Aviation Week

Including Space Technology

Cents

A McGraw-Hill Publication

November 30, 1959

Army Attempts Major STOL Design Advance

NASA Orientation Simulator for Space

AEROJET

for gunfire control

INFRARED FOR THE F-104

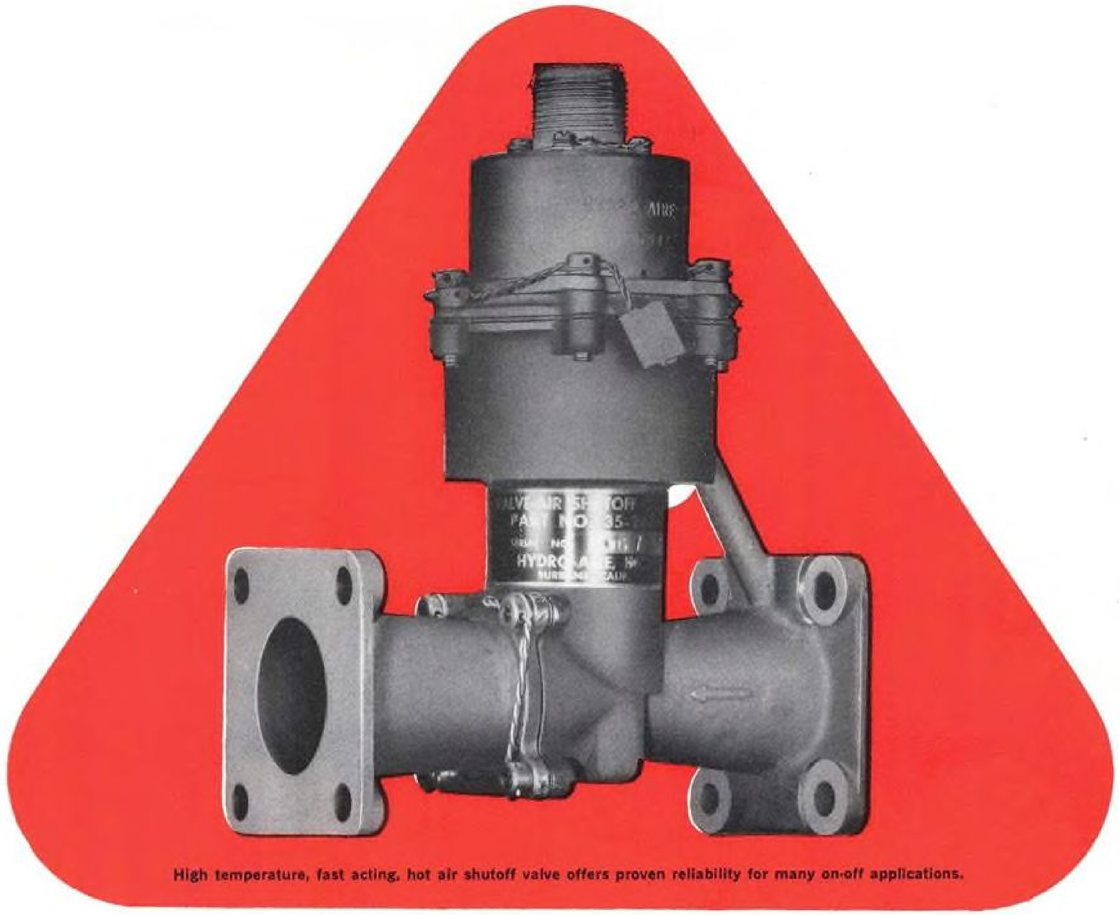


Nighttime capability for the Lockheed F-104 Starfighter is achieved with an Aerojet IR fire control system. A product of our Avionics Division at Azusa, California, it is the only equipment of this type in operation today. Aerojet's Avionics Division constitutes the nation's largest engineering group devoted to research, development, and manufacture of infrared systems.

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Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)



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Hydro-Aire, producers of controls for every basic airborne system, has developed a family of pneumatic-powered, solenoid controlled, gate type hot air shutoff valves. Precision fabricated of stainless steel, with piston rings of S-Monel. The valves are extremely reliable, have minimum leakage, with positive on-off action under one second.

Performance and specifications:

Line size range: ½" to 1¼".
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Investigate these or other designs for help in solving your control problems.

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Developers and producers of reliable control components, sub-systems and systems for aircraft, missiles, electronics, transportation and general industry.

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

AVIATION CALENDAR

Dec. 7-8—Classified symposium on "The Plasma Sheath, Its Effect on Communication and Detection," Boston, Mass. Sponsor: Electronics Research Directorate, Air Force Cambridge Research Center.

Dec. 7-11—National Conference on the Application of Electrical Insulation, