated scheduled passenger helicopter service linking Sheremetyevo International Airport with Moscow. Later service will also be available to and from Vnukovo Airport, which now handles domestic flights exclusively. According to the announced schedule, Mi-4 helicopters carrying up to 11 passengers make 10-12 round trips daily between Frunze Central Airport in the outskirts of Moscow and Sheremetyevo. At present, travel time by taxi or bus takes at least an hour and sometimes more from Sheremetyevo to the center of Moscow. Helicopters make the hop to Central Airport in approximately 12 min., according to officials. Then, passengers can take a taxi or a subway the remaining 6½ mi. into the center of Moscow. Flight is made at 800 ft. altitude. Central Airport, oldest in Moscow area, features concrete landing apron, restaurant, ticket office, waiting room and information center. Aeroflot officials plan commuter type service to nearby communities such as Fryazino, Konakovo and Ruza. Aeroflot bus brings passengers to central airport (below).

tion and to fill in major gaps within its European route structure, which it has tried to support throughout the Congo emergency.

Commercial airlines participating in the evacuation from the Congo have included Air France; Alitalia; Central African Airways of Rhodesia; Ethopian Airlines, KLM Royal Dutch Airlines; Lufthansa-German Airlines; Sobelair, a Belgian nonscheduled airline; Swissair; Trans Mediterranean Airways, a Lebanese charter service; Transair, Swedish charter airline, and Union Aeromaritime de Transport of France.

A significant portion of the refugee evacuation program has been taken over by USAF flying Lockheed C-130 turboprop transports and Douglas C-124s (AW July 25, p. 37), but by far the major load has remained with Sabena.

During the airlift Sabena ferried out a total of 25,711 passengers, including 15,596 adults, 8,327 children and 1,888 infants in a total of 209 flights—62 with 707s, 66 with DC-7Cs, 81 with DC-6 and DC-6Bs. Other carriers, including USAF, transported a total of 8,773 refugees from the Congo Republic during the period. Sabena aircraft logged a total of 6,217 airlift flight hours.

All Sabena aircraft in the airlift have been converted to all-economy configuration, with 188 seats fitted six-abreast into the 707. Since passengers are only permitted to carry a minimum of baggage aboard and, for a period, the security of the Congo airports was almost an unknown factor, the 707s often took off with more than 250 persons aboard, children sitting two and three abreast in the aisles and in closet spaces, infants swinging from bassinets that had been hung from the ceiling. Highest figure to date for a single 707

has been 303–293 passengers and 10 crew members.

On a typical day, five Sabena 707 flights would leave the Congo along with seven DC-7C and eight DC-6 flights carrying a total of approximately 2,500 passengers.

In general, both aircraft and crews were expected to be rugged. A 707 averaged one round-trip flight per day between Brussels and the Congo, flying a total distance of 7,738 stat. mi. in a flying time that ranged between 14.5 and 16 hr. depending upon weather and winds.

Progressive block maintenance checks were maintained throughout, but they were broken into smaller increments. A 707 due for a check requiring three hours, for example, would be hustled to the hangar after a Congo flight, given the first third of the check, buttoned up and pulled out to prepare for another flight to the Congo. On its return, it would be rolled back again for the second hour of its check, finally finishing it after its third flight from the Congo.

Flight crews followed the same pattern. Of Sabena's 280 fixed-wing captains and first officers, 166 were assigned to the airlift, and each crew took its plane from Brussels to the Congo and returned with it.

707 Routing

A 707 crew flew the seven-eight hour flight to Leopoldville, remained there for about two hours while the aircraft was refueled and loaded, and then climbed back into the cockpit for the return nonstop flight to Belgium.

For crews of the piston-engine aircraft, the ordeal was greater. The DC-7C, with intermediate stops for refueling, made it to Leopoldville in about 14 hr., the DC-6 in approximately 17 hr. After a grueling flight over the hump of Africa, the crew then was directed to take off again, picking up evacuees at points within the interior and ferrying them back again to Leopoldville, Elisabethville, Kamina or other collection points. Then, when its aircraft was loaded, the crew began the grind back to Brussels.

Most crews, once back in Belgium, had at least a two-day layover before being called upon again to begin the long haul back to the Congo. And, according to Sabena officials, there was little or no complaining, with the air crews recognizing the humane aspects of their missions and tackling them head-on.

Schedules for both the airlift and commercial service were worked out on a day-to-day basis, depending in the first instance upon the number of refugees to be evacuated and their location; in the second on the number of Sabena aircraft to be available, the flights with the heaviest bookings and, therefore, priority, and the number of other airlines that could lend support by taking over specific flights. The schedules often are drafted no more than 12 hr. before the first flights were to begin on the following day.

European Service

Mainstay of its European service during this period were the five Convair 440s Sabena has on the continent plus one DC-4 from its Congo fleet that happened to be in Brussels for a major overhaul at the time the crisis began. Spending the least possible time on the ground—passengers were sometimes called for one flight as their 440 taxied to the ramp to unload another—the aircraft flew daily to London, Paris, Amsterdam, Glasgow, Manchester, Nice and other points.

If these aircraft were not available for a scheduled flight, Sabena looked for another carrier that had either a parallel flight or an aircraft available in Brussels long enough for a flight to be maneuvered in during the interim.

Almost all European airlines that touch Brussels, including Aeroflot which took over one Brussels-Moscow flight, came to Sabena's aid at one time or another.

On any particular day, as many as 11 of 30 planned flights may have to be canceled, with other carriers taking over many that remain. On a recent day these airlines helped fill the gap:

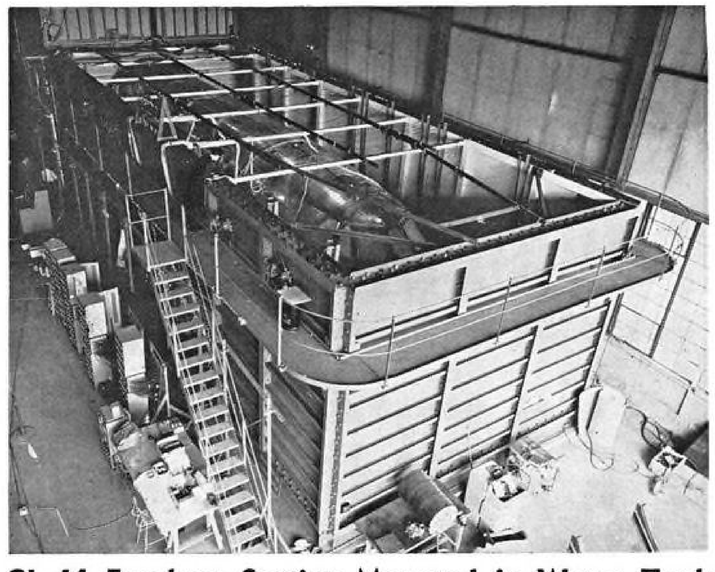
- **Olympic Airways** took over a flight to Athens.
- **KLM** assumed responsibility for a Barcelona flight.
- **British European Airways** flew the three Sabena schedules to London.
- **Scandinavian Airlines System** took over on the Amsterdam-Copenhagen run.
- **Alitalia** flew to Rome for Sabena.
- **Iberia Air Lines** of Spain made a flight to Barcelona and Palma.
- **Swissair** picked up a Zurich flight.

In all such flights, Sabena had attempted to put one of its own stewardesses aboard to complement the regular crew in an effort to retain at least a portion of its passenger identity.

Return to Service

With demands for an all-out airlift at any cost apparently on the decline as the situation quieted in Congo, Sabena officials were hopefully re-introducing their evacuation aircraft to scheduled service.

One 707 was pushed back onto the Brussels-New York route with a schedule of one round trip per day; a second was to begin ferrying paying passengers to Leopoldville, carrying out refugees on its return. DC-7Cs were to begin revenue flights to Elisabethville via Athens or Rome, Cairo and Usumbura, again returning from the Congo with refugees. The larger problem, however, the question of Sabena's future in Africa, still remains.



CL-44 Fuselage Section Mounted in Water Tank

Canadair CL-44 forward fuselage section is mounted in water tank at Montreal, Canada, for static and fatigue testing. External loads are hydraulically applied to the airframe section which is fully instrumented to measure stress levels, loads and deflections. The fuselage section is cantilevered from central bulkheads to simulate the effect of a wing in flight. Rear section of 141-ft. tank has a lateral extension to permit motion of CL-44's swing tail.

Douglas Offers New Caravelle Version

New York—Douglas Aircraft Co., which began a U.S. sales demonstration tour for the Sud Caravelle jet transport last week, will offer three versions of the aircraft including a new Caravelle VIII. Besides the Caravelle VI-R, powered by the Rolls-Royce Avon 533R turbojet with reverser which United Air Lines has ordered, and the Caravelle VII to be powered by the General Electric CJ 805-23D aft-fan engine, Douglas will also offer the airplane powered by the Rolls-Royce RB141-11-A bypass engine.

Latest specifications, issued by Douglast Aircraft, show virtually identical performance for the Caravelle VII and VIII. These versions will be 3 ft. 4 in. longer than the 105 ft. long Caravelle VI and will carry 78 passengers (mixed class) compared with the 72 in the Caravelle VI. In all-first-class configuration the longer airplane will carry 68 passengers as against 64 in the Caravelle VI, and 90 all-tourist passengers compared with 80 in the shorter aircraft.

Caravelle Speeds, Range

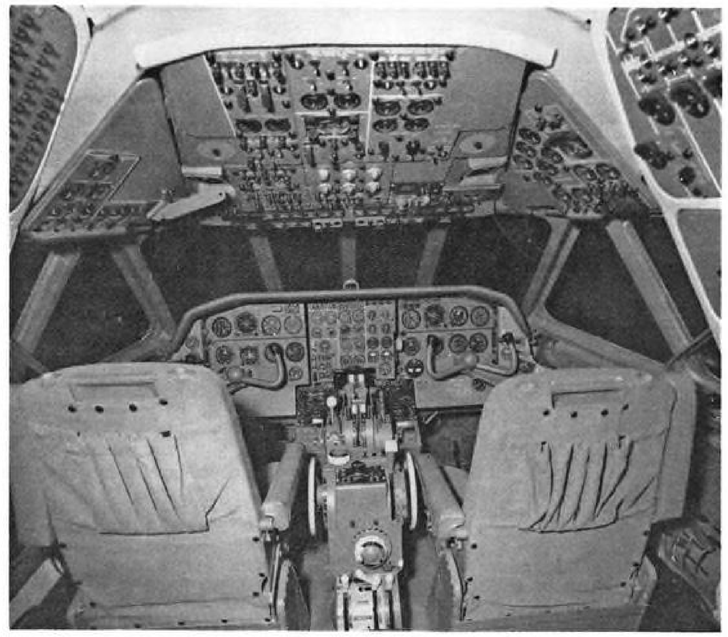
Maximum speed of the Caravelle VII and VIII of 538 mph. is 8 mph. faster than the earlier version. Range with full passenger load increases from 1,930 mi. in the Caravelle VI to 2,350 mi. Takeoff distance (sea level standard day) is 6,650 ft. for the Caravelle VI, 6,400 for the Caravelle VII and 6,450 for the Caravelle VIII; landing distances are 4,800 ft. for the VI and 4,850 ft. for the other two.

Maximum gross weight of the General Electric-powered Caravelle VII is increased in the latest specifications to 114,640 lb. from 110,230 lb. quoted earlier (AW May 2, p. 119), and maximum landing weight rises from 104,720 lb. to 109,172 lb. The same weights are specified for the Caravelle VIII.

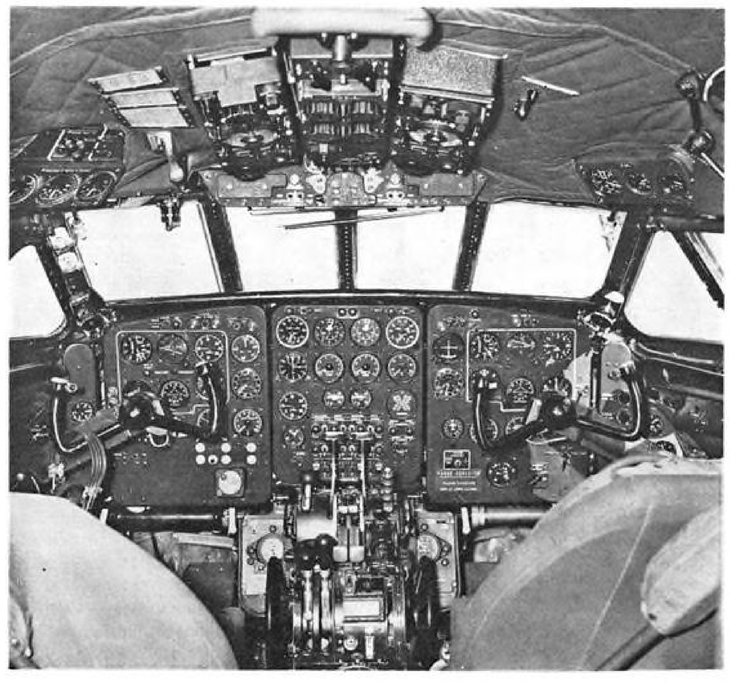
Payload of the VII and VIII is the same—18,220 lb.—compared with 16,860 lb. for the Caravelle VI.

Douglas is leasing an airplane bought by General Electric and delivered to GE here last week. This airplane is a Caravelle III which will be taken to Edwards AFB, Calif., at the end of the Douglas sales tour Aug. 26, where its present Rolls Avon 527 engines will be replaced at GE's flight test center with the company's fan engines. Douglas has a $2.1 million contract to deliver five pods, stubs and related equipment for the engine retrofit.

GE will use the airplane as a demonstrator for its engines, as an additional flight testbed for the engines, and perhaps eventually for a corporate transport. Three of the five pods will go to Sud, two for installation on the



REDESIGNED COCKPIT to go on the Caravelle VI-R and later series will increase visibility. Mockup of the new nose (above) compared with the present cockpit (below) indicates how front windshield panels will be lengthened and side panels increased in size and modified in shape. Seats are moved forward also a visibility aid. Instrument panel and overhead layout is reshuffled and communications and navigation control boxes will be brought down from the overhead and mounted on the pedestal.



Please see B. F. Goodrich Adv. on page 22.

GENERAL ELECTRIC will fit its Caravelle III with CJ805-23 aft-fan engines later this year, using the airplane as a demonstrator and for engine testing.

first Caravelle VII and one for static test.

The GE Caravelle, with the CJ805 engines, will not become a Caravelle VII, for besides retaining the shorter fuselage it will not have the redesigned cockpit that will be incorporated beginning with the VI-R version.

Earlier models still use what is essentially a Comet nose, but the new cockpit, while retaining the aerodynamic shape of the airplane now, will have considerably greater visibility. The front windshield panels will be increased in height and the side panels will be larger, of different shape and repositioned. Pilots' seats will be moved forward as a visibility aid.

The instrument panel will be shallower to permit repositioning of the seats, and the instrument layout will be changed. Communications equipment will be brought down to the console from the overhead, which itself will be extensively modified for other equipment, including two rows of warning lights just above the front windshield.

Douglas pilots were scheduled to demonstrate the leased airplane to trunk and local service airlines at New York, Boston, Montreal, Washington, Miami, Dallas, Kansas City, St. Louis, Chicago, Tulsa, Minneapolis, Denver, Vancouver, Seattle, San Francisco and Los Angeles. United Air Lines maintenance personnel will also be introduced to the airplane.

Douglas is promising delivery of the VI-R version in the fall of 1961 if enough orders are received, and the GE powered version early the following year—or possibly even in late 1961.

Federal Aviation Agency has accepted French certification of the Caravelle after three changes were made:

- **Passenger emergency oxygen** system with automatic pop out feature in case of cabin depressurization at altitude was installed.
- **Cockpit controls** for landing gear and flaps were repositioned, separating them entirely from the pedestal.
- **Flap guide rails** and control surface servos were modified to U. S. standards.

Caravelle Pilot Checks

Federal Aviation Agency is requiring that test pilots demonstrating General Electric's new Sud Aviation Caravelle twin turbojet transport obtain U. S. type ratings in the aircraft.

When General Electric, in conjunction with Douglas Aircraft Co., gave groups of industry spokesmen familiarization flights in the Caravelle in New York at the beginning of a U. S. sales tour, FAA inspector-pilots rode along. After orienting themselves in the aircraft, the FAA inspectors then sandwiched in check rides to give type ratings to the Douglas pilots who earlier had qualified on the Caravelle in France.

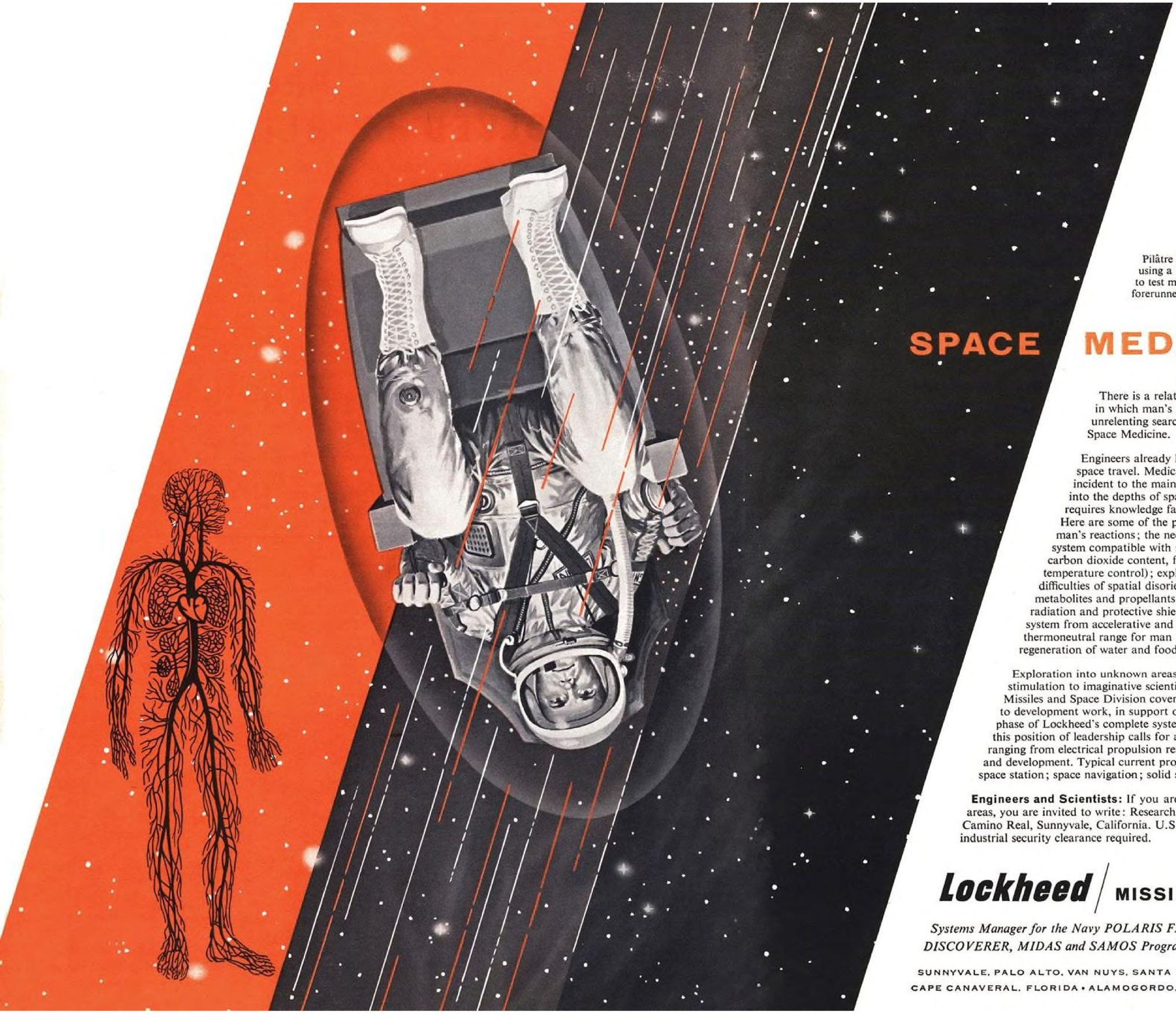
To comply with FAA's three-man minimum crew requirement for the Caravelle, Douglas also had to fly in a company-trained flight engineer from California before staging the demonstration flights.

CAB Blames Explosion For National Accident

Washington—Civil Aeronautics Board has found that detonation of dynamite in the passenger cabin was the probable cause of a National Airlines DC-6B crash Jan. 6 near Bolivia, N. C., in which 29 passengers and a crew of five were killed.

In its accident report, the Board said that a dynamite charge was exploded while the plane was in normal flight after passing the Carolina Beach "H" facility south of Wilmington, N. C. The charge was detonated by means of a dry cell battery within close proximity of a seat occupied by Mr. Julian A. Frank, the report said.

The Board emphasized, however, that no reference is made "in the report concerning the placing of the dynamite aboard the aircraft or of the person or persons responsible for its detonation." It said the criminal aspects of the accident were referred to the FBI for handling.



Pilâtre de Rozier and Marquis d'Arlandes (November 21, 1783), using a Montgolfier balloon, were the first to leave the earth to test man's physiologic reactions. This experiment was the forerunner of intensive Space Medicine studies of today.

SPACE MEDICINE

There is a relatively narrow zone above the surface of the earth in which man's physiologic mechanism can function. Hence the unrelenting search by Lockheed scientists into many aspects of Space Medicine.

Engineers already have equipped man with the vehicle for space travel. Medical researchers now are investigating many factors incident to the maintenance of space life—to make possible man's flight into the depths of space. Placing man in a wholly new environment requires knowledge far beyond our current grasp of human biology. Here are some of the problems under investigation: The determination of man's reactions; the necessity of operating in a completely closed system compatible with man's physiological requirements (oxygen and carbon dioxide content, food, barometric pressure, humidity and temperature control); explosive decompression; psycho-physiological difficulties of spatial disorientation as a result of weightlessness; toxicology of metabolites and propellants; effects of cosmic, solar and nuclear ionizing radiation and protective shielding and treatment; effects on man's circulatory system from accelerative and decelerative G forces; the establishment of a thermoneutral range for man to exist through preflight, flight and reentry; regeneration of water and food.

Exploration into unknown areas such as Space Medicine, provides endless stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum—from pure basic research to development work, in support of current projects. Space Medicine is but one phase of Lockheed's complete systems capability in missiles and satellites. To maintain this position of leadership calls for an extensive research and development program—ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space; oceanography; fuel cells; space station; space navigation; solid state electronics.

Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. H-17A, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

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Industry Probes Nuclear Pulse Radiation

By Barry Miller

New York—Pulse nuclear radiation which could temporarily disable avionics controls in a weapon system and thus jeopardize the success of the weapon's mission is becoming the subject of serious military and industry concern.

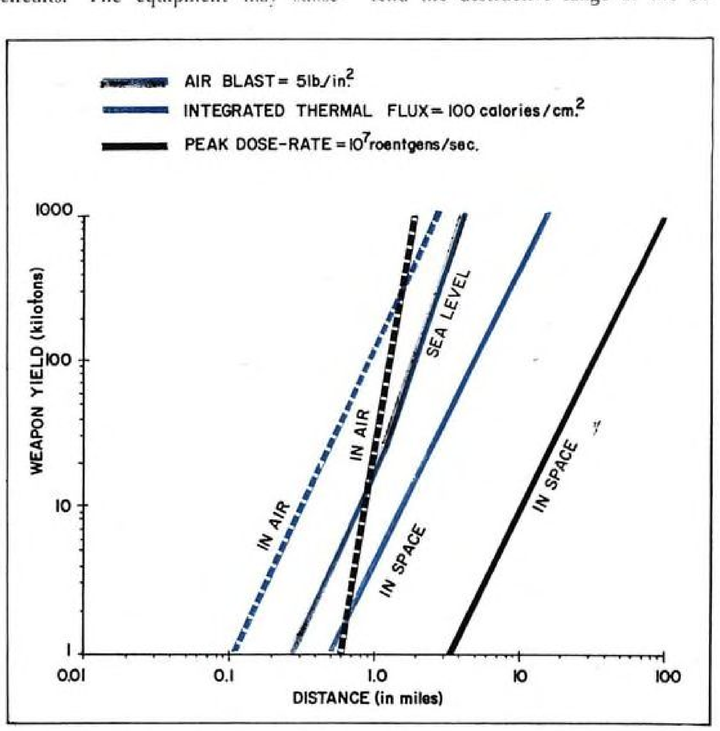
The extremely brief, but very high intensity pulses of radiation that occur immediately following a nuclear explosion can produce disrupting transients or erratic operation of avionic equipment at distances from the detonation point that were once considered to be safe for equipment.

Dosage Negligible

Although the total radiation dosage of high intensity pulses is negligible, and is of magnitude less than that which would permanently destroy equipment, it can produce malfunctions in many circuits. The equipment may subsequently recover from the temporary disturbances, but in certain types of circuits and equipments the transients can be harmful. For example, a pulse of radiation might scramble the memory of a computer in a missile guidance system or may prematurely trigger a decision circuit which would throw the guidance system off. Or the malfunctions might temporarily block radio transmissions from a satellite or a space vehicle. Excessive transients produced by radiation pulses conceivably could permanently destroy some circuits.

Previously, heat and blast were regarded as the nuclear explosion's chief threats to avionic equipment. For the equipment to be permanently disabled or destroyed by cumulative radiation dosages, it would have to be located within the destructive radius of blast and heat effects. More recently there has been growing awareness that transient radiation effects can effectively extend the destructive range of the explosion for microseconds in time through paralytic effects on key equipments.

In space the problem becomes particularly acute in the absence of air which might otherwise absorb a goodly amount of radiation. Hence, an avionic equipment situated about 100 mi. from a one megaton explosion in space—well beyond the reach of thermal damage—would be subject to gamma radiation rates up to 10^9 roentgens/sec., sufficient to produce severe transients in avionic components and circuits, according to a recent report by W. R. Langdon of General Electric Co.'s General Engineering Laboratory in Schenectady. For an identical detonation in air, the equipment would have to be within two miles of the explosion to experience the same critical radiation rate.



ALTITUDE dependence of susceptibility of avionic components to nuclear radiation is shown in this graph. Distances from nuclear explosions at which equipment may be harmed by heat or peak gamma radiation dose rate increase in space. Pulse radiation appears as the principal cause of damage in space; the principal cause of damage in air for low-yield explosions only. Reason for increase in hazardous range of dose rates in space is the absence of air which absorbs gamma rays. Chart was prepared at GE.

Equipment Failures

Specific examples where radiation rate induced transient effects might cause equipment failures at lengthy distances from an explosion are cited by Langdon and John R. Crittenden of GE's Tube Department, Owensboro, Ky. These include:

- **Salvo firing of air defense missiles** with nuclear warheads. If the first missile warhead detonates well out in space, radiation pulses could disable controls on other missiles, thereby causing succeeding missiles to malfunction. Transient effects could then prevent missiles from being fired in close salvos.
- **Nuclear explosions near aircraft.** A high-speed aircraft flying outside the destructive range of a nuclear explosion might experience a loss of control from which recovery could be difficult. Or the control servos of an aircraft which fires short range missiles with nuclear warheads might malfunction because of a pulse induced transient.

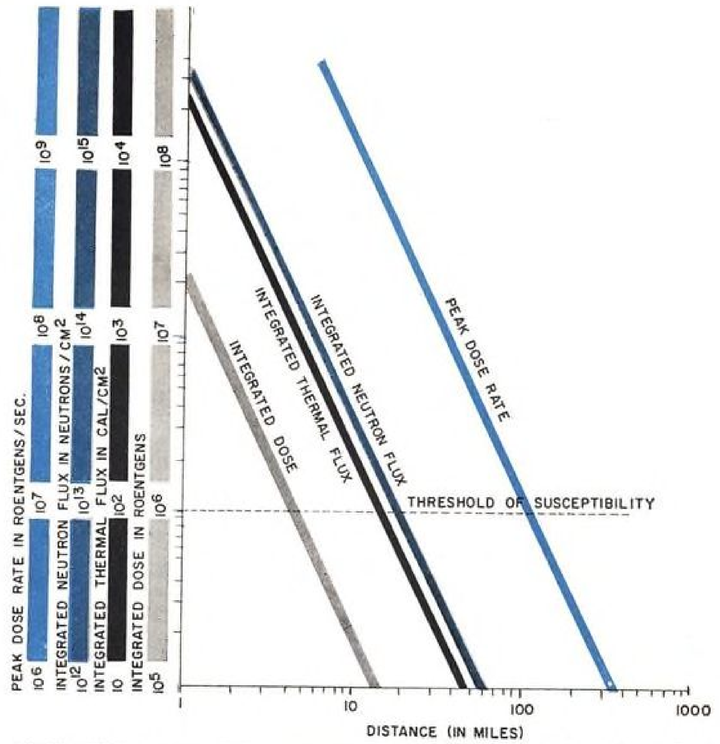
Temporary malfunctions produced by nuclear pulses extend the kill probability of a nuclear weapon fired by an enemy in space. Nuclear pulse effects also might be a critical factor in Project Orion type nuclear rocket propulsion schemes.

Two accompanying charts, prepared by Crittenden on the basis of the Langdon report, illustrate how pulse radiation effects, or peak dose rates, effectively increase the destructive range of a one megaton nuclear explosion in space. Crittenden chose the upper or conservative estimate of the thresholds of susceptibility for various components to nuclear explosion effects.

Major weapon system suppliers—such as Boeing Airplane Co., a prime contractor on the Minuteman ICBM and the Bomarc air defense missile—are studying these pulse nuclear radiation effects on avionic components and systems. The radiation work of Boeing's Aero-Space Division dates back to 1956, according to Dr. Glenn L. Keister. During its first three years, the Boeing group's primary concern was with permanent damage to components like transistors, but last year the main emphasis shifted to transient radiation effects. Motivation for the company's interest, Dr. Keister indicates, is to be able to design equipment which will function in a nuclear weapon environment.

Boeing's work is funded by company-sponsored research, Air Force weapon system contract work and Air Force research contracts. Among the government agencies known to be supporting studies of transient, as well as permanent, radiation effects are the Wright Air Development Division, Air Force Special Weapons Center, Army Ordnance Corps, Army Signal Corps, Diamond Ordnance Fuze Laboratory, Navy Bureau of Weapons and the Atomic Energy Commission. Companies conducting experimental work and/or studying pulse radiation effects besides Boeing and General Electric include Hughes Aircraft, Convair and General Atomic divisions of General Dynamics Corp., Lockheed Aircraft, International Business Machines, Edgerton, Germeshausen & Grier, Inc., Sandria Corp., and the Radio Corporation of America.

Estimates for total funding of these programs for Fiscal 1961 range upward from $2 million. Many of the programs are understood to be one and two man efforts, although several are considerably larger. Boeing's, for instance, presently involves 27 people.



QUALITATIVE measure of damage to avionic equipment from energies released by a one megaton nuclear explosion in space is shown versus distance from the detonation. Dotted horizontal line is conservative estimate of the thresholds at which avionic components may malfunction. From the intersection of this threshold line with slanted energy bars, peak gamma radiation dose rate (for a 0.1 microsec. pulse) can be seen to be sufficient to produce transients in avionic components at distances beyond 100 mi. from the explosion. Equipment must be within 4 mi. to suffer permanent damage from integrated gamma radiation, within 18 mi. for total neutron dosages to harm transistors. Integrated gamma radiation damage can be seen to be academic as heat would destroy the equipment within 17 mi. Chart was prepared at General Electric Co.

Radiation Hazards

Estimated thresholds of susceptibility of avionic devices to energy released in a nuclear explosion, according to W. R. Langdon, General Electric Co., are as follows:

- Peak Dose Rate—10^6 to 10^7 roentgens/sec. Severe transients may be produced in avionic components and circuits at these dose rates; consequently, circuits should be designed allowing sufficient tolerances for transient radiation effects.
- Integrated Dosage—10^6 to 10^7 roentgens. Some material can withstand greater total dosages, but others—like teflon, cellulose and some elastomers—may experience property changes in the indicated range.
- Integrated Thermal Flux—100 calories/cm.². This value will ignite most combustible materials, damage dark or rough stone and tile, but might not damage brightly polished metals or other non-combustible materials.
- Peak Overpressure in Air—3 to 5 psi. These pressures would destroy parked aircraft, wreck wooden frame buildings, only moderately damage medium steel industrial buildings.

Radiation Categories

Radiation effects are generally divided into two categories. These are permanent damage, which persists undiminished for long periods after radiation ceases, and transient effects, which disappear quickly after initial exposure to radiation, according to J. D. Maxey of Space Technology Laboratories (formerly with the Radiation Research Group of IBM's Military Products Division).

Permanent damage is caused by displacement and/or rearrangement of atoms or groups of atoms in a material while transient effects occur due to electronic excitation without atomic displacement. Usually, permanent damage depends on the total, or integrated, radiation dose received and is commonly called the dose effect. Transient effects on the other hand may depend on the dose per pulse, Maxey says, or on radiation dose rate, and are frequencly referred to as rate effects. Permanent effects have been far more extensively studied than transient effects.

It is difficult to find consensus among people working in this field as to the severity of rate effects, the precise levels at which components, materials and circuits are susceptible to transient malfunctions, or even in some cases whether specific components experience temporary blackout or perturbations in behavior, the precise nature of these perturbations, how long they last, etc.

One of the factors which makes it difficult for those working in this field to come to grips with the problem and to work out solutions is the relative lack of good statistical data on the behavior of components subjected to pulse radiation. This results from the difficulty of making accurate measurements of so in-

tense and brief a pulse, variations in measurement techniques and the inability to precisely simulate this effect in test facilities, even on reactors designed to produce pulses of radiation.

Many pulse experiments are conducted on the Godiva reactor at Los Alamos. Godiva produces a pulse, similar to the positive alternation of a sine wave—about 80 microsec. wide at its ½ heights. The peak gamma dose rate is about 10^{17} roentgens/sec., neutron dose rate is 10^{18} neutrons/(cm.^{2}-sec.). Integrated neutron value is 10^{13} or 10^{14} neutrons/cm.^{2} The integrated effects are not sufficient to cause permanent damage to anything other than low speed transistors. Rise time characteristic of the Godiva pulse prevents Godiva from being a realistic simulation of a weapon environment, at least one critic of these experiments says.

A reactor which the military believes more suitably meets its needs for simulation of a weapon environment would have the following characteristics: neutron rates—10^8 to 10^{18} neutrons/(cm.^{2}-sec.); total neutron dosage—10^{11} to 10^{16} neutrons/cm.^{2}; gamma rates—100 roentgens/sec. to 10^{10} roentgens; integrated gamma dosage—10^{-1} to 10^6 roentgens; pulse duration—1 microsec. to 100 millisec. for neutrons and 10^{-3} sec. to 10 millisec. for gamma rays.

Prompt gamma rays (gamma rays that accompany the fission process and are released at fission) are the component of pulse radiation most apt to cause malfunction of avionic circuits. Neutrons interact with bomb materials and the atmosphere, and their speed is slowed, Langdon points out. The neutron pulse is wider (milliseconds rather than fractional microsecond as with gamma rays) and more delayed in time. The neutron intensities and their effects are small at the time of peak gamma intensities. Gamma rays appear to be

Major Microwave Installation Nears Completion

Microwave relay station at Santa Cruz Island, Calif., being completed by Collins Radio's Texas Division, serves Pacific Missile Range. Station has 33 microwave transmitters and 33 microwave receivers. This microwave relay connects with range headquarters at Pt. Mugu, 31 mi., San Nicolas Island, 53 mi., and with a repeater station at Pt. Arguello, 69 mi. Repeater at Pt. Arguello connects with operations building there which is 41.6 mi. away.

Meetings on Effects Of Pulse Radiation

The following reports or meetings devoted to pulse radiation effects are scheduled during the next five weeks:

- "How Radiation from a Nuclear Explosion May Affect Electronic Equipment," a report by W. R. Langdon, General Electric Co., Aug. 11, Pacific General Meeting of the American Institute of Electrical Engineers, San Diego, Calif.
- "The Effective Range of a Nuclear Explosion for Electronic Equipment," a report by John R. Crittenden, General Electric, Aug. 26, Western Electronic Show and Convention (WESCON), Los Angeles.
- "Failure of Digital Computers in the Environment of an Atomic Explosion," a report by Marc Bendick, System Development Corp., Aug. 26, WESCON.
- "Transient Effects of Nuclear Radiation on Typical Electronic Subsystems," a report by John W. Clark and T. D. Hanscome, Hughes Aircraft Co., Aug. 26, WESCON.
- Second Air Force Pulse Radiation Effects Conference (classified meeting), Sept. 13-15, Albuquerque.

responsible for most transient effects although at least one researcher feels they may be equally responsible.

Transient effects induced in components are believed to be due to ionization produced by the gamma pulse. Ionization liberates charge carriers, thereby increasing conductivity. This means large currents are created. The magnitude of the change in conductivity is a function of dose rate.

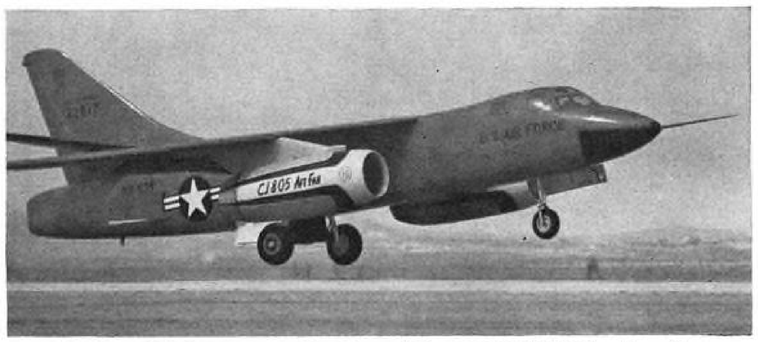
An optimistic view of the transient radiation problem is expressed by William Bohan, who heads a 10-man Air Force sponsored effort in pulse radiation effects at IBM in Oswego, N. Y. Three years ago, when the company's work began, Bohan says, he believed the effects of a Godiva type environment posed design problems which were insurmountable. Now, however, he doesn't believe that a breakthrough is required to design equipment to function through this environment.

The IBM group has conducted experiments at Godiva four times a year for two-day test periods over the past three years. Normally, the company obtains about 10 channels of information on a Godiva run. Heavy demands on the Godiva facility prevent its extensive use by any single organization. Signal Corps personnel, for example, point out that thousands of hours of preparation precede 10 hours of reactor work every six months.

Several groups frequently run tests

Flight Propulsion NEWS

A report about progress in research and products from the Flight Propulsion Division of the General Electric Company



RB-66 modified to accommodate General Electric CJ-805-23C, has been flying since February, 1960. Aircraft recently completed cross-country tour.

Aft-fan Powered RB-66 Tours United States

EDWARDS AFB, Calif.—General Electric's turbofan-powered flight test Douglas RB-66 took off from here recently on a cross-country tour which gave aviation observers their first opportunity to see and hear General Electric aft-fan engines in action.

The tour was a continuation of flight tests begun in February, 1960, when two General Electric aft-fan engines powered the modified RB-66 in this country's first all-turbofan flight with American-made engines. The aircraft has demonstrated outstanding performance in subsequent tests.

During the tour, observers were able to study the aft-fan engine at close range. The design couples the aft fan with G.E.'s proven basic gas generator to provide up to 40 per cent more takeoff thrust and an improvement in specific fuel consumption of up to 15 per cent over straight turbojet engines.

Following a non-stop cross-country flight, the RB-66 made its first stop at Farmingdale Airport, Long Island. Elapsed flight time of five hours 20 minutes included 30 minutes holding, let down through 20,000 feet of clouds to a 1500 foot ceiling, and three low-level flybys.

From Farmingdale, the RB-66 flew to Andrews AFB in Washington, D. C. where government officials watched the aircraft's performance at low altitude. Later, they had a close look at the CJ-805-23 engines with nacelle doors open.

At Wright-Patterson AFB the aft-fan powered test plane underwent close scrutiny by Air Force officials. Most of the comments concerned the short takeoff run and over-all low noise level of the aft-fan engines. Decibel readings taken on the field further verified the intrinsically good noise level characteristics of the aft-fan design.

The test program also provided a demonstration of General Electric's 40-kva hydraulic constant-speed drive with aft-fan engines. The system provides constant input speed for the ship's G-E a-c electrical generators. The two units aboard the RB-66 are the units which completed General Electric's earlier turbojet flight test program. The same accessory package is used aboard the Convair 880 and 990.

Aft-fan engines like those presently powering the RB-66 are scheduled to fly this fall on the Convair 990 Coronado and early next year aboard General Electric's Caravelle VII. Other members of G.E.'s growing aft-fan engine family now being considered by the aviation industry for military and commercial applications are the 4000 pound thrust-class CF700 and the 22,000 pound thrust-class MF239. This engine and other military versions of the aft-fan engine benefit from a 90 per cent reduction of infra-red radiation over straight turbojets.

Following a final stop at Wichita, Kansas, the RB-66 returned home to Edwards AFB, California, to continue an exhaustive test program.

For additional details on General Electric's aft-fan flight test program, check GED-4117 and 4192. Information on constant-speed drive systems is available in GEA-6890, on the CF700 in GED-3986, and on the MF239 in GED-5005. For information on aft fan IR radiation check GED-5006. See coupon.

Strategic Air Command Records Triple Launch of GAM-72 "Quail" Decoy Missile

EGLIN AFB—A Strategic Air Command bomber has recorded a triple launch of three McDonnell GAM-72 "Quail" decoy missiles into free flight over the Eglin Gulf Test Range off the west coast of Florida.

This triple launch marked the first time a SAC crew has launched more than one "Quail" at the same time.

The diversionary missile, powered by a General Electric J85 jet engine, is designed for release in "coveys" of this kind in order to penetrate and confuse enemy air defenses.

The airborne decoys are mounted on special racks in the bomb bay of the eight-jet B-52G. Small fins remain folded around the body of the "Quail" until it is moved into launching position. This space-saving feature makes room for the decoys without interfering with other weapons carried by the SAC aircraft.

J85 powered GAM-72 "Quail" diversionary missile simulates B-52 on enemy radar screens.

After launching, the missiles fly in different directions but at the same speed as the big SAC bomber—more than 650 mph.

Each "Quail" in free flight produces a "blip" on enemy radar screens like that of the mother aircraft. The enemy, confronted by a series of diverging blips, is faced with the problem of determining which is the real bomber.

Slightly more than 10 feet long, the "Quail" uses ingenious electronic equipment to simulate the massive B-52G on radar screens.

When testing is complete, SAC B-52G's will be equipped with several GAM-72 "Quail" as well as two powerful GAM-77 "Hound Dog" air-to-surface missiles.

For additional information on the J85's adaptability to missile and other applications, check GED-4095. See coupon.

Caravelle VII Powerplant Test Program Under Way

TOULOUSE, France—Aircraft #42, the General Electric Caravelle, has been completed at Sud Aviation's Toulouse plant. Scheduled for mid-summer delivery, the ship will become the first aft-fan CJ-805-23C powered Caravelle VII.

Meanwhile, around the world, -23 testing is under way at an accelerated pace. Here is a brief summary of tests under way or already completed.

At Toulouse, wind-tunnel tests of an 18 percent nacelle scale model and of a six percent Caravelle VII scale model have demonstrated excellent low-speed aerodynamic characteristics of the aircraft, nacelles, and thrust reversers.

At Amsterdam, the Netherlands, high-speed wind-tunnel testing has demonstrated excellent characteristics using an eight percent nacelle scale model and a four percent scale aircraft model.

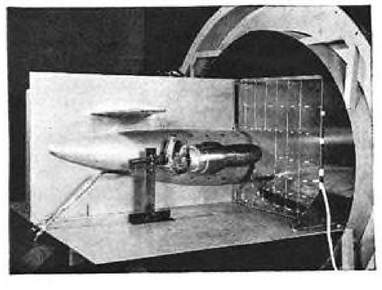
At Santa Monica, California, Douglas Aircraft is mating a Caravelle VII nacelle mock-up to a -23C mock-up delivered ahead of schedule. Work to date has confirmed ease of installation.

At Edwards Air Force Base, California, General Electric has completed tests using a 25 percent nacelle scale model mounted on a pylon under the wing of a flight test XF4D. Aerodynamic characteristics of the nacelle are excellent.

At Cincinnati, Ohio, static load testing of a -23C has demonstrated the engines capability to support the Caravelle VII nacelle. Thrust reverser configuration has been successfully tested using a 1/12th scale aircraft, nacelle, and thrust reverser model. At General Electric's Peebles, Ohio, facility, continuing test-cell runs are demonstrating -23C and thrust reverser performance.

For additional Caravelle VII information, check GED-4176 Caravelle brochure. See coupon.

Scale-model thrust reverser tests using 1/12 scale model of the -23C installation on the Caravelle have confirmed design configuration.



Diverted J85 thrust will power the Bell X-14 this year in a NASA test program.

General Electric's Small Engines Proving Versatile Power Source for VTOL Development

MOFFET AFB, Calif.—A variety of vertical takeoff and landing aircraft are now in development with versatile General Electric small gas turbine engines as the power source.

A lift-fan concept is being evaluated at Moffet Air Force Base, where a dry J85/lift-fan combination is undergoing wind-tunnel testing. J85-powered lift fans hold promise for a broad range of VTOL configurations with the capability of taking off straight up, flying forward at high speeds, and hovering.

In another program, diverted thrust from a J85 turbojet will power the Bell X-14, which NASA is using to test the feasibility of advanced propulsion and control techniques for VTOL and other future aircraft. X-14 flight testing is programmed for later this year.

General Electric's T58 turboshaft engine is the powerplant for two experimental VTOL aircraft which are scheduled to fly this year. Kaman's K-16 combines semi-tilt wing, deflector flaps, and cyclic-pitch propellers. The Fairchild M224 attains VTOL capability from deflected slipstream on the wing's trailing edge.

G.E. is also developing the T64 turboprop/turboshaft engine. Designed to operate continuously from 45 degrees below to 110 degrees above the horizontal, the T64 is especially suited for tilt-wing VTOL applications.

For additional information on the J85, check GED-4095. Check GED-3985 for T58 information, SAE-110A for T64 details. See coupon.

ENGINEERS—If flight propulsion engineering interests you, write to:
R. Marmaroli, Dept. 712
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New York, New York

FOR MORE DETAILED INFORMATION on these and other developments in General Electric products, contact your nearest G.E. Flight Propulsion Division representative or indicate below the brochures you would like to receive.

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- ☐ GED-4117 and 4192 "Progress Reports"
- ☐ GEA-6890, "Constant-Speed Drives"
- ☐ GED-3986, "CF700-1 Turbofan"
- ☐ GED-5005, "MF239C Aft Turbofan Power"
- ☐ GED-5006, "Aft Fan IR Radiation"
- ☐ GED-4095, "J85 Turbojet"
- ☐ GED-4176, "Caravelle VII"
- ☐ SAE-110A "General Electric T64"

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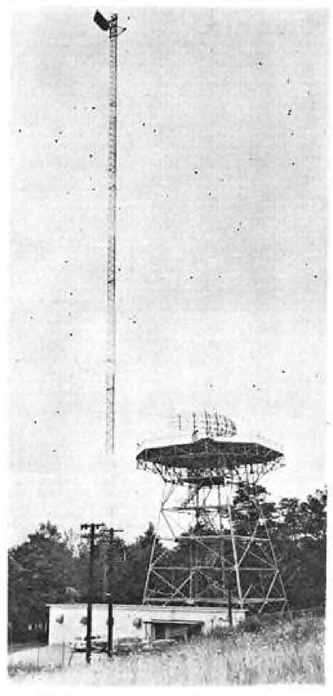
simultaneously and it is possible, Bohan says, for other equipment to interfere with test results of a particular group.

The IBM group has made observations on the following avionic components:

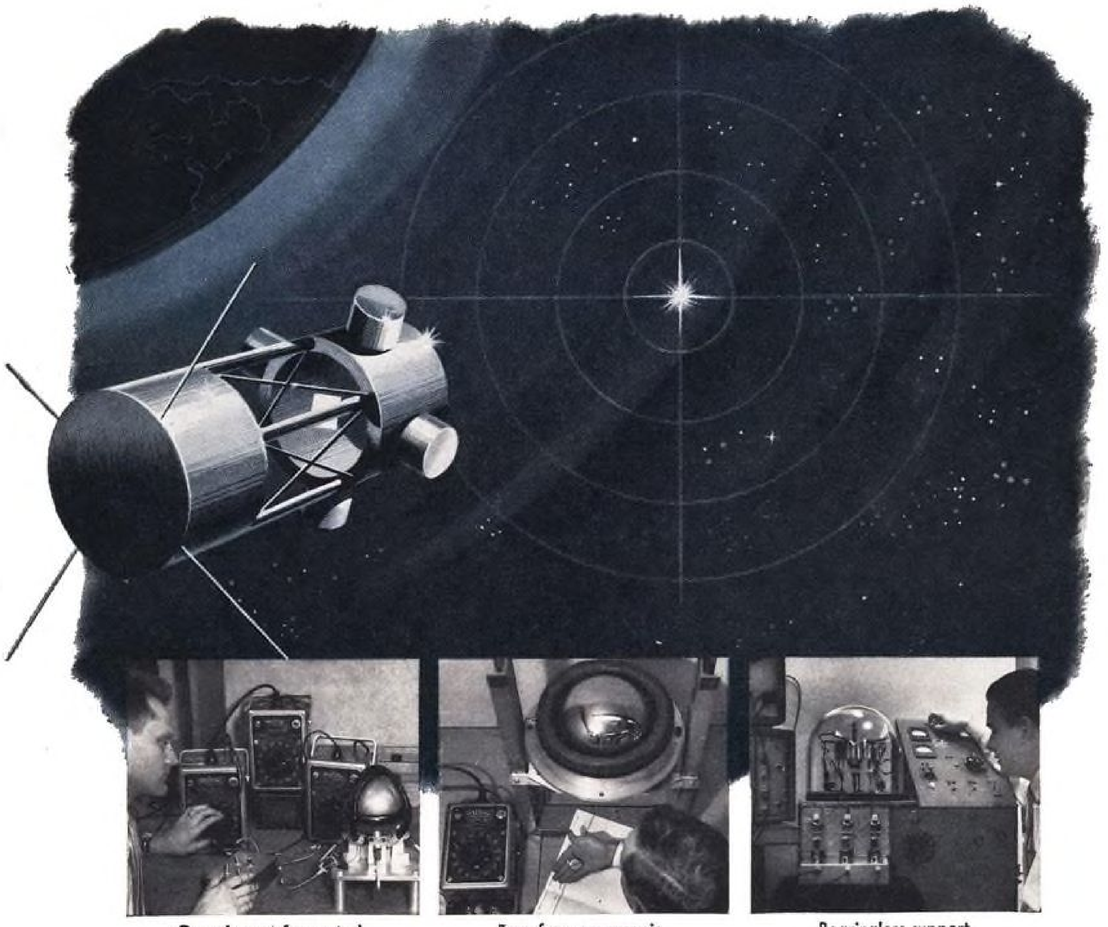
• **Transistors**—Leakage current I_{co} is found to increase with increasing radiation rates, reaching 100 microamperes. The I_{co} tends to follow the shape and time span of Godiva's 10^5 rotentgens/sec. pulse. Some decrease in transient gain $(1 - \alpha)$ was found. Newer, higher frequency, thin base transistors, Bohan and other researchers seem to agree, appear to be far less susceptible to pulse effects than earlier transistors, especially power transistors.

• **Capacitors**—These appear to be the next most seriously affected components. Radiation flux causes charge formations in the capacitor which appears to be discharging during irradiation. The capacitor discharge current can be predicted if the radiation pulse shape is known. The rate of discharge



Microwave Antenna Tower

Microwave antenna tower, alongside new Federal Aviation Agency long-range en route radar near Cleveland, transmits radar information to traffic control center and permits remote control of unattended radar stations. Installation is one of more than 340 built and installed by Collins Radio for FAA, under contracts totaling nearly $20 million.



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This project is part of the over-all Bendix space-systems development program which includes satellite communication, satellite navigation, radiation-resistant electronics, magnetohydrodynamics, plasma shock tubes, and infrared reconnaissance.

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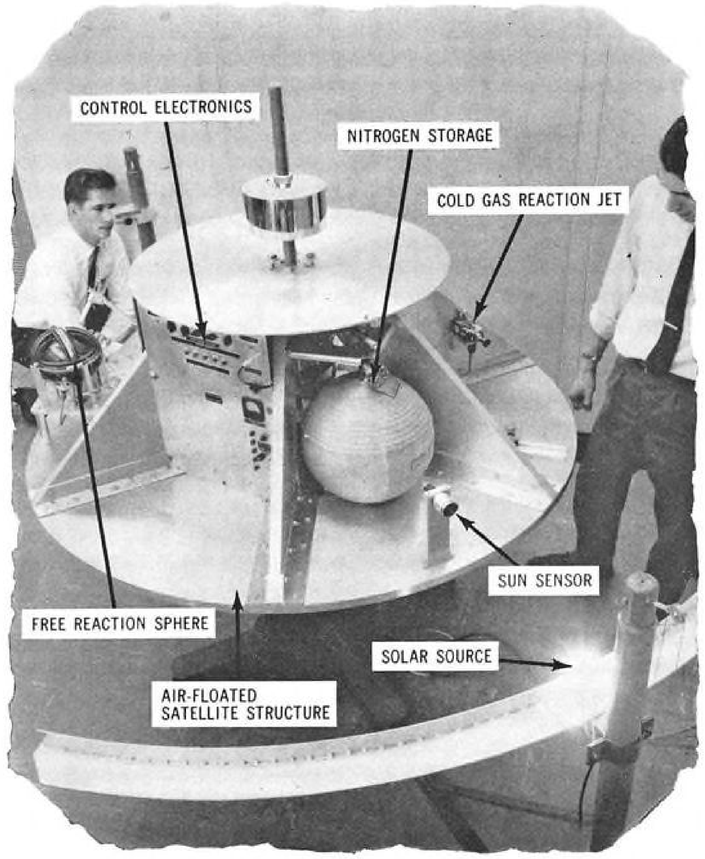

STABILIZATION IN SPACE

The Bendix stabilization system uses cold gas reaction jets for initial orientation, and a free reaction sphere for fine control. Reaction jets each provide 15 pounds of thrust; 5-inch reaction sphere provides torque resolution of 1 part in 10,000. Reaction elements, control computer, and reference sensors are mounted on a rigid satellite structure which is floated on a frictionless air pad to provide three degrees of freedom. A solar or stellar source is moved around the satellite to test tracking accuracy and response. Satellite structure balance may be adjusted within one-millionth of an inch and moments of inertia matched to vehicle design.

This attitude control system is being developed to provide reliable stabilization to an accuracy of one-tenth second of arc for more than a year of continuous operating life in space.

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of capacitors is slower than the Godiva pulse, and becomes longer for large valued capacitors.

• **Vacuum diodes**—Leakage is observed with pulsing when the tube is back biased. Information on the magnitude of the leakage is scanty and the effects of air ionization and other phenomena are not yet separated.

• **Triodes,** (including ceramic triodes) and pentodes—Tubes appear to perform well throughout the radiation bursts although there is some slight shift in d.c. levels.

• **Resistors**—No increases were observed in the values of carbon composition resistors (this is in contradiction to Signal Corps work where such changes were observed). Changes were observed in the shunt resistance paths around resistors observed in air. Resistors in potting compounds are believed to experience some change in values.

• **Quartz crystals**—Changes probably due to ionization paths were noted in the magnitude of the output of a 167-kc. crystal whereas the frequency was unaffected within a measurement error of 3%.

Circuits Tested

A number of circuits were tested by the IBM group during its program. Initially, transistorized multivibrators, employing either germanium or silicon transistors, experienced complete chaos when subjected to Godiva bursts. Redesigned circuits using I_{co} compensation and high frequency transistors operated satisfactorily, indicating the importance of design techniques in overcoming transient effects. A pulse test of a flip flop slated for the Minuteman ICBM and employing 2N705 transistors was operated at a 50-kc. rate and found to be free of transients, according to Boeing.

Transient radiation effects may limit the usefulness of some components such as semiconductor microcircuitry, infrared sensors and photo tubes, according to Boeing's Glenn Keister. Ultimately, he says, design techniques similar to those used in minimizing permanent damage may ease this, especially with the availability of more information on transient radiation effects.

Lessening Radiation Effects

The effect of the transient pulse on a particular component or system depends on its design and function. Scientists working in the field suggest the following to minimize or sidestep rate effects of radiation and thereby reduce the amount of heavy shielding required for avionic equipment:

• **Use radiation resistant components,** whenever possible, designed to reject large noise pulses.

• **Use radiation resistant materials,** particularly inorganics, which appear to

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Strange sounds fill the heavens...sounds that can help us chart the universe for man's conquest of Space. To capture these sounds, the U.S. Navy is sponsoring one of the most imaginative projects man has ever conceived. It is a giant radio telescope that will listen to stars billions of miles away... beyond the reach of even the most powerful optical telescopes.

Though of gargantuan proportions, this cosmic listening device is a fine precision instrument. The "ear," a massive yet lightweight aluminum dish antenna, is being built by the Columbus Division of North American Aviation—one of the most complete systems-creating centers in the world.

The Columbus Division, with its advanced research and development facilities, has developed new techniques for the construction of high-performance, low-cost antennas and complete radio telescope systems. These precision instruments will aid military and research organizations in detection, tracking, surveillance, and radio-astronomy...and contribute vitally to America's assault on Space.

THE BIG "EAR"—The world's largest radio telescope is being built at the U.S. Naval Radio Research Station in Sugar Grove, West Virginia. It will tower to the height of a 60-story building. The movable reflector, directed by an inertial-guidance system, is 600 feet in diameter and more than seven acres in area. The 10-foot thick reflector, with a potential range of billions of light years, will be built by the Columbus Division of North American Aviation.

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Columbus, Ohio

have better recovery characteristics than organic materials.
• **Use analog rather than digital circuits** wherever possible, or employ self-checking circuits in digital system.
• **Use low-impedance circuits** to reduce amount of pulse-induced conductivity and thereby minimize the effects on circuit performance.
• **Design circuit to minimize the effect** of pulse radiation.

The Signal Corps indicates that it plans to incorporate requirements for reducing radiation vulnerability in its tube and transistor developments as soon as sufficient reliable data on rate effects becomes available.

The Signal Corps' own program on rate effects at the Army Signal Research and Development Laboratory is divided into two efforts—one devoted to passive, the other to active components. The passive component investigation, directed by Dr. Eberhard Both, centers on resistors, capacitors and diodes. The group's main interest, according to Dr. Both, is to find components that will live through pulse radiation environments without exceeding their normal tolerances.

Tests Outlined

Various tests have been run at Godiva with the following results:
• **Resistors**—Several one-megohm deposited carbon resistors recently tested averaged a maximum change of 10 to 20% from original value between 0.01 and 0.5 millisec. after the pulse. The resistors returned to their original value in 2 millisec. A sample of 100,000-ohm carbon composition resistors experienced an average maximum change of 10% from original value 0.2 to 0.3 millisec. after exposure, and then recovered to within 2.5% of original value in one millisec.
• **Silicon Diodes**—Forward voltage drop changed 20 to 30% at 0.15 millisec. to 0.25 millisec. after firing of the pulse and recovered to within 15% of original value in one millisec. Reverse current, normally less than one microampere, went to 100 microamp. at 0.2 millisec. after the pulse, and recovered to within 10 microamp. within 1 millisec.
• **Silenium diodes**—Forward voltage drop experienced a maximum change of 6% at 0.2 millisec., then recovered to — 3% at 2 millisec. Reverse current jumped to 20 to 300 microamp. 0.4 millisec. after the pulse and recovered to 15 to 250 microamp. in 2 millisec.

New studies will attempt to determine how microelectronic circuits, such as flip-flops, fare under pulse radiation and how microminiature component vulnerability compares with that of larger components.

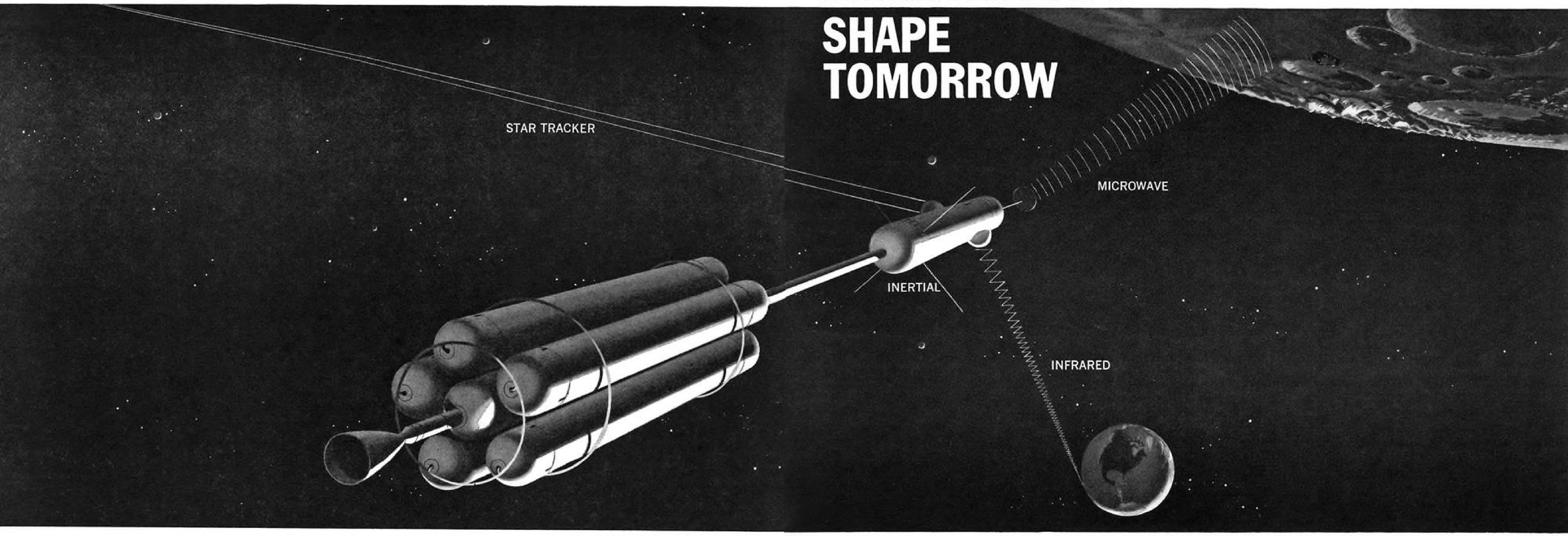
There is a need, Dr. Both says, for a general cataloging of all parts evaluated under pulse conditions so that the avionic circuit designers can select from available components those which are least susceptible to pulse radiation.

A group head by Louis Kaplan has been running tests of tubes and semiconductors on both pulse and steady-state reactors. Kaplan says that recent tests indicate that there may not be any theoretical difference between rate and dose effects as rate effects were observed by his group on steady-state reactors.

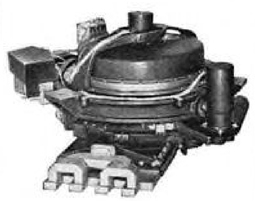
Tubes were subjected to 10^{16} neutrons/cm.^{2} dose in a steady-state reactor which was then shut down for 15 to 20 min. When the reactor was turned on, the tubes were again operating normally, suggesting that the damage had annealed out. Permanent effects are regarded as irreversible.

Edgerton, Germeshausen and Grier, Inc., Boston, is assisting the Signal Corps in providing instrumentation for the simulation tests. The company has measured response of a number of semiconductors and tubes under pulse radiation and has designed and constructed instruments for this work. Chatham Electronics, also under Signal Corps contract, is investigating the effects of radiation on boro-silicate glass and will recommend possible radiation resistant substitutes.

TODAY'S DEMONSTRATED ACHIEVEMENTS SHAPE TOMORROW



SENSORS



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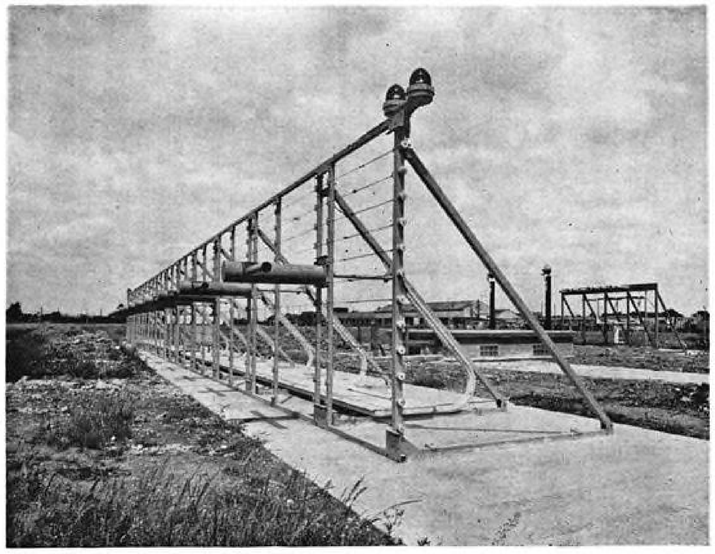


DUAL localizer antennas for STAN 7/8 ILS consist of broadside arrays of wideband dipoles 50 ft. apart (left). Glide path unit is at right.

Improved ILS System Operating at London

By John Tunstall

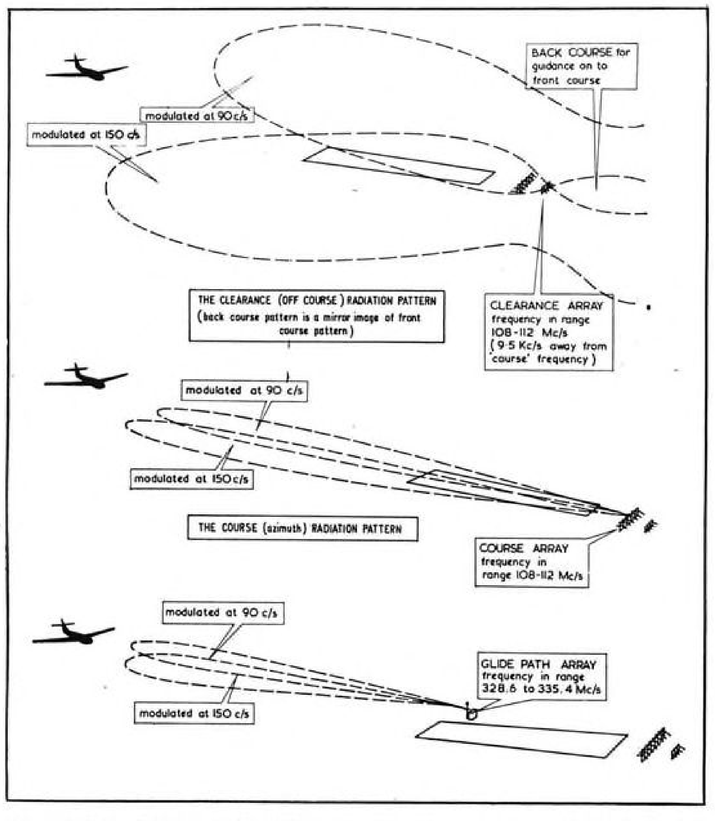
London—Dual azimuth antenna array, fully transistorized circuitry and constant impedance mechanical modulation are claimed to have significantly improved the reliability, stability and accuracy in a new instrument landing system inaugurated at London Airport last month.

Named STAN 7/8, the system has been adopted by the Ministry of Aviation for most of the major civil airfields in Britain following 12 months' evaluation of prototype equipment at Hurn Airport.

Other STAN 7/8 equipments are currently being installed at Brussels and Zurich.

The system has been evolved by Standard Telephones and Cables, Ltd., from a military mobile equipment developed by the STC parent company in the United States for USAF in 1957. The ground installation, which is fully duplicated, includes automatic and continuous fail-safe monitoring equipment, remote control, independent setting up controls and on-load test facilities for standby equipment. Cost of a complete installation is approximately $105,000.

Directional accuracy of the narrow localizer beam has been raised to one and a half minutes of arc giving plus and minus five feet definition of the runway center at touchdown. These accuracies, recorded by monitoring equipment at Hurn, have not yet been confirmed from the air but if they are established the system could replace the leader cables currently needed to provide azimuth information during the final approach and flare in the British blind landing system.



RADIATION PATTERNS of STAN 7/8 clearance array, course array and glide path array.

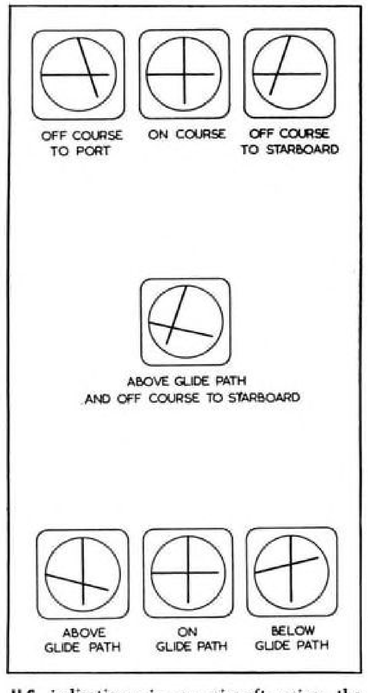
Antenna Arrays

Composite radiation pattern of four localizer signal zones is generated by two independent antenna arrays which radiate two modulated carrier frequencies 9.5 kc. apart, each modulated with 90 cps. and 150 cps.

One of the antennas provides a highly defined, narrow approach beam 10 deg. either side of the runway center and extending to 25 mi. at 2,000 ft. and 75 mi. at 10,000 ft. The twin modulations on this carrier frequency form lobes one either side of the runway and provide a five degree overlap sector. Keeping the directional beam narrow reduces the ground illuminations which previously caused beam deviations due to ground reflections combining out of phase.

A smaller antenna array provides the other pair of signal zones in the form of symmetrical kidney-shaped lobes extending outside the 20-deg. sector of the directional lobes.

Besides providing omni-directional navigational information and a back course facility, the kidney lobes effectively suppress secondary lobes radiated by the directional transmitter which create false signals.



ILS indications in an aircraft using the STAN 7/8 system are shown above.

Sideband field strength of the directional antenna is less than 50% of the peak level when 10 deg. off course and less than 10% of the peak strength at stations 12 deg. off course. The carrier field strength is less than 50% off peak when 7 deg. off course, less than 10% for stations 12 deg. off course.

Mechanical Modulation

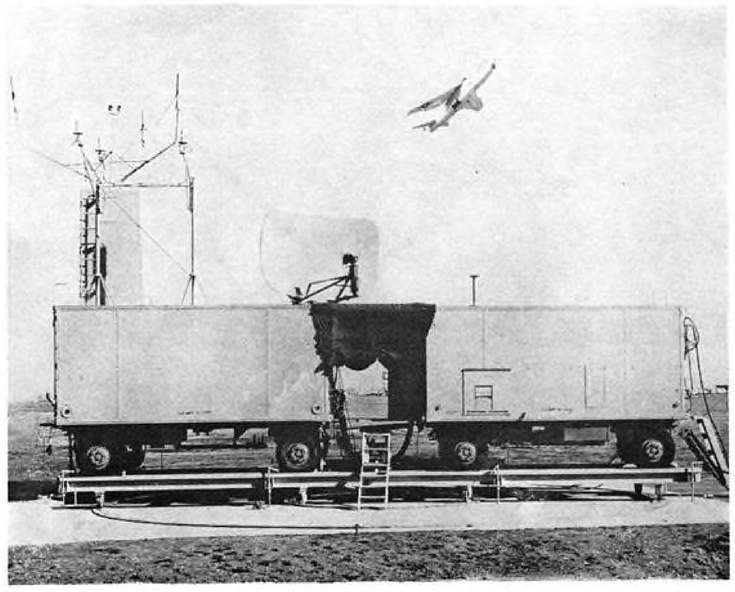
Inputs to the two independent azimuth antenna arrays are provided by two identical radio frequency and modulator sections. Mechanically balanced modulators which have the advantage of constant impedance provide the 90 and 150 cps. modulations. With this modulator system the carrier wave does not pass through the modulator, and there is no phase modulation. Standing waves are eliminated.

Development of a mechanical modulation system was undertaken because it enables directional shift due to phase change between the modulating frequencies to be eliminated and avoids inter-modulation. It is also much simpler and reliable.

Dual localizer antennas consist of broadside arrays of horizontal wideband dipoles 50 ft. apart. Directional array has 12 dipoles and employs a reflector 85 ft. wide, 7 ft. high. The kidney-shaped lobes are radiated by an array of three dipoles.

The glide path installation is virtually identical to the directional localizer equipment turned through 90 deg. It radiates two signal patterns on a common carrier frequency which overlap to form a sector width adjustable between 0.22 and 0.66 of the glide path angle, itself adjustable between two and a half and four degrees. Directional control within three minutes of arc is claimed for the glide path, which extends to 10 naut. mi.

Transistorizing the equipment re-



GCA Unit on Turntable Speeds Runway Shifts

Navy has mounted ground controlled approach equipment on turntable at Naval Air Station, Dallas, and Marine Corps Air Station, Beaufort, which shifts runways in 3 min., compared with 20-30 min. when equipment had to be moved to another hardstand.

Checkout System Studies

Dayton—Unfunded contracts for six-month studies to determine Air Force design standards and requirements for automatic checkout systems in the 1965-75 period have been awarded by Wright Air Development Division to Martin, Minneapolis-Honeywell, Motorola and Northrop. Douglas Aircraft is teamed with Motorola, and International Business Machines Corp. will be associated with Northrop.

Companies will analyze automatic checkout equipment in use or under development for 17 existing USAF weapon systems and the type of maintenance which they are designed to provide at each operational level. Companies also will study expected weapons in the 1965-75 period and recommend checkout system design philosophies that will be required. In the past, checkout system and maintenance philosophies have been established largely by the weapon system contractor.

duced the number of valves by 140 and is expected by the company to lead to a 10 to 1 increase in reliability. Stability has been aided by highly engineered cooling systems both in the monitors and the power equipment and by the use of special-braided cabling which reduces the phase shift to one sixth of normal by the elimination of air voids. The installation is also mounted for the first time in a sunken hut between the two antenna arrays which reduces the cable runs.

Lightweight System Transmits Teletype

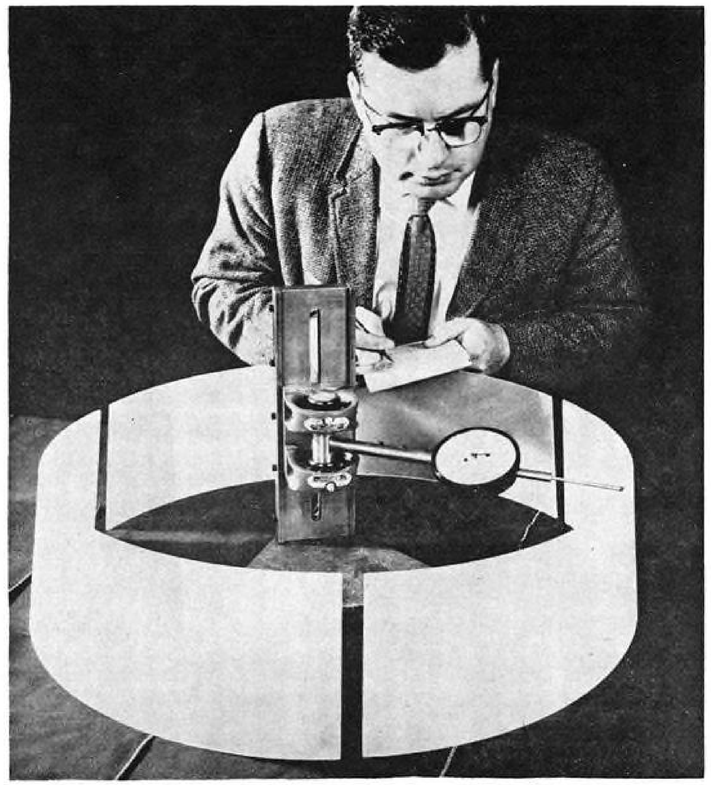
Washington—New low-cost, lightweight tropospheric scatter communications system for transmitting teletype and other digital data over distances up to 500 mi. has been developed by General Electric's Communication Products Department.

New "thin-route tropo system" can provide six 100 word-per-minute teletype channels using a total bandwidth of only 800 cps., according to GE. Cost of a medium-power thin-route tropo system, including antennas, capable of providing up to six teletype channels over range of 200 to 300 mi. is expected to be around $25,000.

Prototype one-hop system installed between Washington, D. C., and department headquarters at Lynchburg, Va., covering distance of about 150 mi., has been operating since January with a character error rate of only 0.14%, GE reports.

Company plans to market equipment suitable for operation at government assigned frequencies of 406-420 mc., 1,700-1,990 mc. and 2,110-2,300 mc.

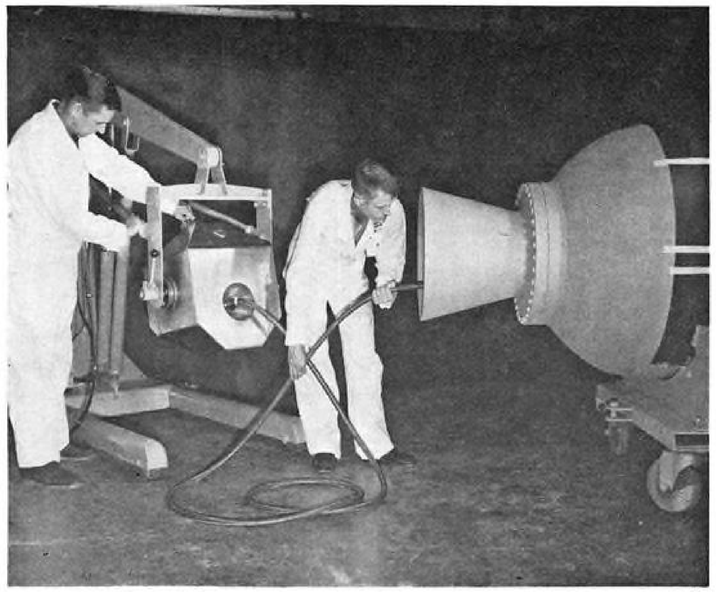
Unlike the wideband tropo scatter communication systems used on the DEW Line, which employ antennas as large as 120 ft. high and transmitters rated in kilowatts, the new GE thin-route tropo system uses small Yagi-array antennas and transmitters rated 500 watts or less. Transmitter used on the Washington-Lynchburg system is rated 170 watts. GE system employs dual diversity, using two antennas and two receivers, with provision for combining the two signals.



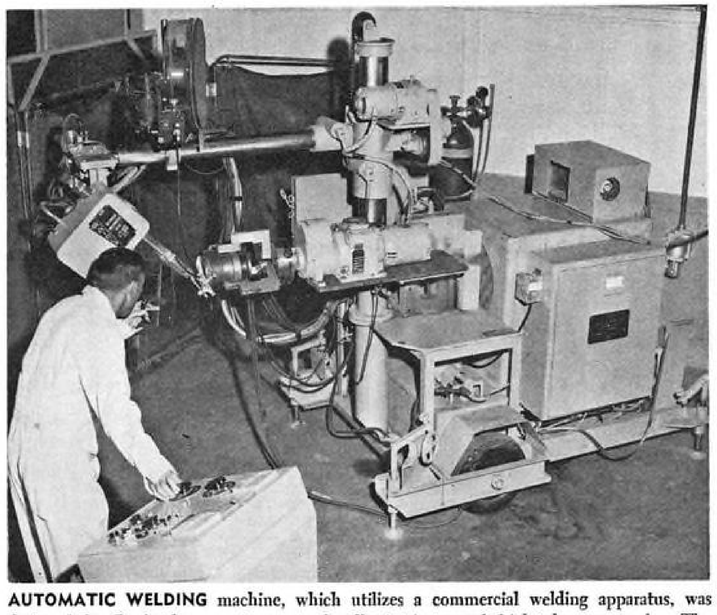
Glass Protects Mercury Capsule Antennas

Glass antenna shields made by Corning Glass Works for Project Mercury capsule form a ring around radio antennas to protect them from heat and thermal shock while permitting radio signals to pass through to ground tracking and communications stations.

Rocketdyne Tests New Solid Propellants



38-IN. ROCKET MOTOR is prepared for checkout using the Cobalt 60 technique at Solid Propellant Operations. The apparatus will permit inspection of possible voids, the proper bonding of the propellant to case and air bubbles in the propellant casting.



AUTOMATIC WELDING machine, which utilizes a commercial welding apparatus, was designed by Rocketdyne engineers to handle intricate and high-tolerance work. The control panel (appearing in left foreground) can be moved outside of the booth for fully automatic remote operation.

By Erwin J. Bulban

McGregor, Tex.—Major gains in propellant mechanical properties have been achieved here by North American's Rocketdyne Division in a new family of castable rocket motor formulations which broaden the environmental capability of solid propulsion systems without sacrificing critical performance.

The new carboxy-terminated linear polybutadiene Flexadyne propellants developed here by Rocketdyne Solid Propellant Operations (SPO) generally appear to be equal to or better than those based on other conventional binders, with respect to ballistic properties, and superior as to aging and mechanical properties, particularly at low temperatures. Included in these studies were polybutadiene acrylic acid copolymer (PBAA) and a copolymer of butadiene and methylvinylpyridine (Bd/MVP).

Intensive long-term testing shows these pertinent characteristics of the new Flexadyne family, SPO propellant laboratory group leader S. C. Britton told AVIATION WEEK:

• **Capability of withstanding** temperature range of −75F to 170F with essentially constant elongation; at any given temperature and solids loading, Flexadyne has nearly twice the elongation of the corresponding PBAA formulation, this advantage being greater at lower solids loading than it is for formulations giving maximum specific impulse. The new SPO family of propellants is said to retain its advantage as to elongation over the entire range of strain rates possible with an Alnico high-rate-of-strain tester. At 0.77 in./in./min. strain rate, for example, at −75F elongation is 53%; at 170F elongation is 52%; at 75F it's 63%, and then far up the strain rate scale—220 in./in./min., elongation is 69%.

• **Tear resistance** is approximately twice as good as the best of the current PBAA formulations, considerably alleviating processing hazards, including mandrel separation. Also, in grain design, particularly in complex configurations prone to providing high stress points, Flexadyne's tear resistance alleviates dangers of grain failures.

• **Slump resistance** is termed excellent, and the formulation is said to recover almost completely from deformations resulting from slump under compression. This characteristic is the reason why Solid Propellant Operations engineers here feel that they have the capability, using Flexadyne, of building 2 million lb. thrust single-grain rocket motors—a powerplant that would probably measure 15 ft. in diameter by 66 ft. in length and contain 360 tons of propellant.

• **Storage life** is as yet an unknown, but indications are that it will be at least equal to that of PBAA-based propellants. Britton sees Flexadyne as easily taking a shelf life of five years and periods of up to 10 years should be possible, he indicated, admitting that the material is as yet too new to have any actual performance on aging capabilities available.

Specific impulse data is classified, but Britton indicated that Flexadyne formulations provide a performance level which is competitive to any available solid propellant on the market today. This would place the new family in the 245 specific impulse regime.

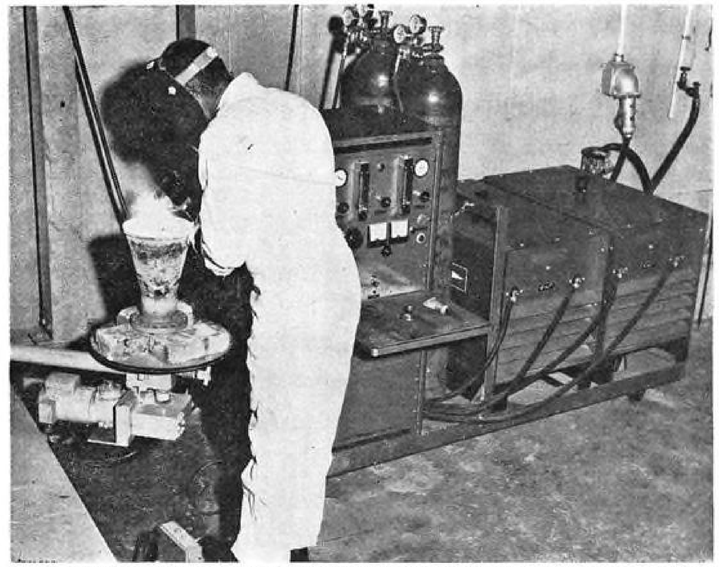
SPO's technicians are extremely conservative in discussing performance claims. They decry what they call the "numbers game" in today's highly competitive rocket motor propellant field, pointing out that increases of a point or two or three in specific impulses do not come merely by adding a pinch of some exotic compound to the propellant formula. Many of the claims of gains of three, five or even 10 points often refer to theoretical specific impulses which are based on extremely small motor test firings and then extrapolated to large sizes, a practice which technicians say rarely stands up in later experience and one of which service technicians have become wary in accepting.

Test Firings

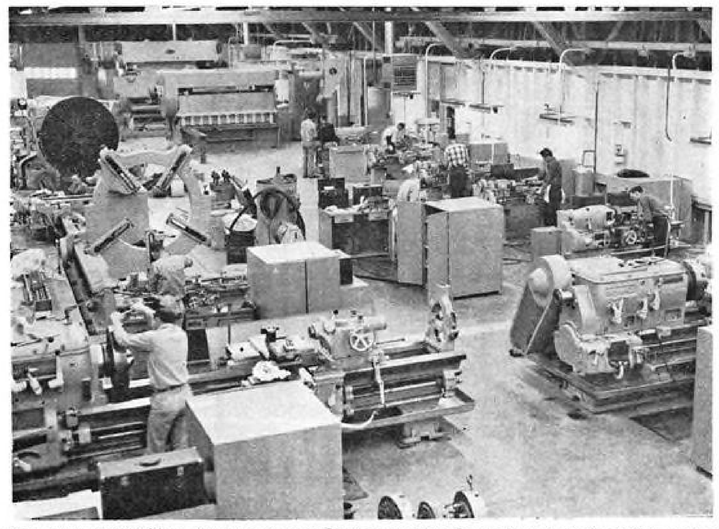
SPO has fired its new propellant in several hundred test motors of 2, 3, 5 and 10-in. sizes, with approximately 30-40 of the rounds tested in 10-in. test motors, and technicians here consider it significant that their data has held up through the test program. Indications are that SPO will soon get an opportunity to evaluate the new propellant in even larger motors. One of the services apparently has granted permission to load at least one of a series of 38-in. motors in a special research study with Flexadyne. These motors will provide some 18,000 lb. thrust over approximately 45-sec. duration.

Ready availability is an important feature of the propellant program. Four formulation numbers in the Flexadyne 500-series have been released to the pilot plants here, initially providing what technicians feel is a firm base line covering basic design requirements, with three varying in solids loading, therefore specific impulse, and the fourth a special formulation incorporating a higher burning rate using catalysts.

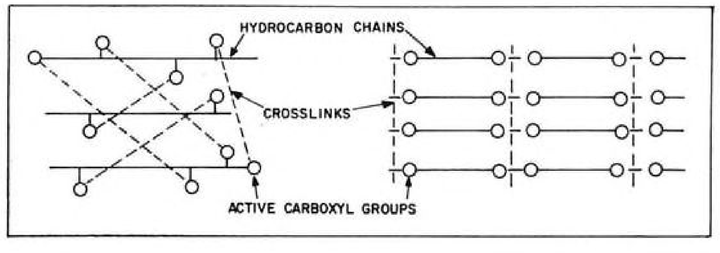
Pilot plant production capacity here at McGregor probably runs over 200,-

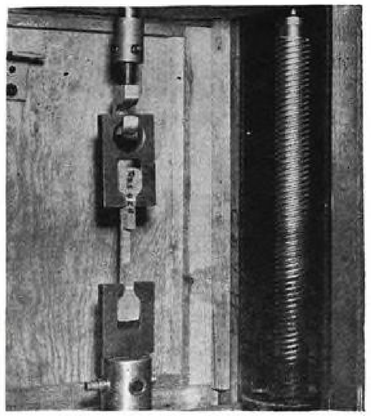


PLASMA coating is applied to an experimental rocket motor nozzle to be tested by Solid Propellant Operations at McGregor, Tex. Coating permits high degree of erosion protection and use of same nozzle for numerous tests at great cost savings.



BUILDUP of 33,000-sq.-ft. research and development hardware shop includes Niles engine lather (left) that can handle rocket motor cases up to 72-in. in diameter and 30 ft. long. Binder polymer cross-linking diagram (below) shows cured PBAA (left) and Flexadyne (right). PBAA shows random number and spacing of carboxyl groups. This, together with overhanging hydrocarbon chains, detracts from reproducibility and gives unsymmetrical cross-linking that promotes rigidity.





IMPROVED elongation traits of new Flexadyne propellant compared with PBAA is shown in demonstration of samples of each tested on an Instron apparatus.

000 lb. monthly on a nominal basis, which can be increased considerably on need. The facility is completely capable of casting and evaluating rocket motors containing up to 10,000 lb. of propellant, AVIATION WEEK was told, in diameters up to 54-in. and lengths up to 13 ft.

Basic approach to the Flexadyne formulation was to emphasize improved physical characteristics rather than attempt a major jump in performance, a slow, time-consuming process. Achieved was a new family of propellants, not merely an improved version of previous formulations.

One of Flexadyne's prominent characteristics is the ability to provide a high degree of reproducibility. Lack of reproducibility of PBAA lots has posed a problem in that propellant family, in that each new lot, usually a few thousand pounds, of PBAA manufacture must be made into test propellant to determine its acceptability, according to Britton.

This requires making a series of laboratory mixes to determine optimum cure, since successive lots react differently to various cure systems. Basic cause is considered to lie in the random molecular structure of copolymerized butadiene and acrylic acid. Total chain length and molecular weight are difficult to control to uniformity by current emulsion polymerization technique, SPO technicians state.

The active groups are inserted in the chains in random numbers and in random spacing. There are uncontrolled overhanging hydrocarbon chains extending beyond the last carboxyl group and these tend to have the same effects as plasticizers.

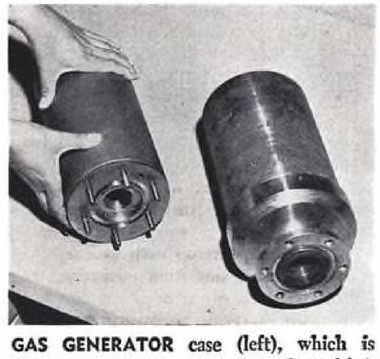
A symmetrical elastometric structure would be an ideal situation, SPO engineers contend. This type of structure is familiar in the curing of Flexadyne binder, whose molecules can be represented by lines of approximately uniform length, each having a carboxyl group at either end. This provides the requisite reproducibility and mechanical properties built in the propellant's binder polymer by use of synthesis techniques that involve controlling these polymer characteristics: cis-trans steriosomerism of interatomic spatial arrangement; side-chain content of the molecule; molecular weight and location of the active terminal groups.

Fractionation provided a comparison of PBAA and Flexadyne binder polymers. Each had an initial viscosity of 420 poises. Nearly 40% of the PBAA, but only 12% of the Flexadyne binder, had a viscosity of 100 poises or less. At the other extreme, 15% of the PBAA had a viscosity of 800 and 1,340 poises, while the Flexadyne yielded no fraction with a viscosity greater than 780 poises. This same data for Flexadyne binder indicates that molecular weight distribution approximately parallels viscosity distribution in Flexadyne binder. The characteristics of the basic polymers provide the expected improvements anticipated in Flexadyne binder as to reproducibility and mechanical properties.

Along with this polymer development was discovery and successful application of a chemical giving a superior cure to the new binder materials, after mixing with over 80% of solid substances including up to 20% of auxiliary aluminum fuel in Flexadyne propellants.

The new propellants also respond favorably to curative level and plasticizer, the latter having only minor effects on tensile strength and elongation while producing major improvements in pot life and castability.

Indications are that the new propellant family will also be well-suited for use with reinforced plastic lightweight motor casings, which pose the problem of greater deformation than lightweight metal cases. Greatly improved elonga-



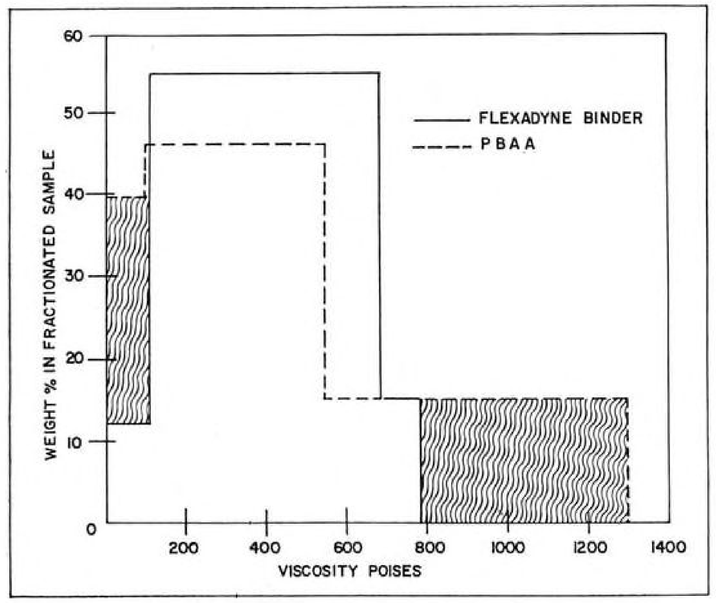
GAS GENERATOR case (left), which is lighter and about one-sixth as costly to fabricate as the present conventional case, is an example of SPO diversification and research.

tion characteristics of this propellant should overcome many of these problems, SPO believes.

Also to be considered is the fact that solid propellant motor sizes are often limited by the strain induced on the propellant grains as a result of pressurization during firing. Under certain conditions, one propellant might be used to produce a motor with a maximum grain outside diameter of 102-in. and a propellant web of 14-in.; a Flexadyne grain in a similar application could feasibly be fabricated with a 188-in. outside diameter having a 56-in. web.

Tests of the actual characteristics of the formulation under exaggerated conditions will be attempted here using a 10-in. motor containing a special flexible wall liner to permit considerable flexing of the grain against the motor wall against firing to provide maximum stress loadings. Grain perforations will probably be varied to develop maximum stresses to develop failure points during firing to determine actual characteristics.

Solid Propellant Operation's conservative attitude towards performance claims does not mean that the group is plodding along at developing new formulations and breakthroughs in the current 245-Isp regime. New research on more exotic specific impulse performance is definitely under way, though definitive data on these activities is difficult to obtain due to combination of military and proprietory security.



VISCOSITY ranges of fractions from 420 poises PBAA and Flexadyne binder polymers are shown above. Shaded areas indicate undesirable light and heavy ends in PBAA.

Polynitramine Studies

Indications are that SPO is putting considerable study into the polynitramines, which unlike the synthetic rubber fuels, carry energy-producing oxygen in their molecular structure, providing a highet energy loading when they are mixed with oxidizer to form a propellant. New propellant research here apparently has developed some promising items, which may provide motors that have specific impulses at least five points higher than current conventional propellants. Indications are that the gain may go considerably beyond this to perhaps 10 points. But discussion in this area becomes limited rapidly and the impression is that SPO is awaiting further testing before saying anything.

Solid Propellant Operations, after a long pull involving considerable expenditure on the part of North American Aviation, appears to have developed its capability to the point where it is becoming a competitive factor in the solid rocket motor field. A year ago, for example, its capability for handling work such as Minuteman's propulsion systems apparently was marginal, at best, an impression gained by talking to technicians here. Today the feeling is that capabilities now are at the point where serious bids for such class projects, or larger, are within the realm of achievement here.

Considerable reorganization in the past year, following drop-out of Phillips Petroleum from the former North American-Phillips combination, then known as Astrodyne, has been possible under the single management.

One important step was formation of an advanced design and analysis group, totaling some 60 persons, composed of both Rocketdyne-Canoga and Rocketdyne-McGregor (SPO), which is separated from both the operational sides of both the respective liquid and solid propellant operations. This organization studies propulsion systems on the basis of applying objectivity in considering the best system for a particular known requirement, and also provides the company with the ability to develop and promote systems on an organized basis without the possibility of rival presentations by the two conflicting and downgrading each other's designs.

Cross-feed benefits from liquid and solid research are also available through this closer coordination. SPO technicians note that they already have gained considerable help from Rocketdyne's liquid systems research applicable to solids, in the rocket nozzle design area and as a result of its studies on reinforced plastic components for rocket motors.

Solid Propellant Operations Manager Thomas E. Meyers also said that reorganization here has paved the way towards SPO's diversification program, which has taken it into design, development and production of rocket motor gas generators and turbine spinners, with expansion into gas turbine starters.

Solid propellant turbine starters developed and built here have resulted in weight savings of 120 lb. on large liquid engines and a total of some 1,000 lb. on the eight-engine Saturn cluster. Reliability tests of these units have shown that in more than 1,000 starts, they have achieved a reliability of 99.6%.

A readily noticeable area of SPO's capability buildup is in its research and development hardware shop, which has undergone complete rebuilding and outfitting with new equipment. This 33,000-sq. ft. facility contains a large Niles engine lathe that can handle rocket motor cases up to 72-in. in diameter and 30-ft. long and a Giddings horizontal boring mill that can take rocket nozzle heads up to 10-ft. in diameter, plus supporting sheet metal, welding, model and other shops.

Examples of solid rocket motor research handled here, some company-sponsored, some with military funding:

• **Variable area nozzle,** using a molybdenum tungsten throat, developed and tested with SPO funds, has been operated at exhaust gas temperatures up to 5,500F. Believed to be the first such operating system, the VAN program was completed in 18 months. Tests have included runs starting with nozzle closed, then opened and then closed in increments, with runs of 16 sec. nominal duration, varying the motor thrust from 700 to 1,200 lb. thrust. Extension of the development program calls for testing the VAN system on higher performance motors.

• **High-temperature,** long-duration uncooled nozzles, which have been successfully run at more than 5,500F. SPO technicians believe that the temperature-duration performance of the molybdenum-tungsten nozzle is some three times better than the duration attained by any other uncooled nozzle.

• **High temperature** short-duration nozzles have been run at 5,500F-plus in the area of 15 sec. Military-sponsored, these are plasma-coated (alumina, tantalum, tungsten and tungsten carbide) graphite nozzles, used in tests of propellants containing metallics.

Plasma coating techniques used here employ a Giannini Plasmadyne apparatus, fitted with a hand gun for optimum flexibility which develops temperatures of some 20,000F. This heat literally opens the pores of the nozzle base material so that the coating flows on and can resist high-temperature rocket motor blasts. In addition to aiding research on high-temperature and long-duration nozzle research, the apparatus provides big savings in test programs, since nozzles can be recoated after the initial coating erodes away, thus can be used many times more than previously.

R&D hardware shop manager Robert Jones feels that the machine already has more than paid its initial cost even in the short time it has been installed. Techniques of using heat-sink materials to dissipate rocket motor temperatures and plasma-coating to resist erosion is making possible major gains in nozzle research, he pointed out. The plasma-gun technique can coat at a cost of approximately 3-10 cents per sq. in., depending upon material used, including labor, Jones explained.

Metal-Working Techniques

Metal-working techniques developed here are playing a major role in SPO programs. Sometimes they are what appear to be relatively simple ideas, such as use of Swedish Blackalloy 525 cutters on molybdenum-tungsten, a material important in advanced nozzle fabrication, which plays havoc with metal-working tools.

Using this cutter, the shop reports that it is machining moly-tung as easily as mild steel, gets about 200% longer life out of its cutters than previously and spends some 20% less time in tool grinding. Its success appears to lie in developing the proper sharpening procedure for the tool. SPO's hardware shop developed a "crater" configuration behind the cutting edge, that automatically maintains the proper edge as the tool wears. This shop is making .010-in. cuts in moly-tung, a half-inch wide per revolution.

Shop technique and engineering combined to develop a major improvement in rocket motor gas generators, which have resulted in a more efficient design weighing approximately one-half the conventional item and costing about one-sixth less to fabricate. Conventional configuration was reusable, perhaps three times. The new version is a single-use throw-away item, which is also reported to be more effective as regards gas tightness.

Conventional gas generator case is a heavy 4130 steel cup forging, worked on a mill, with the nozzle attached by threading onto the case. Despite overtorquing on the thread, use of O-rings and snap rings to reduce gas leakage, the heavy pressure still permitted some leakage. Rocketdyne evolved the new design comprising a standard piece of chrome moly tubing, with a piece of chrome-moly tubing cut to fit the igniter end and the domed head being a pierced, blanked and formed part from chrome moly plate.

Components of the new design are copper-brazed and fusion-welded to form an integral leak-tight component easier to make, using light materials and less man-hours and having fewer parts. Final welding is done with case loaded with propellant.

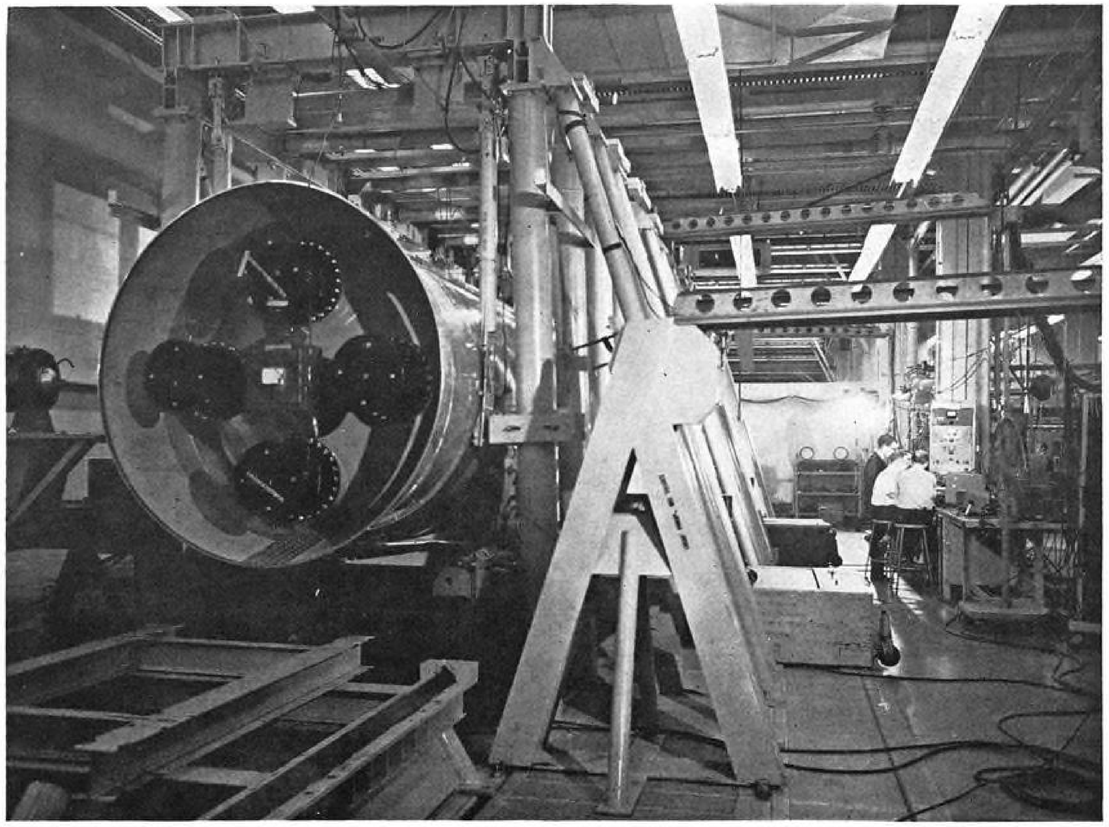
Tungsten inert gas welding process utilizes a novel, remote controlled, fully automatic equipment designed by Rocketdyne engineers. Fitted with a commercially available Airco Heliweld Model D welding head and automatic wire holder mounted on a Rocketdyne-designed frame, the apparatus can handle work up to 7 ft. in diameter and 6 ft. lengths. A ram manipulator, hydraulically operated, positions the welding head, which can also be set to any desired angle. Electronic circuits, also developed at Rocketdyne, permit push-button sequential operation. Entire unit is mobile, so that it can be moved anywhere in the shop, or to any of the other facilities as needed.

New Telescope Planned For Astrometric Study

Washington—Navy will install a 60 in. reflector telescope near Flagstaff, Ariz., that will be able to determine the distances and motions of stars as faint as the 18th magnitude up to 100 light years from the solar system.

Termed the first large reflector telescope designed specifically for astrometry, the $1.9 million system will be located at the Naval Observatory station five miles west of Flagstaff at a altitude of 7,600 ft. It will be housed in a three-story building 60 ft. in diameter which also will provide space for photographic work and testing of optics and electronic equipment.

Along with basic research in astronomy, the telescope will permit observation of deep space probes.



DUMMY Minuteman nozzles duplicate actual hardware but rocket motor cases are actual production items.

Boeing Tests Minuteman Casing Dynamics

By William S. Reed

Seattle, Wash.—Dynamic testing of the USAF-Boeing Minuteman intercontinental ballistic missile casing and airframe is virtually completed and, aside from proving out original theory, the tests are providing valuable data for guidance and flight control parameters.

Originally scheduled for completion in December of this year, the vibration testing of combinations of propellant loadings and different second and third stage engines has gone well enough so that the program will end nearly four months ahead of schedule.

Boeing Minuteman program manager T. A. Wilson attributes the early completion to the same causes which permitted completion of the silo firing program at Edwards AFB, Calif., after only eight of the 18 scheduled launches were conducted (AW June 27, p. 63). Wilson said that this is "a result of either fantastically good theory, good support, or simply good luck." Actually, it is a combination of all of these.

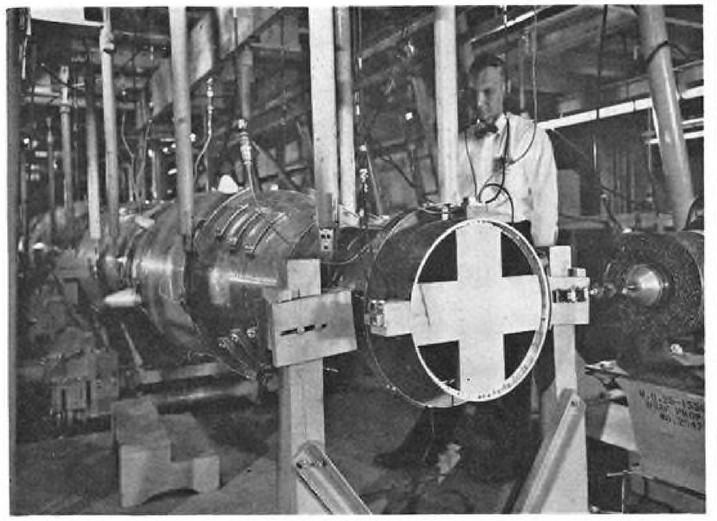
Not all parts of the Minuteman program are as far ahead as the dynamic testing and silo development programs, Wilson added, but the entire program, from Boeing's standpoint, is largely on schedule.

Data gathered from the dynamic testing program are providing the necessary back-up proof to theoretical calculations on the flexibility inherent in the missile shell and airframe during various phases of flight. Additional data on precisely where the bending occurs will facilitate location of control system transducers and establishment of the validity of analytical load data.

Production line Minuteman stages are subjected to instrumented vibration tests in a horizontal test rig at the Boeing Aero-Space Division facility. Resembling a very heavy bridge truss, the test rig suspends the missile from overhead on thin, high-strength steel straps. Original idea of conducting the tests in the upright position was rejected since it proved difficult to reproduce movement in the base of the missile, thereby reflecting less true a picture of in-flight bending moments. Tension on the various straps supporting the Minuteman is varied hydraulically to eliminate sag in the airframe while it is at rest. The missile is so suspended that it can be grasped at the nose cone and oscillations can be induced throughout the airframe by applying hand force.

All components are not in place since many are not in the final form available for testing. However, the precise size and weight of each of the components is reproduced. The external fairing that houses control system electrical cables is duplicated by a series of lead blocks fastened to the skin. The nose cone is a boiler plate reproduction of the production item in size and weight distribution, as are the exhaust nozzles and the internal components.

Minuteman airframe is tested under several different conditions, such as with all three stages in the full propellant condition, the first stage empty, first stage removed, second empty, etc. Behavior of the missile under these conditions is established experimentally by inducing vibration through the 11 Boeing-developed electronic vibrators. Comparison is made between the test data and theoretical calculations as to the amplitude, period and nodes of bending. So far as dynamic testing is concerned, theory has come out very close to experimental data, which is



MINUTEMAN dynamic test facility uses boilerplate nose cone, duplicates production cone.

probably the main reason that the program finished ahead of schedule.

Delay in decision on the award of a contract for the third stage engine has caused the test program to be duplicated for both stages under competition. After the test conditions have been applied to an airframe equipped with an Aerojet-General Corp. third stage, the entire series of test conditions must be duplicated for an airframe bearing a third stage built by Hercules Powder Co. Differences in weight and in weight distribution between the two third stages is sufficient to render data from one inapplicable to the other. However, when the decision on awarding the third stage contract is announced, data for both already will be accumulated.

Further complications in the vibration test program stem from the need for testing the back-up second stage built by Thiokol Chemical Corp. Having two different second stages and two different third stages make the problem one of permutations of combinations.

Data Collection

Data collection on the dynamic tests takes a short time once the test has been set up. Generally, all pertinent test points can be run in a matter of a few hours. Preparations for the test cause the greatest expenditure of time. Full stages must be replaced with empty ones, the missile must be removed from the test rig to change third stages and the instrumentation accelerometers, vibration pads, etc., must be affixed to the test article. The problem is not so much one of collecting data as it is of the logistics of removing and replacing the missile in the test apparatus, says Boeing's Dynamic Test Manager J. J. Shepherd.

Behavior of solid propellant fuel in Minuteman also is being investigated in the program because it has been found that the propellant does not necessarily behave like a solid. Because of its solid rubber-like composition, it was thought that the propellant would not contribute to the flexing problems, but such is not the case. Results of the vibration test program indicate that the propellant acts like a rubbery mass actually moving about within the case and setting up oscillations which change the dynamics of the over-all structure.

Production Testing

Vibration testing also is being conducted on the missile instrumentation and the interstage structures on a production basis, which is expected to reach a peak during August. For this purpose, Boeing uses two 25,000-lb. capacity shakers mounted on oil tables. Although located in the R&D Center, the shakers will be used in production testing rather than constructing duplicate facilities at other locations.

The Dynamic Testing Program is only one small facet of a larger over-all project known as the Seattle Test Program. Designed to shake down all the various features of the complete Minuteman weapon system, the STP is concerned with the missile components and subassemblies, the complete weapon itself, support and checkout equipment, environment and flight testing. Scope of the operation covers the program at Edwards AFB, Vandenberg AFB, the Air Force Missile Test Center at Cape Canaveral, operational sites at Malmstrom AFB, Great Falls, Mont., the mobile Minuteman trains and the Boeing assembly and overhaul facility at Hill AFB, Ogden, Utah.

XM-474 mobile launcher made by Food Machinery and Chemical Corp. for Army-Martin Pershing missile has speed of 40 mph.

Pershing Fired From Tactical Launcher

Washington—Army-Martin Pershing was fired for the first time from its tactical mobile launcher July 26 in the sixth successful short-range test of the missile in as many attempts.

The two-stage, solid propellant test vehicle carried a dummy second stage on its 30 mi., 230 sec. flight down the Atlantic Missile Range. First stage burned out approximately 40 sec. after launch. This was the third test in which wind velocities and directions were artificially varied and corrected while the test vehicle was in flight.

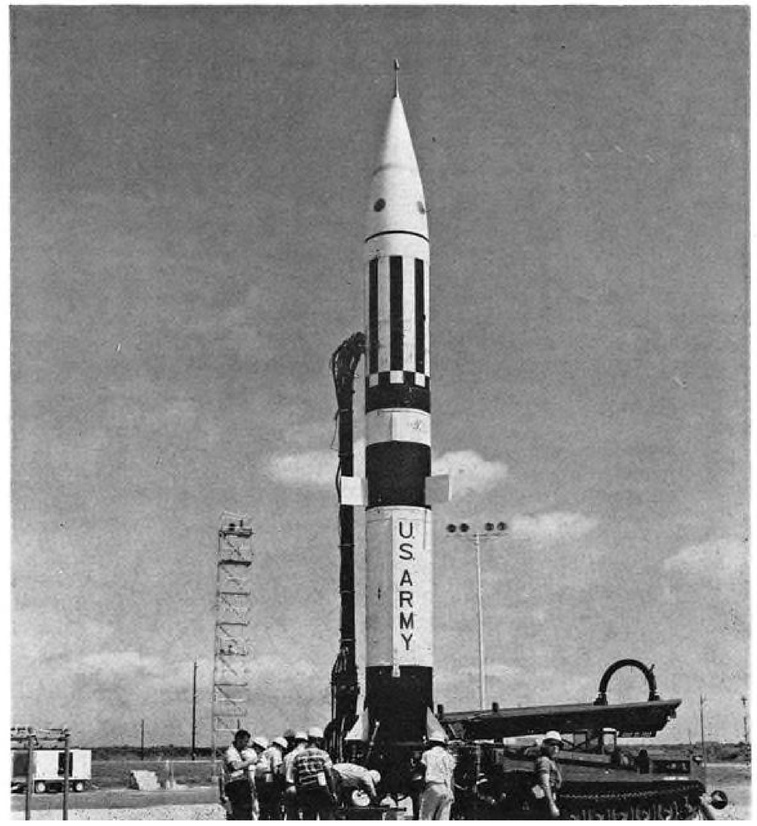
Test flight was the first made from the transporter-erector-launcher (TEL) developed by Thompson Air Products Co., a subsidiary of Thompson Ramo Wooldridge, for tactical use with Pershing in the field.

Special Test Range

As Pershing moves toward the longer range phase of its test program, Pan American World Airways, AMR operator, is completing construction of a special 13 station test range for the missile. This new range is required because Pershing has an impact area different from the areas used with previous missiles at AMR."

The $3 million Pershing range extends 300 mi. from Cape Canaveral to Eleuthera and includes five new downrange stations. Each of the 13 stations is being instrumented with radar, long-range accuracy system (LORAC), ultra

PERSHING is checked out before firing from mobile launcher July 26 at Cape Canaveral.



TAPCO POWER SYSTEMS

TAPCO HAS ENGINEERING AND MANUFACTURING EXPERIENCE IN

SOLID PROPELLANT ROCKET NOZZLES

TAPCO can and has produced large quantities of high quality nozzles, on schedule and at competitive prices. A few of the many configurations are shown below.

ENGINEERING—For the past several years the TAPCO Group has been working with solid rocket firms on development of both fixed and vectoring nozzles.

TAPCO's work in this field has produced advancements in nozzle materials and techniques, including low-ablation reinforced plastics, refractory metal throats, and low torque, positive seals.

These projects are handled by an outstanding project engineering team, capable of proceeding from concept through prototype production on a tight schedule. This team is supported by heat transfer specialists, dynamics analysts, structures and materials experts, a large plastics laboratory and an advanced high-temperature metallurgy laboratory.

Advanced projects at TAPCO offer excellent career opportunities for qualified engineers and scientists. Write Director of Professional Employment.

TRW

MANUFACTURING—The million-and-a-half square feet of the TAPCO Cleveland plant contain all the direct and supporting equipment required for nozzle production on any scale, including a new 2500-ton reinforced plastics press for pressure-molding high density, low-ablation materials.

Each production nozzle program at TAPCO is under the direction of a program manager. His job is to insure that quality and performance of products are constantly checked and rigidly maintained, and that the work is delivered on schedule.

Because of TAPCO's nozzle engineering experience, customer-initiated design changes are efficiently handled. Changes are analyzed by the product engineering team, and are promptly phased into production.

TAPCO can work for you on make-to-print business at a competitive price... can work with you on design concept... or can contribute to your nozzle program at any step along the way. You determine the help you want, TAPCO has the capability to provide it.

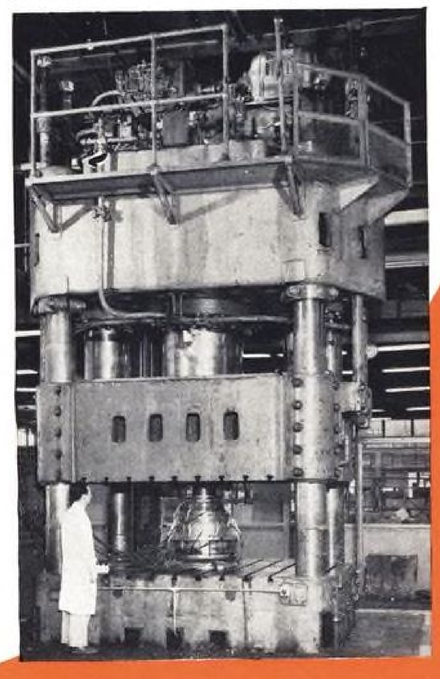
TAPCO GROUP

Thompson Ramo Wooldridge Inc.

Dept. AW-1860 • Cleveland 17, Ohio

DESIGNERS AND MANUFACTURERS FOR THE AIRCRAFT, MISSILE AND SPACE, ORDNANCE, ELECTRONIC AND NUCLEAR INDUSTRIES

This 2500-ton reinforced plastics press, recently added to TAPCO's manufacturing facilities, can pressure-mold plastics up to 8 feet in diameter and 4½ feet long.



high frequency doppler system (UDOP) and ballistic cameras.

New stations will be at Middle Carter and Great Sale Cays on Grand Bahama Island, and at Green Turtle Cay, Dundas Town and Great Stirrup Cay on Great Abaco Island.

Existing stations being fitted with Pershing instrumentation are Jupiter, on the Florida mainland; North Riding Point, West End, Walker Cay, Little Carter Cay and Allan Cay, all on Grand Bahama Island; a site south of Dundas Town on Great Abaco, and Eleuthera.

Also being instrumented for Pershing tests is the Twin Falls Victory, a 465-ft. merchant ship being converted at Mobile, Ala., shipyard.

The 34-ft. Pershing, which has a diameter of approximately 40 in., is smaller, lighter and considerably easier to handle than the 61-ft., 61,000-lb. liquid-fueled Redstone which it will replace. Use of TEL system on its own tracked carrier is designed to provide full battlefield mobility with a self-contained system.

The tracked carrier, manufactured by Food Machinery and Chemical Corp., is called XM-474. It weighs 11,000 lb. and has a speed of 40 mph. Dimensions are 202 in. long, 76 in. high and 96 in. wide. Launcher is an electro-mechanical system which the Army says can erect Pershing into firing position in minutes.

Thiokol Chemical Corp. is motor contractor, and Eclipse-Pioneer Division of Bendix Corp. manufactures the all inertial guidance system for Pershing.

Initial contracts for the Pershing system were awarded Mar. 25, 1958, and first launch was Feb. 25, 1960. Other firings were Apr. 20, May 10, June 9, June 30 and July 26. First firing of two-stage configuration is expected before the end of this year.

The contract covers a part of over-all Pershing development planned for the 1961 fiscal year. The $30 million provides for continuation of engineering services and procurement of long lead time items. Contracts covering other aspects of the Pershing program will be awarded later this year.

Transit III-A Launch Slated for November

Washington—Transit III-A experimental navigation satellite will be launched into a 28 deg. orbit from Cape Canaveral, Fla., in November and will carry a small piggy-back satellite in Navy's second test of the dual payload technique (AW June 27, p. 26).

This will be the first Transit to carry a small-capacity memory device for receiving and transmitting orbital parameters. It will obtain data for use in designing the full scale operational memory unit. Primary payload will transmit four doppler frequencies and carry an electronic clock, as did Transit II-A. Army Map Service's SECOR geodetic experiment also will be carried in the main satellite.

A small satellite, attached to the main payload at launch and separated from it in orbit, will carry a very low frequency radio experiment developed by Naval Research Laboratory. Launching vehicle will be a Thor-Able Star.

All experiments in Transit II-A, which was launched June 22, have operated successfully, Navy said. Naval Ordnance Test Station's infrared experiment terminated June 27, as expected, and the Canadian galactic noise receiver experiment in the small satellite also ended as scheduled.

Army Reorganizes Missile Management

Washington—Army Ballistic Missile Agency last week received management responsibility for seven additional programs in a shuffle of Army Ordnance Missile Command assignments.

ABMA now will manage ballistic systems, which Army defines as those in which the warhead is fired on a set trajectory. Army Rocket and Guided Missile Agency will manage programs in which the path of the missile can be changed after launch.

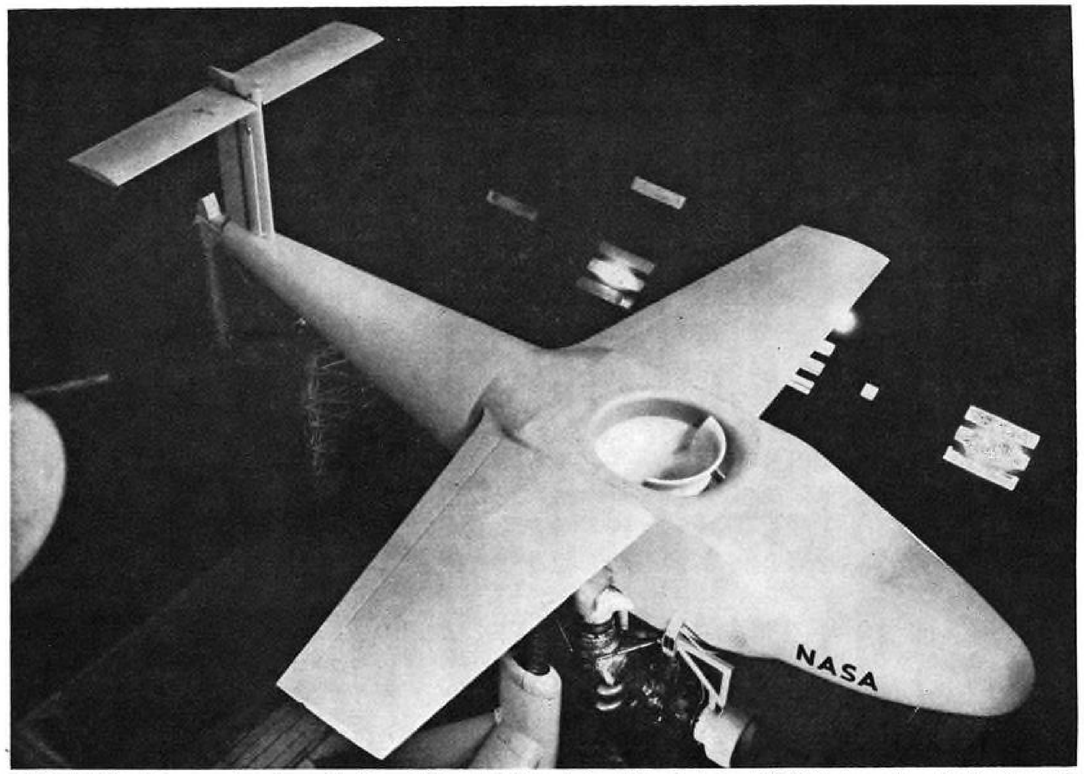
These definitions result in the transfer to ABMA from ARGMA of Honest John, Little John, Corporal, Sergeant, Light Anti-Tank Weapon (LAW), Missile A and Missile B. ABMA will continue management of Redstone, Jupiter and Pershing systems. ARGMA retains Nike Ajax, Hercules and Zeus, Hawk, Redeye, Lacrosse and the Shillelagh.

McGuire and Otis Get First Bomarc-Bs

Washington—Air Force will install the first Boeing Bomarc-B air defense missiles at McGuire AFB, N. J., and Otis AFB, Mass.

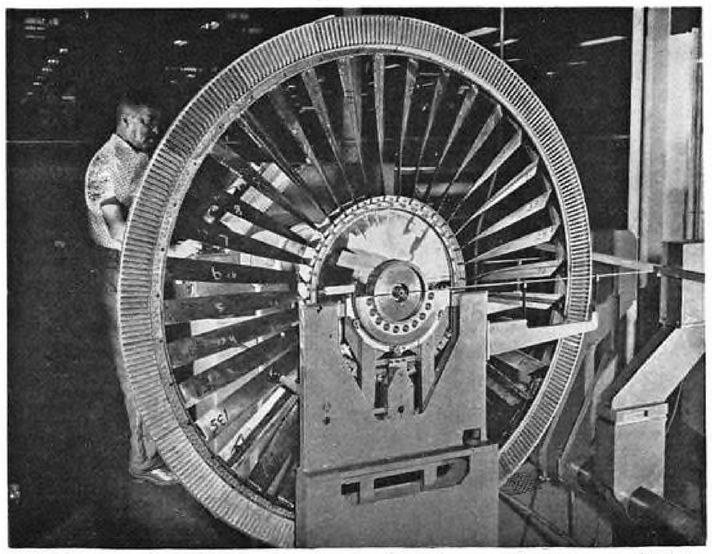
Each site will have 28 launchers, to be built under the supervision of the Army Corps of Engineers. Both bases are operational with Bomarc-A missiles, McGuire having 56 Bomarc-A launchers and Otis 28. The Bomarc-A launcher damaged at McGuire when a nuclear warhead burned in June (AW June 27, p. 23) currently is under repair.

Congress approved $244 million for the Bomarc-B program this year after a House move to eliminate funding for the entire system. Bomarc-B has a solid propellant booster and can fly twice as far as the 200-mi. range Bomarc-A.



GENERALIZED airframe used to house the General Electric lift-fan during full-scale tests at NASA's Ames Research Center would function as prototype for two-man, 400 mph.-plus, VTOL close observation aircraft.

Lift-Fan Engine Shows VTOL Potential



FAN ROTOR for first GE lift-fan is made primarily of sheet metal. Rotor assembly being balanced above has a tip speed of 720 fps. Fan pressure ratio is 1.115.

By J. S. Butz, Jr.

Washington—Highly successful full-scale wind tunnel tests of an Army-General Electric lift-fan engine installed in a generalized aircraft configuration have established the general feasibility of this engine concept and demonstrated its potential for VTOL aircraft.

Twenty hours of tests performed during July in the 40 x 80 ft. full scale tunnel at the National Aeronautics and Space Administration's Ames Research Center have shown that the lift-fan concept has met the most optimistic estimates of its designers in its first realistic trials.

GE believes technical outlook for the lift-fan engine has improved considerably because two of the main uncertainties regarding the system have been answered positively by the Ames test and the ground running that preceded it. These uncertainties were:

• **Distortion of the air flow** into the fan to be expected during transition flight. As a VTOL aircraft moves horizontally after its vertical takeoff, the air entering the fan has to make an increasingly sharp turn as forward speed increases. Theoretically, it could not be proven absolutely that the flow into the fan would be balanced after the air makes the sharp turn. If the air tended to enter one side of the fan more than the other, blade loadings would fluctuate and vibrations would occur.

The Ames tests showed that there is virtually no flow distortion on the fuselage installation tested there, up to forward speeds of 80 kt., which essentially cover the complete transition flight phase for the test configuration. Future tests will have to be made to prove that serious flow distortion would not occur if the fan were mounted in a wing and did not have the long intake duct possible with a fuselage location. It is believed, however, based on the Ames results, the wing-mounted fans will not give trouble in this respect.

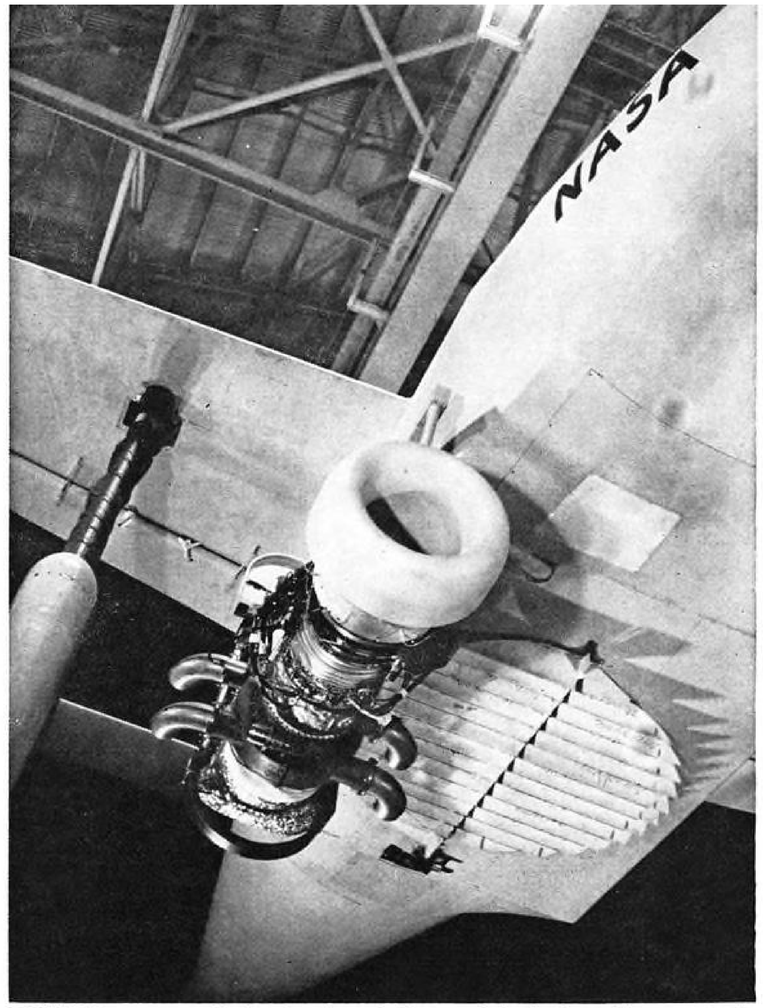
• **Installation weight of the lift-fan** system with its gas generator, diverter valve, ducting, scroll and fan with an integral tip turbine. Weight estimates on a system like this varied considerably two or three years ago when they were in the paper stage. The GE lift-fan now running takes full advantage of the current state of the art in sheet metal construction and is considerably lighter than the majority of estimates used in the past in the preliminary design comparison of VTOL aircraft. The present 76 in. dia. fan coupled to a GE J85-5 turbojet, plus the necessary ducting, etc., weighs 1,145 lb. and produces 7,430 lb. of lift thrust and 2,580 lb. of horizontal thrust for cruise. Many hours of component testing and 40 hr. of ground running of the complete engine system plus the tunnel time at Ames indicate that the lift-fan will have adequate life at its present weight.

Engine Matching Problem

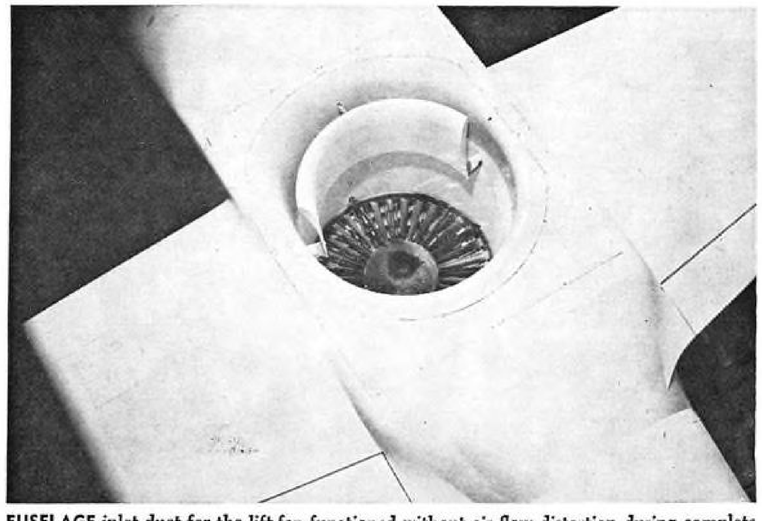
The ratio of takeoff to cruise thrust on the present lift-fan design is just about right for VTOL aircraft, which have always presented an engine matching problem because they need roughly three times more thrust during takeoff than they do at maximum speed. Thrust required by high performance aircraft for horizontal flight and maneuvering usually is about 0.3% of the takeoff weight.

If larger engines are used so that the thrust available is a little more than the takeoff weight and vertical takeoff is therefore possible, then the engines must be throttled back during cruise to such an extent that their operation is inefficient and fuel consumption increases.

If VTOL capability is achieved by adding extra engines just for use during takeoff and landing, then they must be carried as dead weight during hori-



LOUVERED vanes cover the fan air exit on the bottom of the fuselage. They turn to the rear during transition flight in coordination with the diverter valve which redirects the gas generator flow from the fan to a straight horizontal exhaust.



FUSELAGE inlet duct for the lift-fan functioned without air flow distortion during complete simulation of transition flight in the Ames tunnel. Key design factor to eliminate inlet air flow distortion is a high velocity inlet flow and a fan pressure ratio above 1.1.

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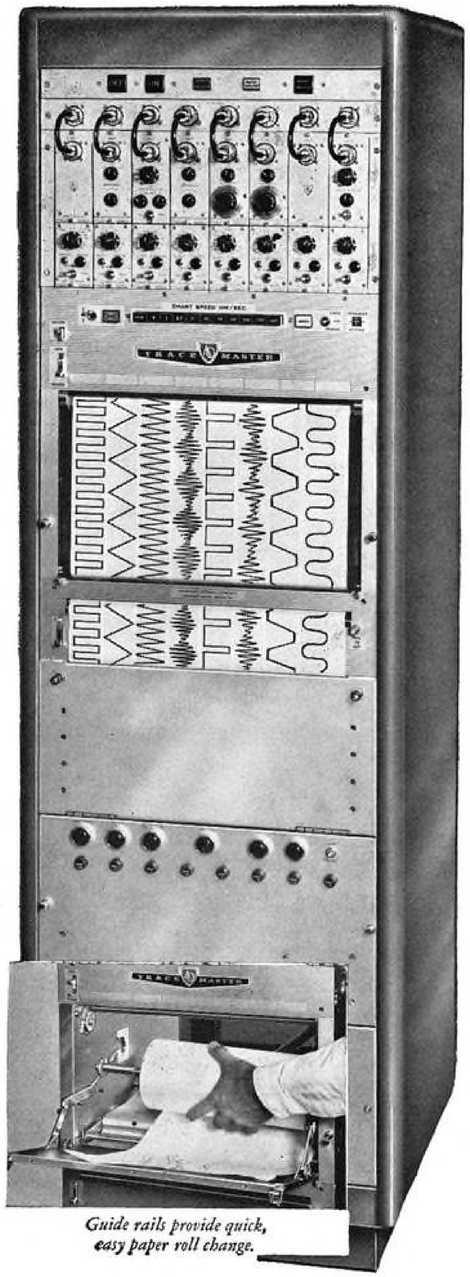

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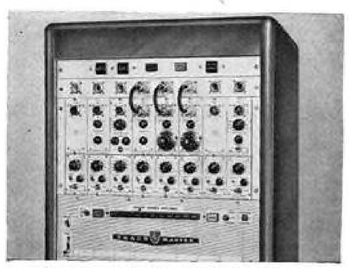

Compact panel contains all signal input and conditioning facilities.

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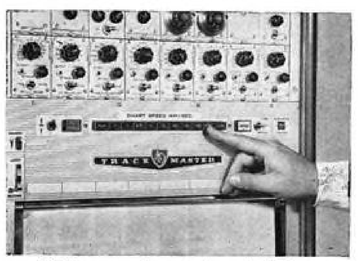

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zontal flight and the fuel load must be increased.

Proponents of the lift-fan system believe that the practical demonstration by the GE engine has shown that it will provide VTOL capability with the smallest dead weight penalty of any known system. A major disadvantage of the system is the volume taken up by the fan, especially in a fuselage mounting. Partial alleviation of this problem is planned by closing the fan air intake on the top of the fuselage with doors that swing open 180 deg. when the fan is operating.

A sizable amount of avionic gear and other equipment could be carried on the inside of these doors and partially fill the intake volume during high speed flight.

A rough example of what could be done with the GE lift-fan in its current configuration and weight using the generalized aircraft shape that was tested at Ames is a small, two-place VTOL observation aircraft capable of speeds above 400 mph. Such an aircraft would weigh about 6,500 lb., carry in the neighborhood of 800 lb. of reconnaissance equipment and operate at high speeds for about an hour. It would not be the most efficient reconnaissance aircraft from a weight carrying standpoint but the performance penalty required to get vertical takeoff capability is much lower than that predicted a few years ago by many designers.

Engine failure during transition would be catastrophic on this type of aircraft, however, without some type of fast-starting emergency gas source to power the fan. Design philosophy today seems to favor larger aircraft with either a single fan driven by two gas generators or two complete fan units similar to the one under test with interconnecting ducting so one engine could drive both fans. Heavy duty landing gear probably would be required on these aircraft for emergency landings.

Large Diameter Fan

Technically, the GE lift-fan is described as a large diameter fan with a partial induction tip turbine. The hot gas drives the fan by passing through turbine blades on the tip of the fan blades. The gas is fed to the turbine through a scroll that extends only partially around the fan circumference. Another fan of this type is being developed in the free-world by Avro Aircraft of Canada for its saucer-shaped aircraft, which is behind in its original development schedule.

Future potential of the lift-fan concept is considered very bright by GE engineers. They have made preliminary studies of fans that exceed 100 in. dia. which would be suitable for use in large transports. These would be powered by T58, T64 or J79 gas generators.

Very light weight turbojet engines designed for lifting only have been studied as gas generators for fans. These gas generators plus expected improvements in fan specific weight will result in thrust/weight ratios of 15 to 1, in the opinion of GE specialists. This could be translated into a substantial improvement in aircraft performance compared with one described above using the present lift-fan, which has a thrust/weight ratio of about 6.5 for lift. Almost immediate improvement of this figure to the range 7.5 to 9.0 can be made according to GE estimates by substituting a dash number of the J85 gas generator and slight fan installation improvements.

A flight test program will be required for complete demonstration of the lift-fan's capability. The Ames wind tunnel tests indicated that the test aircraft configuration would remain stable and make a smooth transition from vertical to horizontal flight. During this transition the hot gas must be diverted smoothly from the fan and exhausted horizontally in close coordination with a rearward movement of the louvered vanes on the fan exit, which turn the fan flow to the rear and add to the forward force. Although a flight type diverter valve was not used in the Ames tests, its flow characteristics were simulated. The transition during landing from horizontal to vertical flight was also shown by the wind tunnel tests to be completely stable.

Flight Test Program

Complete picture on stability cannot be obtained from wind tunnel tests, even though the tests can expose major problems. Flight tests are necessary to get adequate design data for incorporating any type of propulsion system into a VTOL aircraft, whether it keeps its fuselage horizontal during transition or not. Expense of a vehicle and flight test program will make a sizable change in the funding requirement for the lift-fan development.

Approximately $6 million has been spent on the lift-fan program to date. It originated in 1957 with preliminary design studies sponsored by the Army Transportation Corps. In May, 1959, the Transportation Corps let a contract to GE for the construction of an experimental fan and for a proof test through 40-50 hr. of ground running and for 20 hr. of tests in the NASA tunnel at Ames with the fan driven by a J85 engine.

Army expenditure on the program has totaled about $2 million and the Air Force and General Electric have each put in approximately the same amount of money. The Air Force financial assistance has been primarily in the form of "contributing engineering" by which engineers on Air Force contracts are allowed to assist briefly on work which is of potential value to USAF. The development of the diverter valve for the system was sponsored by the Air Force through a $400,000 contract. The J85 engine in the program was also made available by the Air Force. GE feels its confidence in the potential of the system has been demonstrated through its investment.

Future of the lift-fan system, however, is closely hinged to an ability to keep costs low if a flight test program is pursued. Low priority has been given to VTOL development by the Department of Defense. Hopes for the development of operational VTOL vehicles by the services during the early 1960's have faded in the last six months. The Air Force decided to bypass VTOL for its new Tactical Air Command fighter (AW Mar. 14, p. 29) and the Army did the same in choosing a helicopter for its next generation close observation aircraft (AW Mar. 28, p. 33). These decisions to postpone operational VTOL vehicles through another round of development programs were made on Department of Defense level. Dr. Herbert York, director of defense research and engineering, and specialists from his office coordinated a tri-service evaluation of the VTOL progress made to date and this evaluation indicated that an effort to develop operational VTOL vehicles with all of their necessary ground equipment within four or five years would not be successful.

A VTOL policy and technical evaluation committee headed by Cal Muse of Dr. York's office has been responsible, since February, for constant review of the VTOL work of the three services, other government agencies, private companies and universities. The Army, Navy and Air Force have representatives on this committee.

Committee Formed

An ad hoc committee has also been formed on the assistant service secretary level to get a decision from the services on what type of VTOL transport can be built which would allow each of them to study and define their detailed engineering and operational requirements for this class of aircraft. Design and construction of this transport apparently will receive the bulk of VTOL funds during the next few years.

Lift-fan concept is not under serious consideration for the VTOL development transport, which is currently planned around one of the VTOL systems already flight-tested. These include the deflected slipstream, tilting

rotor, unloaded rotor, rotating duct and tilt-wing aircraft that have flown successfully in the past (AW Aug. 1, p. 28).

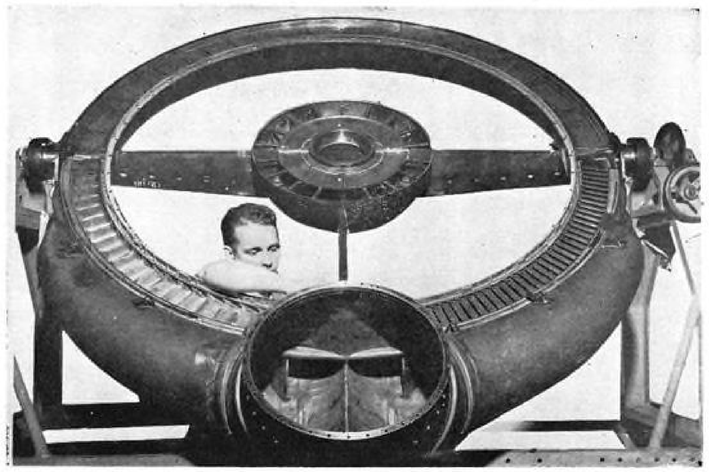
Many VTOL experts in the three services believe that a flight test of the lift-fan is called for at the earliest possible date so that this currently successful research program is pushed through and a final positive answer regarding its capability is obtained. If this philosophy is followed, it is probable that the lift-fan flight test program will be a joint venture of the three services and will make maximum possible use of available hardware by adapting the existing fan to an airframe in current use.

Such a less-than-optimum vehicle would not reveal the exact capabilities of the system but should answer the question of feasibility and provide valuable design data for an optimum aircraft. More important today, it would keep costs low and raise the probability of a continuation of the program.

The test configuration has been scheduled back into the Ames full scale tunnel in October and GE is assembling a second 76 in. dia. fan for test running.

No decision has been reached on a flight test program.

Lift-fan designers must compromise between a desire to have small compact fans which are easily located structurally and a desire to get a high augmentation ratio, which is the ratio of takeoff lifting thrust of the fan to the thrust provided by the gas generator. Augmentation ratio increases as fan pressure ratio decreases but small compact fans require a high velocity exhaust stream and a high pressure ratio to provide a specified amount of lift. Small fans, even though they provide a lower augmentation ratio than those of large diameter, have a lower weight per pound of thrust produced.



SCROLL extending partially around the circumference of the fan feeds hot gas to the tip turbine. Exhaust gases enter the scroll from the gas generator at about 1,200F. Lifting power of fan system can be improved if more fuel is burned in duct just ahead of scroll

If fans are located in wings, the wing aspect ratio and wing loading restricts the size of fan that can be used. This in turn determines the fan disc loading, and augmentation ratio.

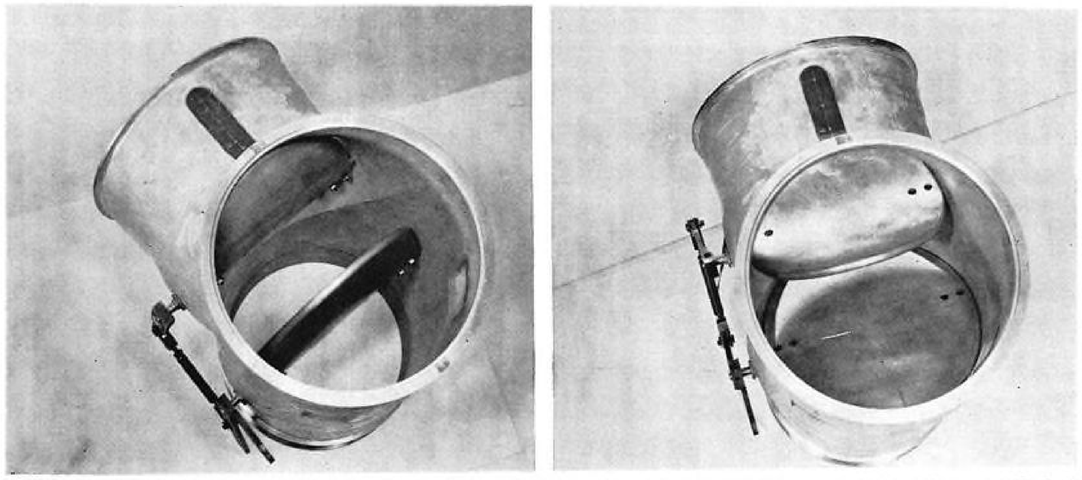
Fan Pressure Ratios

Relatively low altitude, subsonic aircraft with good cruise characteristics will have fan pressure ratios of 1.1 to 1.5, according to GE studies, as the best compromise between high augmentation ratio and small compact ratio.

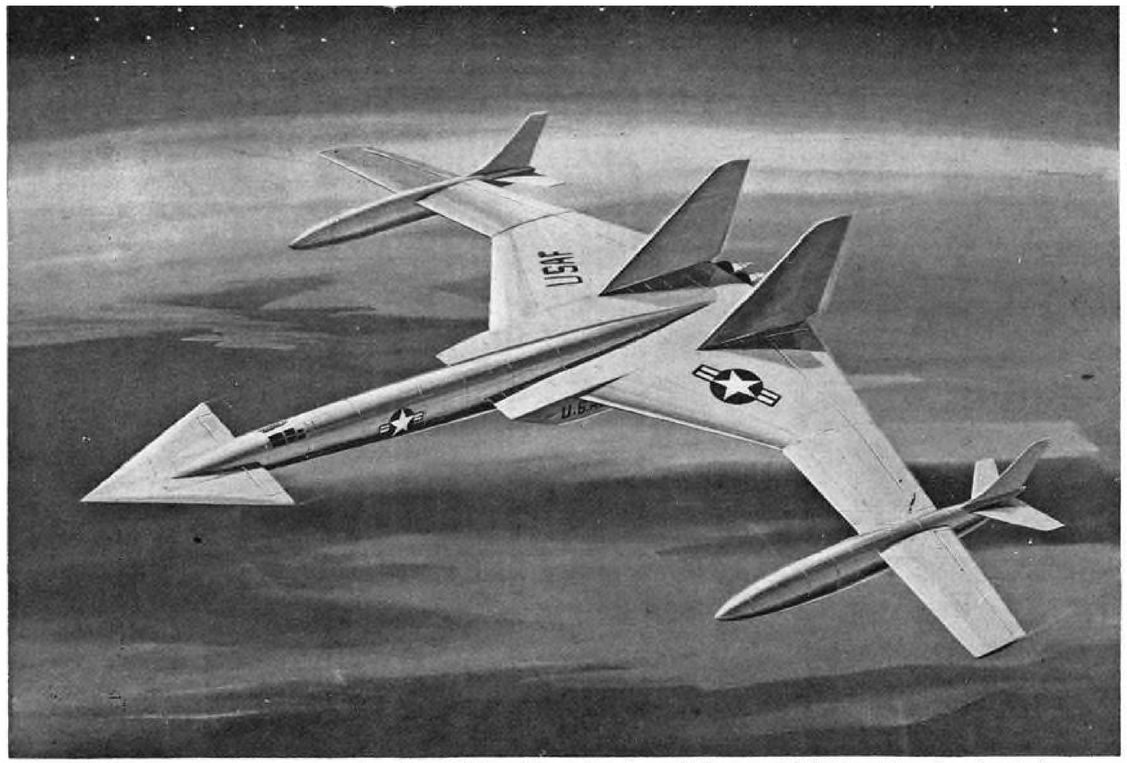
Burning fuel in the duct leading from the gas generator to the fan turbine has also been studied to provide very large augmentation ratios out of small fans. This inter-burning appears possible but it increases duct design problems and complexity and raises the specific fuel consumption for the system.

One design problem that has been cited in the past as a drawback to wing or fuselage lift fans was a downward force produced when the exhaust from the fan passed at high speed under the aircraft.

This rapid flow caused a venturi effect between the aircraft and the ground, creating a low pressure region that tended to hold the aircraft down. Most aircraft manufacturers and GE believe that this situation can be avoided with proper landing gear design, wing location and deflector plates and that down-lift will not be a problem on operational vehicles.



DIVERTER valve (above) is used to direct the hot air from the gas generator either to the lift-fan or into a nozzle to provide horizontal thrust. The valve is then positioned to turn the flow 90 deg. into the fan scroll.



EARLY MACH 3 bomber designs were rejected by USAF. Above aircraft would have carried jettisonable outer wing tanks.

B-70 Will Create Enemy Defense Problems

By Craig Lewis

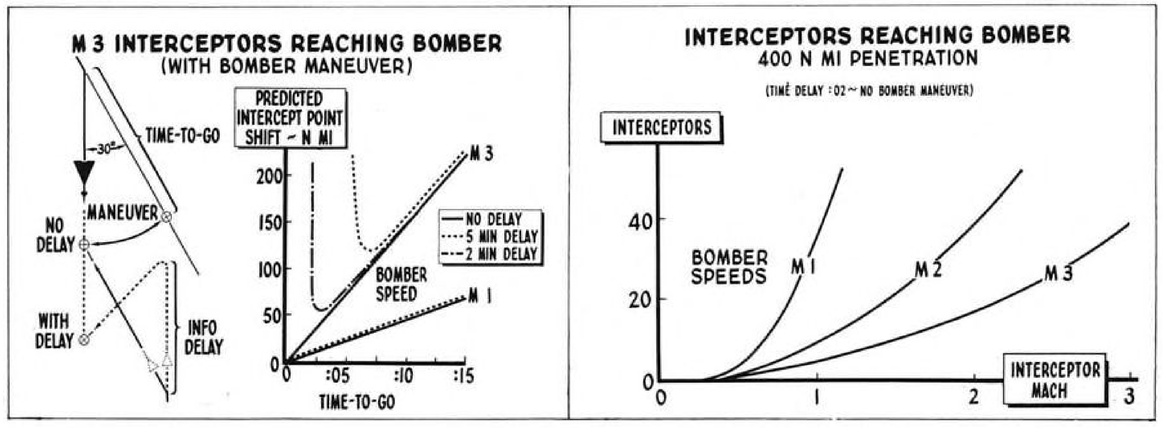
Washington—High performance and flexibility of the North American B-70 will give the strategic bomber force a substantial increase in penetration capability, and this margin will create serious new problems for enemy air defenses.

Planned Mach 3 speed and 80,000 ft. penetration altitude of the B-70 could make all defense weapons in any enemy inventory obsolete and force an enemy to invest heavily in new weapons and control systems, according to an analysis of the B-70 by the Senate Preparedness Investigating Subcommittee.

Strategic Air Command estimates that a $10 billion investment in a fleet of B-70s would cost the Soviet Union $40 billion to improve defenses to compete with this fleet. The Senate report notes that "some thought should be given to the effect that a Soviet B-70 would have on our existing forces."

Speed alone is a valuable penetration aid because it reduces exposure time and minimizes the number of air defense weapon systems which can reach the attacking bomber. Even if a defense system reacts instantaneously, it is estimated that the Mach 3 bomber will be intercepted by only 11% of the number of weapons which will be able to reach an attacking Mach 1 bomber. Time delays in the defense system increase the B-70's advantage even more.

These time delays stem basically from the time it takes to relay data through the defense control system and from ground radar problems in sorting out targets and getting their range. B-70 should be able to expand the ad-



B-70 MANEUVERING in a 30 deg. turn toward an attacking Mach 3 interceptor 15 min. before planned intercept would be 225 naut. mi. from the predicted point at the planned intercept time. Number of interceptors reaching Mach 3 bomber are shown at right.

Controls for the "hot ones"

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- for the B-70's air-induction system
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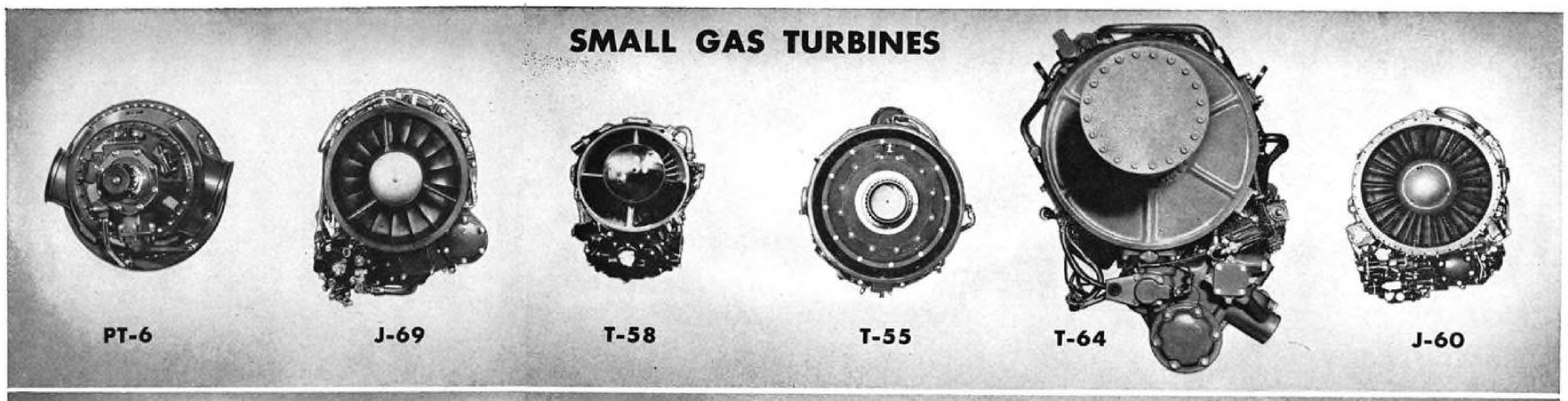
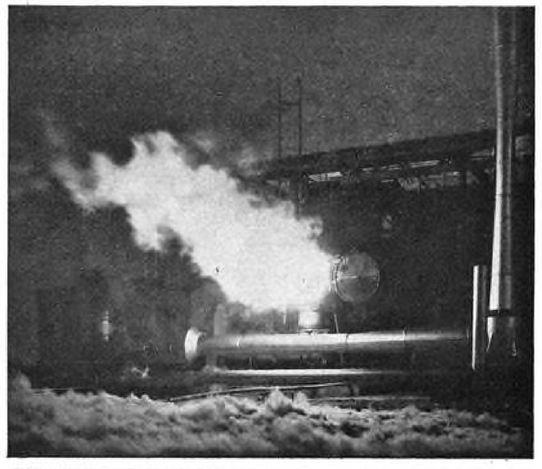
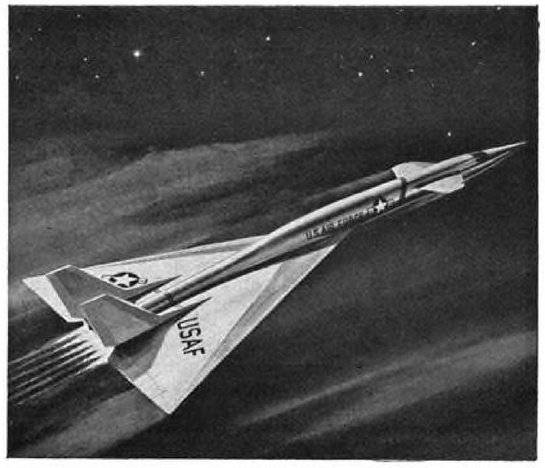
Hamilton Standard has the ability to solve your control problems–from concept to completion. Your inquiry is invited.





ROCKET ENGINE CONTROLS. Hamilton Standard has developed thrust modulation controls and fuel-oxidizer shut-off valves for an advanced liquid hydrogen engine. This work has provided important breakthroughs in low-temperature sealing problems and system reliability.



B-70'S AIR-INDUCTION CONTROL SYSTEM, now under development at Hamilton Standard, involves some of the most advanced control problems ever encountered. It is designed to provide the most efficient air-flow into the plane's engines over an unusual range of operating conditions.

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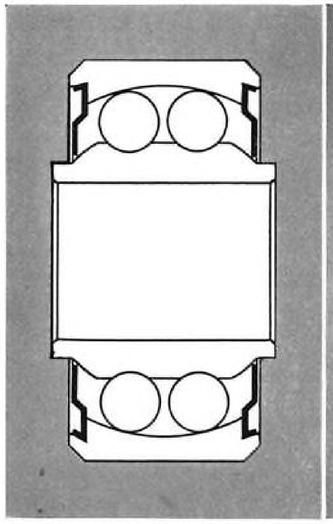
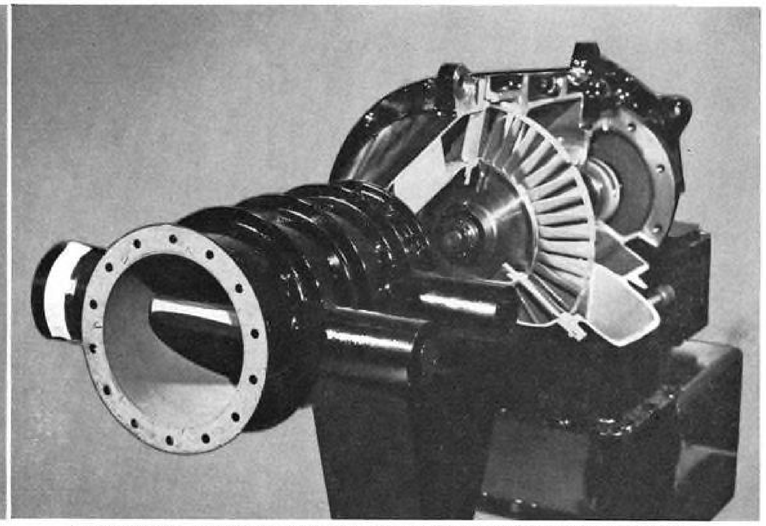
ELECTRONICS at Hamilton Standard includes broad experience in flight control, instrumentation, static power inversion and electrical control for aircraft, missile and GSE components.

Early Boeing B-52 Stratofortresses, equipped with G-E turbodrives, were first to use pneumatic-driven accessories only.



Fafnir Extra-Small Ball Bearings of tool steel take high temperatures, heavy loads, save space and weight.



G-E turbodrives operate on air ducted from engines to drive accessory equipment. Butterfly valves in turbo alternator (above) are equipped with Fafnir Ball Bearings.

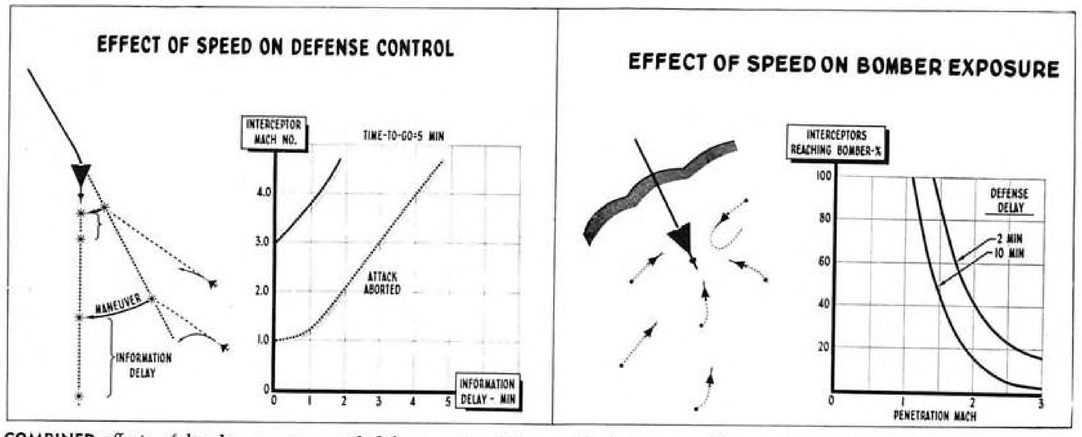
Fafnir Ball Bearings of tool steel "beat the heat" in aircraft turbodrives

Two butterfly valves in General Electric's air-driven turbo alternators control the pressure and flow of the air stream that reaches the turbine wheel. These valves must work with smoothness and precision for proper performance of the constant speed drive. Fafnir ball bearings help assure reliability.

Made of chrome tungsten molybdenum tool steel, these Fafnir ball bearings are designed for trouble-free, precision performance under heavy loads, and temperatures up to 750°F. Their reliability has been proven by the remarkable performance record of the turbodrive units themselves, including nonstop operation round-the-world aboard the B-52.

Fafnir's experience with high temperature bearing requirements, and advanced work with exotic materials for increasingly critical needs, could supply bearing answers *you* need. Write The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR
BALL BEARINGS



COMBINED effects of bomber maneuver and defense system delays on the intercept problem are shown at left. Chart at right shows the percentage of an interceptor force reaching a Mach 3 bomber with defense system delays of two minutes and 10 min.

vantage provided by its high performance through use of various electronic countermeasures and tactics to further reduce the response time of the defense systems it will face.

Measuring the increased prospects for penetration as defense system time delays increase, the Senate report estimates that an increase in delay from two minutes to 10 min. would decrease the number of weapons intercepting a B-70 bomber by 85%, while it would decrease the number of weapons meeting a Mach 1.5 bomber by 47%.

As bomber speed increases, so must interceptor speed increase to deal with the faster bomber. Comparing equal numbers of Mach 1 and Mach 3 interceptors attempting to meet a Mach 3 bomber, an estimated nine times as many Mach 3 interceptors will reach the bomber.

Any class of interceptor will get to nine times as many Mach 1 bombers as Mach 3 bombers.

Any maneuvering by an attacking B-70 will create further problems for interceptors. For example, if a Mach 3 bomber makes a 30 deg. turn toward an attacking Mach 3 interceptor 15 min. before the predicted interception, the bomber will be 225 naut. mi. away from the predicted intercept point when the interception is supposed to take place. Any information delays in getting data on the changed course to the interceptor will decrease its chances of catching the Mach 3 bomber.

Senate report estimates that with five minutes to go before an intercept, a B-70 making a 30 deg. turn toward a Mach 1 interceptor will outrun it even if there is no time delay in the defense control system. It will evade a Mach 2 interceptor if there is a two minute delay. A 30 deg. turn away from a Mach 3 weapon is calculated to preclude attack by the interceptor under any conditions.

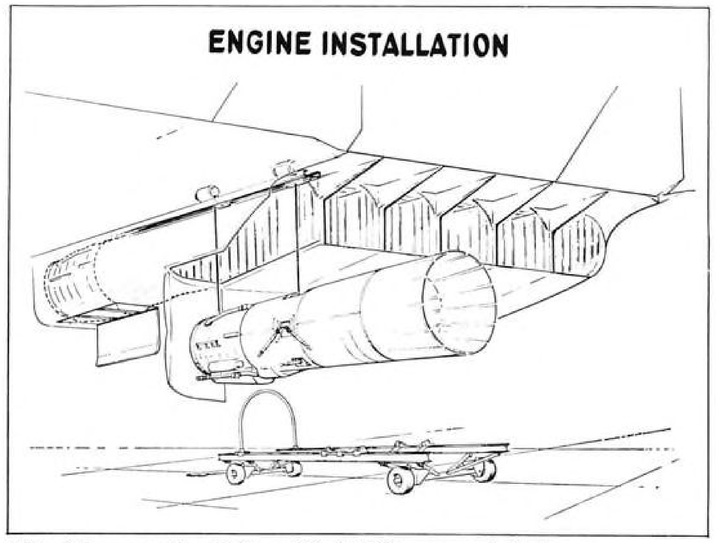
Flexibility in penetration altitude gives the B-70 an advantage and forces an enemy to provide high and low radar coverage.

The Mach 3 bomber will be able to fly below radar coverage in approaching an enemy border, then climb to cruise altitude and fly to its target at Mach 3 once it is detected. A subsonic bomber is more limited in this aspect because it has to stay close to the altitude at which it is detected in order not to increase the time-to-target by losing speed during climb. Thus, the B-70 cuts exposure time as well as flying above the effective altitude of current defense weapons.

The B-70 design range of over 7,000 naut. mi. with one KC-135 refueling gives the bomber flexibility in its attack route once it has reached the enemy area over a great circle route. Since the bomber can choose a variety of penetration routes, an enemy must spread his defense thin or increase his investment to cover all avenues of attack.

Long range of the B-70 will make it adaptable for airborne alert operations. A typical mission might involve taking off from a SAC base in the northern U.S., flying north for a refueling rendezvous, then patrolling in the area for 2½ to 3 hr. After a second refueling, the B-70 would cruise at subsonic speed toward enemy territory until it no longer had enough fuel to reach its target. If the order was given to attack before this point was reached, the bomber would go to its target at Mach 3. If it received no attack order before its fuel was depleted, it would fly back to its base.

Although it was cut back to a prototype flight test program last December,



B-70 will be powered by six General Electric J93 engines and afterburners.

the B-70 project now is eligible for more intensive development with extra funds made available by Congress. These are only the latest turns in the long history of the B-70 program.

This program got under way as the result of a general operational requirement issued in October, 1954, for a chemical-fueled manned bomber to replace the B-52 in the 1965-70 period. It was labeled Weapon System 110A, and the first wing of 30 aircraft was to be ready in 1963. WS 110A was to cruise at Mach 0.9, then make a 1,000 mi. penetration at higher speed. High altitude was an important objective, along with highest possible supersonic speed during penetration.

In June, 1955, the USAF deputy chief of staff for development ordered WS 110A into development as a competitive Phase I program. Earlier that year, a requirement was issued for an intercontinental reconnaissance system with similar objectives. In July, this system became WS 110L, and the two programs were combined as WS 110 A/L.

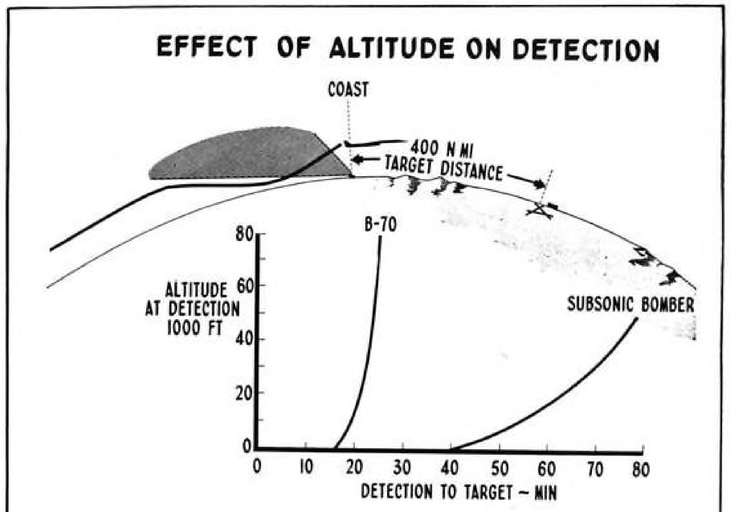
Program Proposals

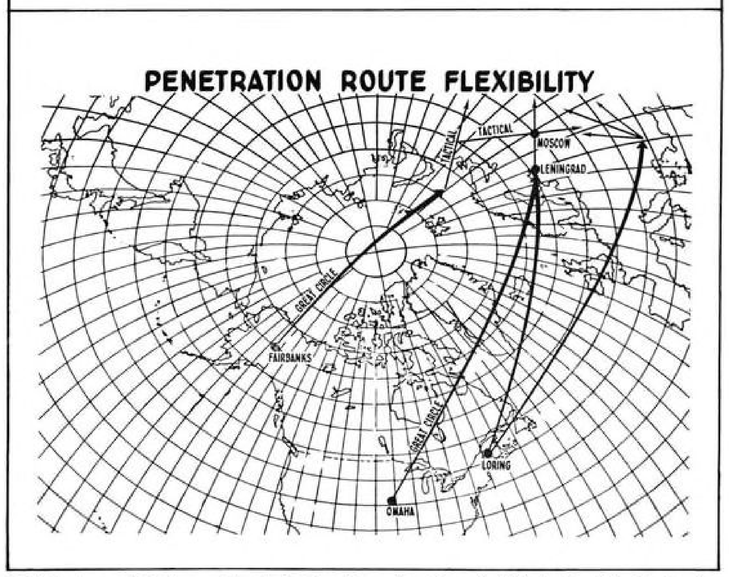
Of six aircraft manufacturers deemed eligible for the WS-110 project, only Boeing Airplane Co. and North American Aviation submitted proposals. Both companies got Phase I contracts in November, with mockup scheduled for November, 1957, first flight for March, 1960, and equipping of the first SAC wing by December, 1963. Meanwhile, ARDC headquarters postponed target date for the first operational wing from 1963 to July, 1964.

Boeing and North American submitted their preliminary design proposals, and the Air Force began analyzing the program at top levels in May, 1956. ARDC earlier had halted work on the WS 110L phase of the program pending an evaluation. This phase was never resumed.

After prolonged study, USAF decided in October to discontinue Phase I development and permit the companies to continue work only on a reduced research and development basis. Senate group points out that this effectively canceled the program and that this action came directly as a result of disappointment with the company's proposals. The designs were considered too cumbersome, and USAF suggested that future effort include investigation of high energy fuels and boundary layer control to extend range.

After taking another look at the problem, Boeing and North American independently reached the conclusion that with high energy fuels burned in the afterburner, WS 110A could become an all-supersonic cruise bomber. This was reported in July, 1957, and





TIME between detection and arrival at target as a function of altitude at which the bomber is detected by ground radar is shown at top. Map below shows penetration routes.

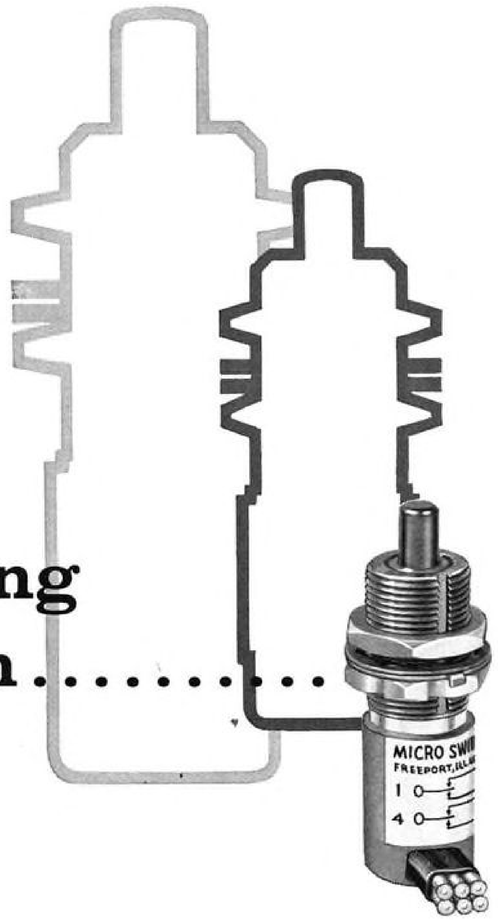
the companies went into a second competitive design effort that fall, using new system characteristics. The proposals were reviewed, and the Air Force decided the North American design was superior. The company got a Phase I design contract in December.

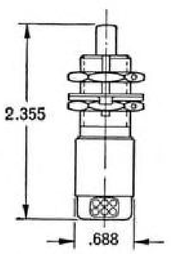
Program Acceleration

ARDC and Air Materiel Command studied ways of accelerating the program and found an 18 month acceleration to the then existing schedule was possible. They recommended buying the entire weapon system, except the engine, through North American. General Electric Co. was to supply the engine. This approach for accelerating the project was approved, and North American got a letter contract as prime contractor in January, 1958.

In April, ARDC and SAC met with North American in a B-70 Weapon System Evaluation Conference in which the aircraft design was changed. Most significant change was increased takeoff weight to more fully exploit the vehicle load and volume capacity and to minimize any future retrofit. In May, International Business Machines Corp., which had been developing a bombing-navigation system under separate con-

We've been reducing again.....





402EN SEALED SWITCH

Operating Force	6-12 Lbs.
Pretravel	.040 In. Max.
Differential Travel	.020 In. Max.
Overtravel	.250 In. Min.

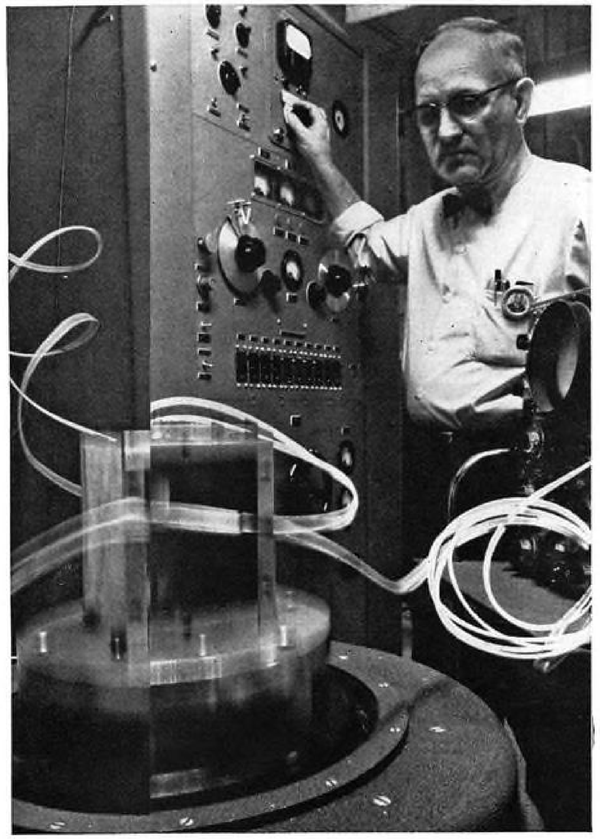
Electrical rating at 28 vdc: resistive, 7 amperes; inductive, 4 amperes.

New 402EN—smallest two-circuit sealed environment-free switch available—The new reduced diameter of the MICRO SWITCH 402EN makes it possible to "tighten up a notch" on component designs, save both space and weight. This plunger-actuated sealed environment-free switch contains two sub-subminiature basic switches, for two single-pole double-throw circuits—yet measures only .688" in diameter.

It is fully enclosed and sealed against changes in atmospheric conditions. An "O" ring seal on the actuator shaft, plus glass-to-metal terminal seals and potted leadwire termination seals keep dust, water and air from entering switching chamber. An ice scraper ring on the actuator shaft removes ice or mud that might cause jamming or binding. The new 402EN meets immersion test requirements of MIL E-5272A Procedure 1.

For more information on this new unit, check the Yellow Pages for the nearest MICRO SWITCH branch office or write for Data Sheet No. 171.

H HONEYWELL **MICRO SWITCH Precision Switches**



Before choosing a sealed switch . . . ask this vital question:

Does the testing and quality control behind that switch really guarantee the precision and reliability needed? MICRO SWITCH has the largest test laboratory of its kind where tests simulate actual operating conditions exactly —heat, shock, altitude and other conditions that affect switch performance.

In production, MICRO SWITCH tests vital materials literally by the inch to be sure they will perform as required. Throughout the manufacturing process the most precise quality control in the switch industry is used to safeguard the precision and reliability of these switches.

MICRO SWITCH manufactures a complete line of sealed switches for aircraft and missile applications. This specialized engineering experience is also available for recommending special switch designs for particular components. Ask the nearby MICRO SWITCH branch office or write for the new Catalog 77 which describes sealed environment-free switches for airborne applications. Check your switch requirements with MICRO SWITCH to be absolutely sure of precision and reliability.

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tract for WS 110A, became a subcontractor to North American.

The B-70 Weapon System Development Engineering Inspection was conducted in March, 1959, and during this review, the 159 USAF participants requested 761 changes. A review of these alteration requests indicated that only 381 would be properly accomplished under the then current contract, and 95% of them had been made by Dec. 3, 1958. Mockup review was conducted in April, and 95% of the 35 changes this inspection produced also had been completed by December.

Engine Changes

Air Force canceled the GE J93-5 engine which was to burn high energy fuels in its afterburner, leaving the B-70 dependent on the J93-3 which burns JP-6. Senate report said that wind tunnel test of design improvements had indicated the B-70 range had reached a point where high energy fuel was no longer required to meet minimum range requirements—it added about 10% range, while a single KC-135 refueling could add twice that range.

USAF canceled the F-108 Mach 3 interceptor program in September. North American was developing this airplane, and much of the research and development effort was shared by the bomber and interceptor programs. This cancellation is estimated to have added $180 million to the cost of the B-70.

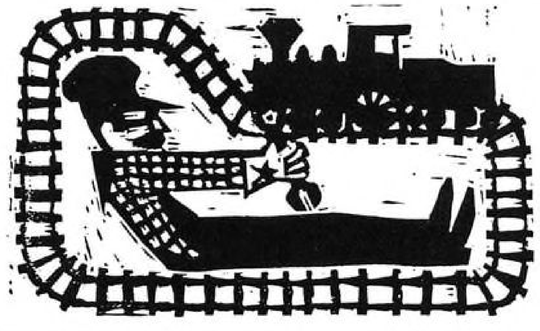
On Dec. 3, 1959, USAF canceled the B-70 weapon system program and reoriented all effort toward development of a single flight test prototype aircraft. Fiscal 1960 funds were cut from $345.6 million to $150 million, and $75 million was allotted for Fiscal 1961, although Congress now has made an extra $290 million available. First flight was rescheduled from January, 1962, to December of that year.

Discussing the advantage of using a two prototype approach under the present program orientation, the Senate report pointed out that using two flight test aircraft would shorten the test program and the ground rework involved and would furnish an element of insurance in case of an accident. Second vehicle could fly by April, 1963, and would cut an estimated 16 months off the flight test program. Report said this second prototype would cost $62 million to build, but that $23 million saved in a joint test program would make its net cost $39 million.

Senate group said that if the full B-70 funding appropriated for Fiscal 1961 were released immediately, first flight would be made in December, 1962.

With adequate future financial support, the first SAC wing could be equipped by the fall of 1966.

PROBLEMATICAL RECREATIONS 26



An engineer constructing a model train layout (for his son, of course) wished to fence off two equal adjacent squares of a certain area. His available frontage was 2 inches short. However, by using 2 more inches of fencing, he was able to fence in the desired area in two squares. What were the sides of the squares?

—School Science and Mathematics

ANSWER TO LAST WEEK'S PROBLEM : L's scarves are much too heavy, Z's are not warm enough, so it's M.L.Z.

Aerospace Officers List Salaries, Stocks

Washington—Following is a list of aerospace industry officers' and directors' salaries and stock holdings for 1959 as reported to the Securities and Exchange Commission:

Cessna Aircraft Co.—**D. L. Wallace**, president and director, $85,500 salary, 54,759 shares of common stock and 22,936 shares of common stock beneficially owned by Wallace's family; **F. A. Boettgerm**, vice president, treasurer and director, $60,840 salary and 8,875 shares of common stock; **D. R. Roskam**, vice president-Aircraft Division and director, $59,280 salary and 9,039 shares of common stock; **T. B. Salter**, vice president-engineering and director, $43,680 salary and 5,685 shares of common stock; **W. F. Cassedy, Jr.**, president-Aircraft Radio Corp. (a subsidiary) and director, $31,200 salary and 4,368 shares of common stock; **S. Coleman**, director, no salary and 1,040 shares of common stock; **R. Russell**, director, no salary and 1,128 shares of common stock.

Bell Aircraft Corp.—**L. Faneuf**, chairman of the board, president and director, $94,473 salary, 700 shares of common stock and 1,579 shares of common stock contingently allotted; **H. Gaylord**, senior vice president, president-Bell Helicopter Corp. (a subsidiary) and director, $69,815 salary, 300 shares of common stock and 973 shares of common stock contingently allotted; **R. P. Whitman**, first vice president and director, $60,235 salary, 5,975 shares of common stock.

Following directors were not paid a salary: **J. E. Bierworth**, director, no stock; **K. G. Donald**, director and director of Equity General Corp., no stock; **R. S. Elliott, Jr.**, director and director of Equity General Corp., no stock; **F. Field**, director and director of Equity General Corp., no stock; **P. B. Garrett**, director and director of Equity General Corp., **P. Husty**, director, 100 shares of common stock; **D. M. Milton**, director and president and director of Equity General Corp., no stock; **G. Olmsted**, director and director of Equity General Corp., no stock.

G. D. O'Neill, director and director of Equity General Corp., no stock; **J. F. Schoellkopf**, director, 400 shares of common stock; **W. A. Yates**, director, 3,382 shares of common stock. **Equity General Corp.** a wholly owned subsidiary of The Equity Corp., beneficially owns 1,349,006 shares of Bell Aircraft Co. common stock.

Douglas Aircraft Co., Inc.—**F. W. Conant**, vice chairman of the board, senior vice president and director, $100,800 salary and 1,122 shares of common stock; **G. E. Donovan**, vice president and director, $42,050 salary and 400 shares of common stock; **D. W. Douglas**, chairman of the board and director, $151,000 salary and 10,150 shares of common stock; **D. W. Douglas, Jr.**, president and director, $100,800 salary and 1,082 shares of common stock; **J. A. Dundas**, executive vice president and director, $55,166 salary and $24 shares of common stock; **I. C. Eaker**, vice president and director, $41,000 salary and no stock; **A. E. Raymond**, senior vice president and director, $76,705 salary, 9,000 shares of common.

Following directors were not paid a salary: **M. W. Bekins**, 618 shares of common stock; **L. Florez**, 412 shares of common stock; **C. S. Jones**, no stock; **C. J. Lick**, 618 shares of common stock; **G. Mayo**, no stock; **E. H. McLaughlin**, 1,000 shares of common stock; **N. Paschall**, 1,158 shares of common stock; **N. Petree**, 154 shares of common stock; **D. Whiting**, 1,000 shares of common stock and $10,000 in 4½% convertable subordinated debentures.

The Garrett Corp.—**J. C. Garrett**, chairman of the board, president and director, $61,450 salary and 27,673 shares of common stock; **W. R. Ramsaur**, vice president and director, $60,339 salary and 5,811 shares of common stock; **K. B. Wolfe**, executive vice president and director, $59,659 salary and 105 shares of common stock; **E. A. Bellande**, vice president, vice chairman of the board and director, $45,177 salary and 296 shares of common stock; **H. H. Wetzel, Jr.**, vice president and director, $39,115 salary and 14,765 shares of common stock.

Following directors were not paid a salary: **E. Barlow**, 15,050 shares of common stock; **Lamm. T. Cohu**, 100 shares of common stock; **H. W. Elliott**, no stock; **C. T. Leigh**, 153 shares of common stock; **W. R. Lovelace II**, no stock; **V. H. Rossetti**, 153 shares of common stock.

Grumman Aircraft Engineering Corp.—**L. R. Grumman**, chairman of the board and director, $55,200 salary and 133,160 shares of common stock; **L. A. Swirbil**, president and director, $105,250 salary and 10,500 shares of common stock; **W. T. Schwendler**, senior vice president and director, $55,200 salary and 48,600 shares of common stock; **E. C. Towl**, administrative vice president and director, $52,750 salary and 8,000 shares of common stock; **E. W. Poor**, treasurer and director, salary not listed and 34,090 shares of common stock; **A. P. Loening**, director, no salary and 35,000 shares of common stock; **C. A. Wright**, director, no salary and 1,000 shares of common stock.

The Kaman Aircraft Corp.—**C. H. Kaman**, president and director, $48,667 salary, 6,917 shares of Class A common stock and 30,425 shares of Class B common stock; **E. J. Odlum**, senior vice president and director, $35,917 salary, 2,373 Class A common stock and 341 shares of Class B common stock; **B. F. Clark**, senior vice president, salary not listed, 500 shares of Class A common stock and no Class B common stock; **K. W. Erickson**, vice president and director, salary not listed and no Class A or B common stock; **J. S. Murtha**, secretary and director, salary not listed, 893 shares of Class A common stock and 30 shares of Class B common stock.

Following directors were not paid a salary: **W. A. Coolidge**, 15,448 shares of Class A common stock and 11,768 shares of Class B common stock; **G. P. Gardner, Jr.**, 600 shares of Class A common stock and 733 shares of Class B common stock; **M. N. Glover**, 105 shares of Class A common stock and six shares of Clas B common tock; **E. S. Grant**, 556 shares of Class A common stock and no Class B common stock; **E. B. Hotchkiss**, 410 shares of Class A common stock and 277 shares of Class B common stock; **G. H. Morrissey**, 5,019 shares of Class A common stock and 120 shares of Class B common stock.

Lear, Inc.—**W. P. Lear, Sr.**, chairman of the board and director, $100,569.76 salary and 451,060 5/30 shares of common stock; **A. G. Handschumacker**, president and director, $22,584.64 salary and 237 shares of common stock; **R. M. Mock**, chairman of the executive committee and director, $53,849.15 salary and 11,310 shares of common stock; **P. E. Golde**, vice president, secretary and director, $34,005.26, stock not listed; **A. F. Haiduck**, vice precident and director, $37,694.42 salary, stock not listed; **J. L. Anast**, vice president 1/1/59 to 4/9/59 and president and director 4/9/59 to 8/1/59, $34,823.77 and no stock; **R. J. Benecchi**, group vice president and director, $36,332.19 salary, stock not listed.

Following directors were not paid a salary: **E. A. Adams, Jr.**, 100 shares of common stock; **K. MacGrath**, 1,206 20/30 shares of common stock; **R. W. Millar**, 200 shares of common stock; **C. J. Reese**, 1,000 shares of common stock; **R. A. Stevenson**, 1,200 shares of common stock.

Helio Aircraft Corp.—No officers received more than $30,000 aggregate remuneration during the year 1959. Total officer's salaries and commission for the year 1959 totaled $33,433. Following is a list of stock holdings: **L. L. Bollinger**, president, treasurer and director, 24,313 shares of common stock and 182 shares of preferred stock; **E. B. Berlinrut**, secretary and director, 4,050 shares of common stock; **G. M. Bond**, director, 1,150 shares of common stock; **C. E. Ford**, director, no stock; **R. B. Kimmach**, vice president-sales and director, 1,000 shares of common stock; **O. C. Koppen**, vice president and director, 15,516 shares of common stock and 80 shares of preferred stock; **C. A. Rheinstrom**, director, 5,400 shares of common stock; **L. N. Smithline**, technical director and director, 300 shares of common stock.

Chance Vought Aircraft, Inc.—**C. J. McCarthy**, chairman of the board and director, $66,900 salary and 1,000 shares of common stock; **F. O. Detweiler**, president and director, $96,500 salary and 1,500 shares of common stock; **R. C. Blaylock**, vice president and director, $61,400 salary and 750 shares of common stock; **H. B. Sallada** (retired 1/31/60), $53,800 salary and no stock listed; **C. E. Burt**, vice president and director, $56,450 salary and 600 shares of common stock; **G. K. Johnson**, vice president and director, $58,950 salary and 250 shares of common stock; **W. P. Thayer**, vice president and director, $48,700 salary and 100 shares of common stock.

Following directors were not paid a salary: **D. A. Hulcey**, 200 shares of common stock; **L. F. McCollum**, 400 shares of common stock; **J. E. Mitchell, Jr.**, 100 shares of common stock; **W. M. Overton**, 500 shares of common stock; **D. L. Simmons**, 100 shares of common stock; **R. L. Taylor**, 100 shares of common stock; **J. R. Wood**, 200 shares of common stock and $3,000 in 5¼% convertible subordinated debentures.

General Dynamics Corp.—**F. Pace, Jr.**, chairman of the board and director, General Dynamics, and chairman of the board and director, Canadair, Ltd., $152,500 salary, 30,000 shares of General Dynamics common stock and 1,625 shares of Canadair common stock under that firm's stock purchase plan; **E. D. Johnson** president and director, General Dynamics, and vice chairman of the board and director, Canadair, $132,250 salary, 3,500 shares of General Dynamics common stock and 1,625 shares of Canadair common stock under that firm's stock purchase plan; **J. T. McNarney**, consultant to the corporation and director, $32,816 salary and 10,513 shares of common stock; **J. G. Notman**, senior vice president of General Dynamics and president of Canadair, $108,000 salary (paid by Canadair), stock not listed.

Following directors were not paid a salary: **E. C. Alvord**, 5,495 shares of common stock and 14,568 shares of common as substantial owner in another corporation; **W. McC. Blair**, 5,950 shares of common stock; **S. C. Coleman**, 300 shares of common stock; **W. P. Dixon**, 500 shares of common stock; **B. E. Finucane**, 1,500 shares of common stock and 1,500 shares of common stock as substantial owner in a family corporation; **I. M. Laddon**, 407 shares of common stock.

O. Marx, honorary chairman of the board, three shares of common stock and 3,150 shares of common stock as substantial owner in a family corporation; **D. N. McDonald**, 171 shares of common stock; **C. M. Miller**, also a director of Canadair, 14,000 shares of common stock and 1,625 shares of Canadair common stock under that firm's stock purchase plan; **R. C. Patterson, Jr.**, no stock; **D. Richardson**, 100 shares of common stock; **R. F. Windfohr**, 6,000 shares.

H. Crown, director, no common stock,

192,951 shares of preferred stock. In association with certain members of his family, Crown holds 54.9% of General Dynamics preferred stock. These associates are: **Glady K. Crown,** 74,101 preferred shares; **Lester Crown,** 207,162 preferred shares; **E. A. Crown,** 373,559 preferred shares; **Irving Crown,** 269,134 preferred shares; **Arie & Ida Crown Memorial,** 17,081 preferred shares for an associate total of 941,037 preferred shares. Coupled with H. Crown, the total preferred share ownership is 1,133,988.

Thompson Ramo Wooldridge, Inc.—J. D. Wright, chairman of the board, chief executive officer and director, $155,500 salary and 13,838 shares of common stock; **F. C. Crawford,** vice chairman of the board, vice president and director (retired 12/28/59, but remained as a director), $150,625 salary and 36,749 shares of common stock; **D. E. Wooldridge,** president and director, $87,602 salary, 44,080 shares of common stock and 300 shares of common stock held jointly with Mrs. Wooldridge; **S. Ramo,** executive vice president and director, $88,750 salary, 48,477 shares of common stock and 1,090 shares of common stock held with Mrs. Ramo; **H. A. Shepard,** vice president and director, $88,750 salary and 4,400 shares of common stock.

B. W. Chidlaw, vice president and director, $75,625 salary and 600 shares of common stock; **A. T. Colwell,** vice president and director, $82,000 salary and 13,000 shares of common stock; **J. H. Coolidge,** vice president and director, $81,750 salary and 14,000 shares of common stock; **H. L. George,** vice president and director, $79,731 salary and 34,000 shares of common stock; **R. P. Johnson,** vice president and director, $63,404 salary, 13,250 shares of common stock, 50 shares of common stock held jointly with Mrs. Johnson and $400 in 4⅞% convertible subordinated debentures.

North American Aviation, Inc.—J. L. Atwood, president and director, $141,000 salary and 5,100 shares of common stock; **G. B. Brophy,** senior vice president and director, $78,833 salary and 1,734 shares of common stock; **C. J. Gallant,** executive vice president and director, $87,667 salary and 3,100 shares of common stock; **J. H. Kindelberger,** chairman of the board and director, $168,000 salary and 10,917 shares of common stock; **R. A. Lambeth,** senior vice president and director, $78,833 salary and 1,200 shares of common stock; **J. S. Smithson,** senior vice president and director, $78,833 salary and 816 shares of common stock.

Following directors were not paid a salary: **A. V. Call,** 1,000 shares of common stock; **H. B. du Pont,** 3,466 shares of common stock; **H. G. Fales,** 2,500 shares of common stock; **R. A. Lovett,** 1,200 shares of common stock; **W. C. Mullendorf,** 234 shares of common stock; **C. A. Rude,** 350 shares of common stock.

The Marquardt Corp.—R. E. Marquardt, president and director, $66,670.88 salary and 60,634 shares of capital stock; **R. L. Earle,** (resigned February, 1960), executive vice president and director, $51,959.62 salary and no stock; **D. L. Walter,** vice president and director, $44,315.40 salary and 2,381 shares of capital stock; **W. H. Schwebel,** vice president-finance, treasurer and director, $41,343.60 salary and 830 shares of capital stock.

Following directors were not paid a salary: **B. A. Gillies,** no stock; **H. A. Klagsbrunn,** 620 shares of capital stock; **F. Lindvall,** no stock; **W. Littlewood,** no stock; **C. B. Millikan,** 3,410 shares of capital stock; **C. E. Unterbergan,** no stock; **T. F. Walkowitz,** no stock; **H. Woodward,** 3,600 shares of capital stock. Woodward is an associate of L. S. Rockefeller, who is in possession of 184,574 shares of Marquardt capital stock.

Northrop Corp.—W. C. Collins (deceased 5/12/59), president and director, $83,333 salary, no stock listed under his name or estate; **W. C. McDuffie,** chairman of the board and director, $62,500 salary and 1,000 shares of common stock; **T. V. Jones,** senior vice president, president and director, $81,250 salary and 2,250 shares of common stock; **R. R. Miller,** senior vice president and director, $80,042 salary and 2,500 shares or common stock; **J. Allen,** vice president, assistant to the chairman of the board and director, salary not listed, 200 shares of common stock.

Following directors were not paid a salary: **L. L. Austin,** no stock; **E. W. Carter,** no stock; **E. M. Jorgensen,** 500 shares of common stok; **J. O'Melveny,** 342 shares of common stock; **A. E. Ponling,** 300 shares of common stock; **H. P. Robertson,** no stock; **A. C. Rubel,** 100 shares of common stock.

Douglas Moves DC-8 Into Profit Column

Douglas Aircraft Co, write-downs on its DC-8 jet transport program declined sharply in the second quarter and the company is now delivering "profit" airplanes, according to President Donald Douglas, Jr.

Charges against earnings in the second quarter for the cost of production airplanes dropped to $3,104,000 from $10,425,000 the previous quarter, an indication that Douglas was reaching the point of turning out airplanes showing a profit on an inventory basis (AW May 2, p. 177). Development charges were still being written off, and these did not decline as much relatively. Such charges totaled $6,247,000 in the first quarter and $5,261,000 in the second.

Douglas said the company would show a profit in the last two quarters in contrast to a $1,820,000 deficit in the second quarter and one of $6,949,000. Whether the profit would be enough to offset the first half deficit is still problematical, he said.

First half net sales for Douglas totaled $566,508,422 compared with $447,853,496 for the same period last year. First half net loss of $8,796,063 declined from $15,009,920 the year before.

• **Chance Vought** reported consolidated sales of $113,440,412 for the six months period ended June 30, which compares with $132,529,134 for the same period last year. Net income totaled $1,535,396 or $1.29 per share compared with $3,087,786 or $2.60 per share for the same period last year. Chance Vought's backlog decreased $45,330,025 to $184 million as of June 30, primarily because of a scheduled drop in Crusader fighter deliveries.

• **Martin Co.** earned $7.6 million or $2.48 a share in the first six months of 1960 on sales of $301.9 million, compared with net earnings of $6.2 million or $2.02 a share on sales of $248.2 million in the first half of the previous year.

• **Republic Aviation Corp.** reported first half sales of $67,659,241 and net income of $839,378 or 59 cents a share compared with sales of $109,812,737 and net of $1,577,807 or $1.07 a share for the period last year. Mundy I. Peale, president, said acceleration of deliveries during this second half will increase sales and earnings for the year.

Temco Plans Orderly Phaseout of Corvus

Dallas, Tex.—Temco Corvus air-to-surface anti-radar missile will undergo an "orderly" termination, making use of available missiles built and building at the time Navy canceled the program (AW July 25, p. 35) to obtain maximum benefits from state-of-the-art advances represented in the design, company officials stated here last week.

Details of the phaseout program have not yet been completely worked out, according to Clyde Skeen, executive vice president-general manager of Ling-Temco Electronics, Inc., who spent several days in Washington discussing the Corvus termination program with Navy officials.

Program is expected to provide data benefiting other missile systems now in development, by making it unnecessary to start from scratch in certain phases of their design, equipment, employment.

It is too early to determine how long the Corvus test series will require, Skeen said, but he said that Temco plans no further layoffs of personnel engaged on the project and that the company actually plans to call back "certain numbers" of the personnel who were laid off or given separation notices.

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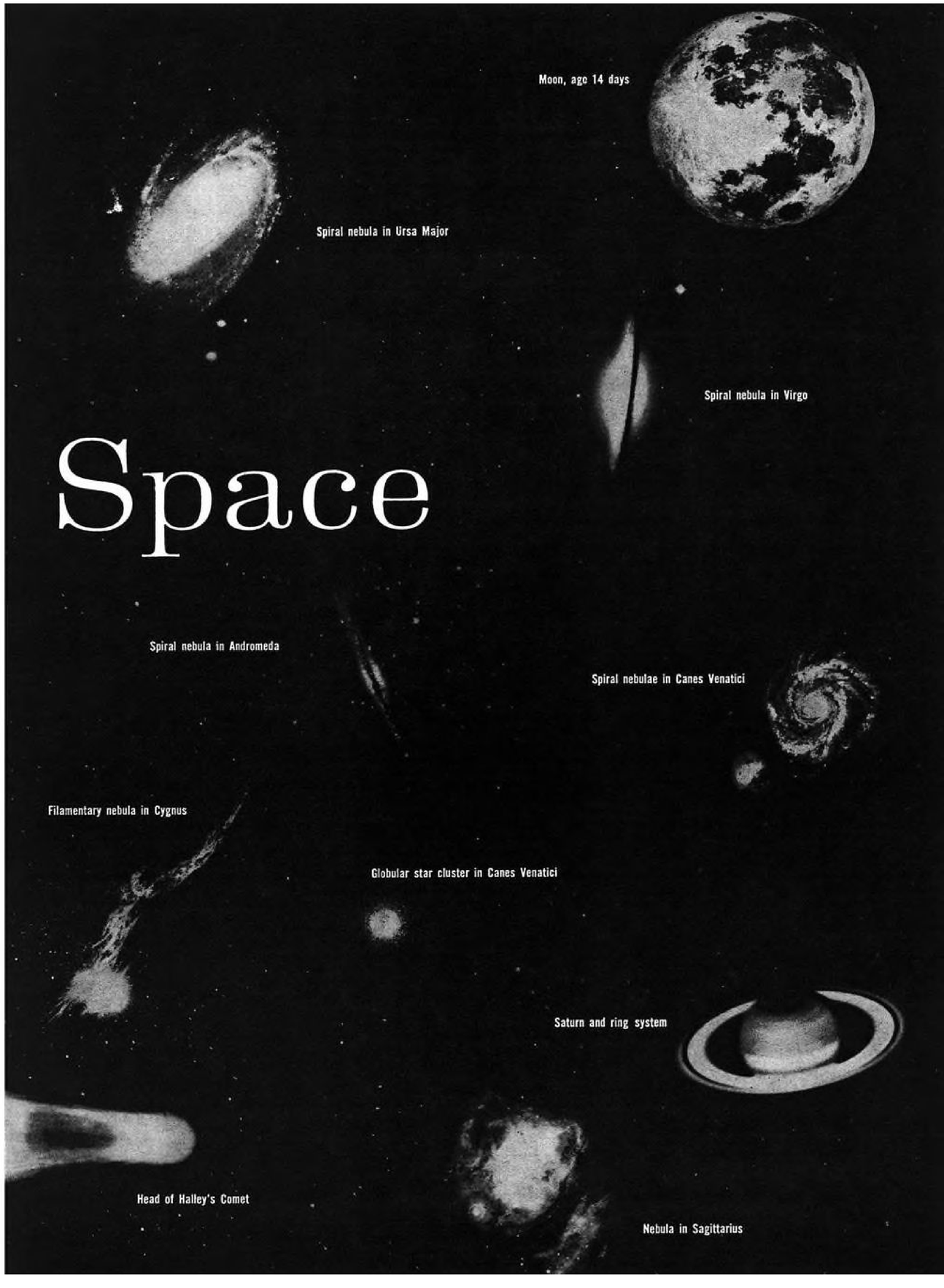
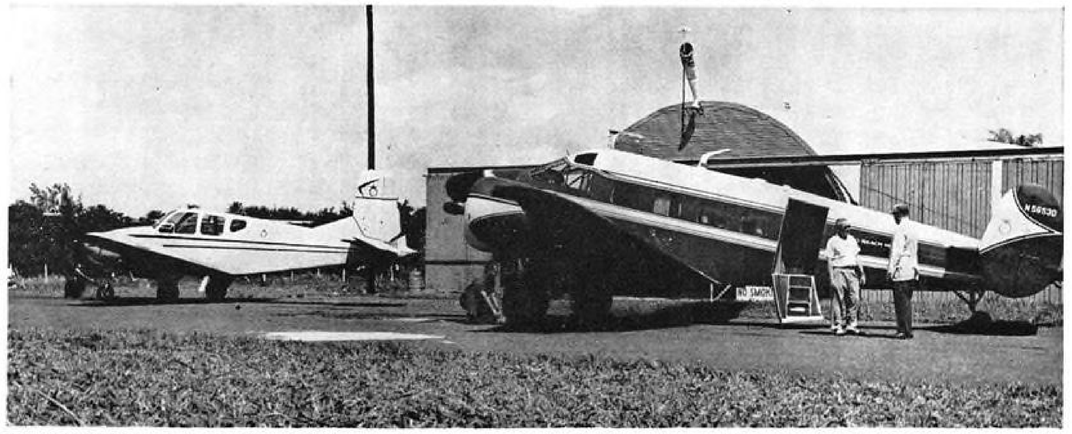




BEECHCRAFT Travel Air (left) and E18s owned by Laurance S. Rockefeller and operated by the Dorado Beach Hotel are parked in front of the hotel's hangar. Planes flew cover when nationalists threatened to bombard hotel golf course with leaflets urging independence for Puerto Rico. Aircraft logged 528 hr. and added $50,000 to hotel's income during last year's December-April season.

Hotel Draws Business With Own Air Fleet

By David H. Hoffman

Dorado, Puerto Rico—A 3,446-ft. paved runway and a fleet of three twin-engine aircraft are proving useful competitive devices for the Dorado Beach Hotel, separated by 20 mi. of tropical forest from San Juan, Puerto Rico's capital city.

The corporate executives who base their business trips at the Dorado Beach have begun to lean upon its unusual air department in scheduling conferences and visiting plant sites across the vast Caribbean basin. Tourists, too, are finding the Beechcraft Travel Air and E18s and the Cessna 310 operated by the hotel a boon in commuting to and from San Juan and in island-hopping to secluded Caribbean vacation spots nearby.

Executives Arrive

Since December, 1958, when Laurance S. Rockefeller formally opened this seaside hotel, at least 15 top U.S. corporations have flown their managements to Dorado for conventions or conferences. Many of the visiting executives deplaned from company Convairs, DC-3s and Gulfstreams by the former Army Air Corps airstrip on the hotel property.

Others, touching down on board commercial jets, were met at San Juan International Airport by a hotel aircraft and ferried to Dorado—10 min. away by air.

Already this year more than 20 big companies—among them Ford, Chrysler, IBM, Pepsi-Cola, Encyclopedia Brittanica and Helene Curtis—have reserved convention space at the 148-room hotel, where less than a mile separates their conference chambers from the runway.

That same runway launched Amelia Earhart on the second leg of her last flight, on which she disappeared in the South Pacific on her way around the world.

From sales, advertising and public relations offices in New York, the Dorado Beach deals directly with 2,000 travel agents in cities across the United States. It also works closely with the charter-booking departments of the airlines that serve Puerto Rico—Eastern, Pan American, Trans-Caribbean, Delta, BOAC, BWIA, Air France, Caribair, Iberia and Dominican Airlines—offering discount rates to visiting company and vacation groups.

Aware that the Caribbean competition for tourist dollars is growing hotter each year as more and more resorts are built, the hotel still depends on its own facilities to keep occupancy rates above 90%, their present average. At the same time, the Dorado Beach relies upon its aviation department to refute the argument that the hotel is inaccessible.

Frequently, hotel planes deposit sightseers or businessmen at the old Isla Grande Airport on the edge of San Juan's business section, less than 10 min. from Dorado by air and less than 10 min. from downtown by taxi.

To underscore flying's popularity here, Dorado Beach planes carried 3,438 paying passengers, logged 528 aircraft hours and added about $50,000 to hotel income during last year's December through April tourist season. In that period, the hotel's fleet, owned directly by Rockefeller, flew more than 21,000 mi. Workload, at times, got so heavy that the Cessna Skylane belonging to the hotel manager was pressed into supplemental service.

G. Bland Hoke, general manager of the Dorado Beach, admits that the air department is not yet earning a profit. But Hoke, a 3,500-hr. pilot himself, also refuses to estimate his air arm's hidden value as an attraction and convenience for hotel guests, who often arrange charters even before arriving in Puerto Rico.

Excluding the hotel's shuttle service to San Juan, the most popular side trip at Dorado is to the free port of St. Thomas, in the Virgin Islands about 90 mi. away. Nearby, on St. John Island, are the Virgin Island National Forest and Cancel Bay Plantation, another resort developed by Rockefeller.

Inbound to St. Thomas five winter mornings a week, the seven-passenger Twin Beech carries Dorado Beach guests, who, for variety, may spend the day at Cancel Bay. Outbound, after a quick turnaround, the same plane flies Cancel Bay guests to Dorado. When the trips are reversed in the evening, a stop is added at San Juan International for customs inspection.

Charter Rates

Charter rates range from $60 (for the Travel Air to St. Thomas and return), to $900 (for the Twin Beech on the 1,130 mi. round trip to Barbados). Routine charters in the Cessna 310, the hotel's "middle-size" plane, are to St. Croix, 101 mi. and $95; Antigua, 294

mi. and $280; Ciudad Trujillo, 310 mi. and $400; and Port-au-Prince, 519 mi. and $450.

When the Dorado Beach air department opened 18 months ago, it had the 250-ft.-wide east-west runway, a corrugated steel Quonset hut and single-engine Cessna 182 to work with. Under Thomas C. Losh—the airport manager who came to Dorado from Atlantic Aviation Corp. in New York—it accumulated a $15,000 spare parts inventory. Today, with a seven-man maintenance staff, the department inspects and repairs its expanded air fleet as necessary.

Losh also installed runway lights, an illuminated wind cone and a Narco VHF Unicom to boost airport efficiency. On occasion, he reports, airline pilots approaching Puerto Rico radio Dorado Beach operations on 122.8 mc. to arrange air taxi service for unexpected guests of the hotel.

The airport, boasting clear approaches at each end of its runway, also offers 100 octane gasoline, Douglas DC-3 loading ramps and a fire-fighting Ansul Jeep. No landing fee is charged.

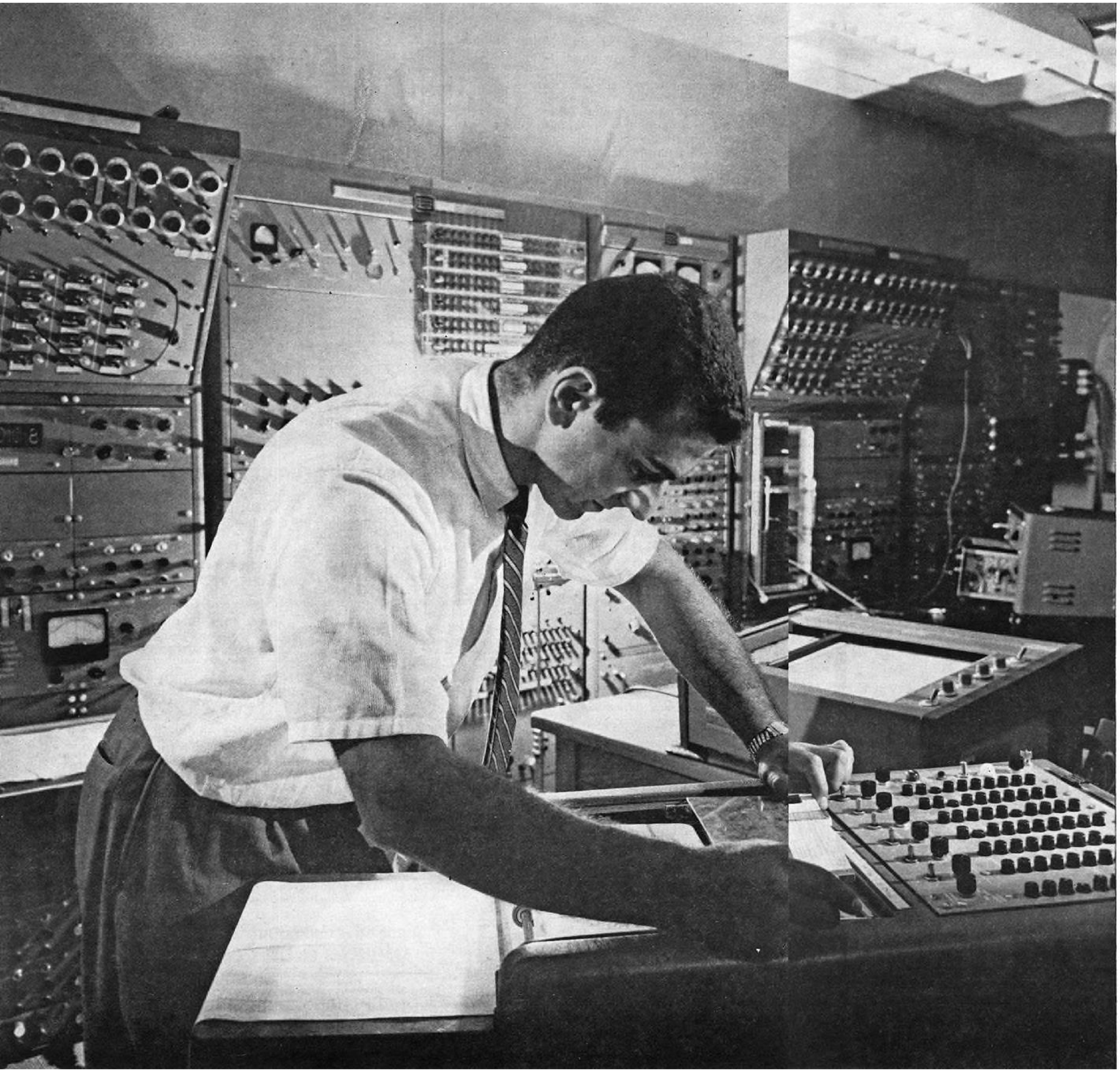
A disguised trump card for the Dorado Beach air operation is the road connecting the hotel's 1,500 acres with the city of San Juan and its airport, about 10 mi. farther to the east. Limousines make the trip in roughly an hour, crossing countryside not quite scenic enough to compensate for deep ruts in the road. During January, a typical month, 159 guests flew in from San Juan on Dorado Beach planes, but 199 elected to depart by air, their apprehension cured by the rough ride in.

Begun in 1930

The present Dorado airport had its beginning in 1930, when Clara Livingston, a pioneer aviatrix, carved a grass landing strip from the surrounding grapefruit plantation she had inherited from her father. She had earned pilot's wings only a few months before—soloing at the old Curtiss-Wright School of Aviation in Valley Stream, Long Island, N. Y.

In 1931, with less than a year's experience, Miss Livingston flew her three-place biplane to Puerto Rico. Accompanied by her instructor, she was intent upon opening a flying school at Dorado. Even at the then prevailing rates, $36 an hour dual, the course attracted a half dozen students before it collapsed.

On June 1, 1937, Amelia Earhart and Fred Noonan, her navigator, landed their Lockheed "Flying Laboratory" at Dorado. In the Livingston plantation home, they spent the first night out on a flight that, had it reached destination, would have been the first piloted by a woman to circle the globe. Instead, the two aviators



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presumably crashed on July 2 near Saipan Island.

Noonan, a former station manager for Pan American World Airways at Port-au-Prince, Haiti, had been a close friend of Miss Livingston.

After serving as a flight instructor during World War II, Miss Livingston returned to Dorado in 1947 to reopen her flying school. The airstrip, which she had loaned to the Army Air Corps in 1941, had been paved and lengthened.

Two years after the flight school closed in 1953, she sold the first 550 acres of her tropical plot to Rockefeller but kept a residence on the property. Granted landing rights for life, Miss Livingston, a colonel and commander of the San Juan Civil Air Patrol unit, flies almost daily to her San Juan headquarters in a single engine Navion.

PRIVATE LINES

Of 70,000 civil aircraft registered with FAA, 8,761 are registered in California. States with the next-highest number of active registrations are Texas, 6,187, Illinois, 3,791, New York, 3,334 and Ohio, 3,109, according to FAA publication, "U. S. Active Civil Aircraft by State and County."

Grumman Aircraft Engineering Corp. flew an Ag-Cat 8,995 mi. to Uruguay via the Andes Mountains to deliver the agricultural biplane to the Litoral Sugar Co. Another Ag-Cat was flown 2,468 mi. to Puerto Rico by Joaquin Baze, Jr., operator of a sugar cane plantation there.

Two Beech Model 65 Queen Airs have been delivered to the Venezuelan air force; planes were purchased by the Ministry of Defense through William C. Morales & Co., Beechcraft distributor at Caracas. Two more Queen Airs will be delivered to the government operated Civil Flying School for use as twin engine trainers.

New terminal building and control tower has been completed at the University of Illinois airport at Urbana, Ill. Construction has started on a new hangar for business aircraft basing. Airport is operated by the University's Institute of Aviation.

Idaho Search & Rescue Unit, a unit of the Idaho State Department of Aeronautics, has issued its 7th edition of the state's air map and its companion publication, the Airport Facilities Director, according to Chet Moulton, Boise, department director. Map includes listing of forestry lookout towers as navigation aid.

WHO'S WHERE

(*Continued from page 23*)

Changes

Howard E. Roberts, manager-research and product planning, Whittaker Controls Division of Telecomputing Corp., Los Angeles, Calif.

William Swan, assistant sales manager, Parker Seal Co., Cleveland, Ohio.

Richard E. Palmer, manager, The Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, Calif.

D. G. Wilson, manager of the Torrance (Calif.) plant, Aero Hydraulics Division of Vickers, Inc., division of Sperry Rand Corp., and **J. R. Rea,** manager of the Joplin (Mo.) plant.

Dr. Van W. Bearinger, director of research, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., and **Dr. John N. Dempsey** and **Edward E. Rexer,** assistant research directors.

E. G. Erickson, director of engineering, Capital Airlines.

William S. Aiken, director of engineering, Thompson-Ramo-Wooldridge Products Co., Beverly Hills, Calif., a division of Thompson Ramo Wooldridge, Inc.

R. V. Fite, director of advance program development, Defense Contracts Organization of Burroughs Corp., Paoli, Pa.

Dr. Willis C. Schaefer, Washington, D. C., representative for Systems Development Corp.

Thomas E. Clemmons, director of advanced studies, International Business Machines Corp., New York, N. Y.

Lyle A. Jakus and **James C. Evans,** senior scientists in the newly formed systems laboratory, Hughes Aircraft Co.'s ground systems group, Fullerton, Calif.

Melvin Cohen, head of the newly established Washington, D. C., technical liaison office of United Technology Corp., a subsidiary of United Aircraft Corp.

Gilbert A. Hegemier has joined the technical staff of National Engineering Science Co., Pasadena, Calif.

Leonard I. Kent, director of engineering, Narda Microwave Corp., Mineola, N. Y. Also: **Donald R. Robertson,** works manager.

Dr. Stanley Grand, head of the Chemistry and Arc Research Department, Vitro Laboratories, West Orange, N. J.

Richards L. Loesch, chief of flight test, Boeing Airplane Co., Seattle, Wash.

C. Harold Hannan, director of research, Miniature Precision Bearings, Inc., Keene, N. H.

Robert T. Jones, director of International Operations for Autonetics, a division of North American Aviation, Inc., Downey, Calif.

Pierre J. Tapernoux, system design manager, Systems Management Department, Electronics Division of Stromberg-Carlson, a division of General Dynamics Corp., Rochester, N. Y.

Thomas C. Pridmore, chief engineer, Bradley Semiconductor Corp., New Haven, Conn.

Dr. Arthur Goldsmith, director of engineering, Wilcox Electric Company, Inc., Kansas City, Mo.

(*Continued from page 138*)

It will be seen that for zero, one, two, three or four failures the TBO would be increased by 200 hr. The total probability of these is 0 + 0 + .01 + .03 + .06 = .10.

For five, six or seven failures the TBO would be increased by 100 hr. (subject to inspection). The total probabilities of these is 0.35. For eight or nine failures, the TBO would be unchanged. The total probability of these is 0.26. For 10 or more failures the TBO would be reduced by 100 hr. The probability of 10 or more failures is 0.28.

Summarizing these:

Change in TBO hr.	Probability of this
+200	.10
+100	.35
None	.26
−100	.28

If we considered a series of 20 three-monthly periods, then we would have:

Increased TBO 200 hr. . . . Twice
Increased TBO 100 hr. . . . Seven Times
Made no change. . . . . Five Times
Decreased TBO 100 hr. . . Six Times

These would be scattered randomly over the five years occupied by 20 three month periods. The TBO would have gone up nine times, stayed put five times, and decreased six times. This is the effect which chance would play for an engine whose real shutdown rate is assumed to have remained constant, if the proposed rule were applied. It shows that the rule, for such an example as that taken, makes TBO jump up and down in an erratic manner even when no change at all has occurred in the average rate. The rate will, in fact, vary from time to time, and the already erratic changes in TBO would become even more so. But the justified changes, if they existed, would be masked by those due to chance.

The objects of FAA in proposing the rule, namely to reduce the probability of incidents and accidents, are appreciated and are shared by the writer, whose full-time job is airworthiness. It is submitted, however, that no evidence has yet been put forward to show that any significant increase in safety would be achieved. This evidence may, nevertheless, be available. If so, it should be made public. It is also submitted that the rule, due to the large part which chance would play in its operation, would impose a severe economic penalty without, as far as can be seen at present, an adequate return for this.

F. P. Stanton
Chief Airworthiness Engineer
Bristol Siddeley Engines, Ltd.
Filton, Bristol, England

(Air Transport Assn., speaking for its member trunklines, still opposes the Federal Aviation Agency's mathematical approach to TBO extension. While the overall concept is being debated, the carriers are urging FAA to refine its definition of in-flight power loss, which, the ATA believes, is far too nebulous. As another interim change, ATA proposes that allowable failure rates for turboprop engines be adjusted upward. Meanwhile most ATA airlines have modified their first stand—to keep current TBOs rather than resort to the FAA formula—and are applying for overhaul time extensions when such are warranted by engine failure rates.—Ed.)

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Electronic Instrumentation Engineers

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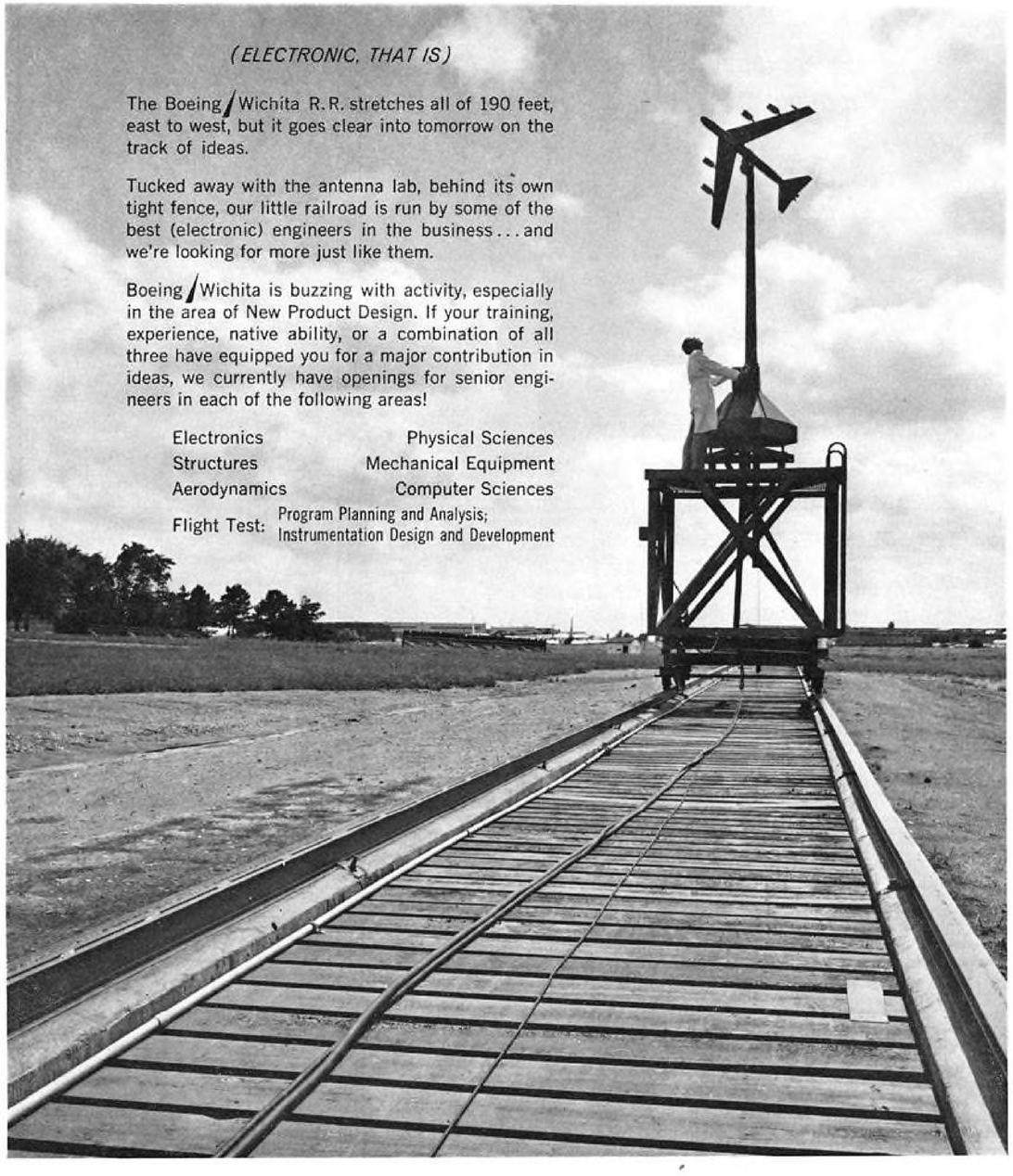

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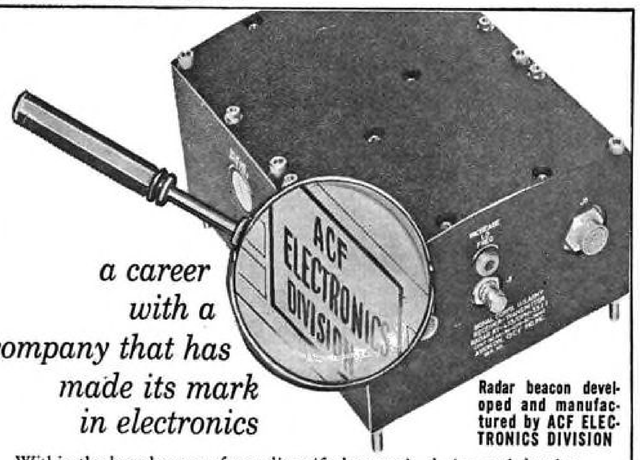

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PUBLISHED BY THE FLIGHT PROPULSION DIVISION OF GENERAL ELECTRIC IN CINCINNATI, OHIO / **AUGUST, 1960**

FPD NEWS offers latest information on openings throughout the Division to interested engineers and scientists. Technical information and news relating to current projects will also appear from time to time in this column.

New Fan Burner Engine Proposed for 2000 MPH Speed Range

Recently the general manager of FPD, J. B. Montgomery, announced that 2000 mph military and commercial transport aircraft can be powered efficiently and reliably by a new type of jet engine which FPD can produce whenever it is needed.

Called a fan burner, its principle involves burning fuel in the exhaust of a fan mounted directly behind the basic jet engine. From an engineering point of view, the manager indicated it would also be possible to apply this principle to an existing engine such as G.E.'s J93, powerplant destined for the B-70.

This development is an interesting example of Flight Propulsion Division's gearing up for the unique requirements of commercial jet powerplants over the next decade. In this area, the Division is "leading from strength"– basing new programs for industry on its impressive and continuing record in combat aircraft propulsion.

Broader Scope Envisioned For New FPD Jet Engines

Artist's conception of the hydrofoil craft under development by Grumman exemplifies FPD's emphasis on continually broadening the scope of engineering and product applications. Craft will be powered by FPD Model 240 turboshaft developing 20,000 shp. Cutaway on illustration indicates approximate position of engine.

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UNITED TECHNOLOGY CORPORATION

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P.O. Box 358 Sunnyvale, Calif.

British TBO Comment

We are interested in the current U.S.A. debate about FAA's proposals on turbine engine overhaul (AW May 2, p. 43 and May 9, p. 38).

Regarding the proposal described in the May 9 article, summarizing this, if the in-flight engine failure rate has, during the last three months, been as listed in the lefthand column of the following table, then the time between overhauls (TBO) is affected as shown below:

In-flight failure rate over the last three months per 10,000 engine hours	Action
Less than 1.0	Increase engine TBO by 200 hr. Increase accessory TBO by 500 hr.
Greater than 1.0 but less than 1.5	Increase engine TBO by 100 hr. Increase accessory TBO by 250 hr.
Greater than 1.5 but less than 2.0	No change
Greater than 2.0	Reduce engine TBO by 100 hr. Reduce accessory TBO by 250 hr.

In-flight failure is defined by FAA as any loss of power or thrust, or inability to control it, while the aircraft is airborne. Failures due to foreign object ingestion can be disregarded. "Accessory" means those essential accessories without which the engine cannot be started, or run.

It is assumed that the rule is proposed in the belief that it will help to prevent aircraft incidents and accidents due to engine failure. Changes in the TBO of an engine will, however, only significantly effect the number of incidents or accidents if a change in TBO results in a significant change of the in-flight failure rate. Very little information, if any, appears to have been published on this subject. In the absence of such information, it is not possible to say what effect upon aviation safety the proposal would have.

It is known, however, that some turbine engine failures are due to causes which do not show any correlation with the life of the failed component or of the engine, either since new, or since overhaul.

Changes in the TBO will not affect the frequency of such failures. This is recognized by FAA in the case of failures due to foreign objects, since such failures can be excluded from the total. It would seem equally reasonable to exclude any other failures which are shown not to be affected by life. In order to assess the improvement in airworthiness if the rule came into force, the facts about the relationship between the TBO and failure rate from past experience should be published and studied.

Limited information available to the writer shows that on a particular large turboprop engine, a change of 100 hr. in the Air Registration Board-approved TBO of 2,000 hr. affects the failure rate by 5%.

It can readily be shown that if the failure rate of an engine is 2.0 per 10,000 engine hours, then for a three hour flight of a four engined aircraft, the probability of having a failure of two or more engines is 2.2 in 1,000,000 flights. (The probability of a single engine failure is not dealt with because all transport aircraft have to be capable of safe flight after failure of a single engine at any stage of the flight.) If the engine failure rate is reduced by 5%, then the probability of a multi-engine failure falls from 2.2 in 1,000,000 to 2.0 in 1,000,000.

Such a change, in a probability which is already very small indeed, would not appear to be a significant one.

The rule is, it is suggested, only warranted in those cases for which the proposed changes in TBO would have a much greater effect upon the failure rate than in the example quoted.

There is another practical aspect of the matter which will bear examination. If an event occurs with a certain probability, that is, on average it occurs Z times every week, month or year—or Z times every 10,000 engine hours, it will not occur exactly Z times in each week, month, year or 10,000 engine hours. The probability that it will occur exactly Z times, and other numbers of times, can be determined from the Poisson distribution, which says that:

If the "expected" number of occurrences of an event is Z, then the probability that the event will occur 0, 1, 2, 3 . . . . (Z + 1), (Z + 2) . . . . times is given by the successive terms of:

$$e^{-Z}\left(1 + Z + \frac{Z^2}{2!} + \frac{Z^3}{3!} - - -\right)$$

This distribution is derived from considerations of mathematical probability. More important to engineers, when it is applied to various practical cases, the Poisson distribution fits observed results very well. This has been found to apply to goals scored by a football team, failures of electric lamps, number of defective bearings in a batch, deaths from horse kicks of U.S. cavalrymen (1920-1930), road accidents, turbine blade failures, and many other events which maintain a given average value, but vary over individual units of time or number.

For an expectation of 8.0, the probabilities of various numbers of occurrences are given below:

Expectation of 8

Actual No. of events	0	1	2	3	4	5	6	7
Probability of this number	.	.	.01	.03	.06	.09	.12	.14
Actual No. of events	8	9	10	11	12	13	14	15
Probability of this number	.14	.12	.10	.07	.05	.03	.02	.01

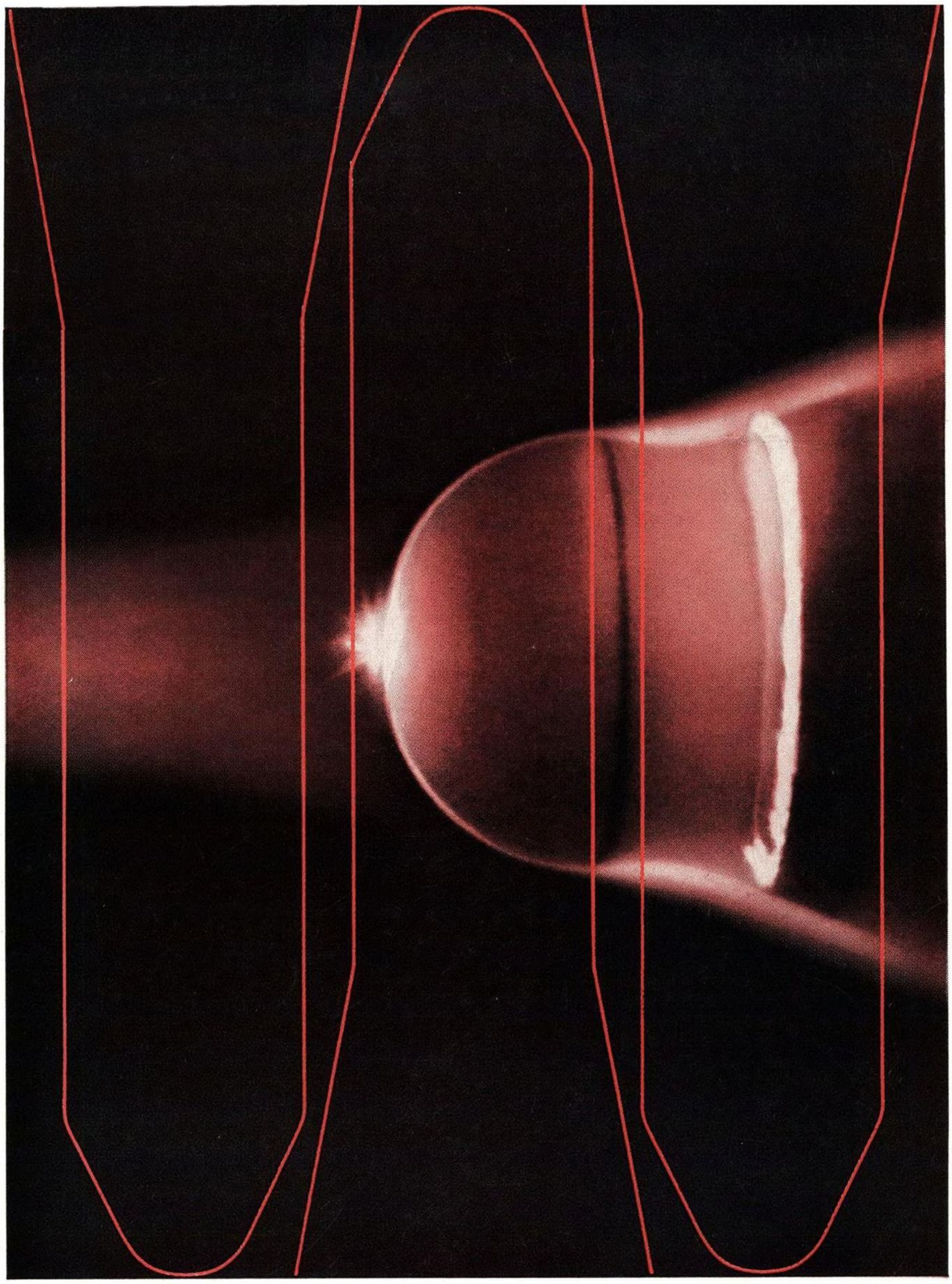
The probability of having exactly eight occurrences is .14, that is, we would only get exactly eight 14 times out of very 100. On three out of 100 occasions, we would get three occurrences only. On two out of 100 we would get 14 occurrences. The probabilities of each number add up, of course, to 1.00, since some number must occur each time.

Let us apply this to a fleet of aircraft. Suppose we have 15 aircraft, each averaging 3,333 hr. per year. This gives 50,000 aircraft hours per year, or 50,000 engine hours per three months. Suppose the average number of shutdowns per three months is eight, equivalent to a rate of 1.6 per 10,000 engine hours. The probabilities of various actual numbers of failures, the corresponding rate, and the action on TBO which would be taken under the proposed rule are tabulated in the box.

Where the rate falls exactly on one of the boundary figures proposed by FAA, the most adverse effect on TBO has been assumed.

Actual Number of Shut-downs	Probability of this number	Rate per 10,000 Engine Hours	Effect on TBO in Hours
0	Less than .01	Zero	Increase 200
1	"	0.2	" 200
2	.01	0.4	" 200
3	.03	0.6	" 200
4	.06	0.8	" 200
5	.09	1.0	" 100
6	.12	1.2	" 100
7	.14	1.4	" 100
8	.14	1.6	No change
9	.12	1.8	"
10	.10	2.0	Decrease 100
11	.07	2.2	" 100
12	.05	2.4	" 100
13	.03	2.5	" 100
14	.01	2.6	" 100
15	.01	3.0	" 100

(Continued on page 130)



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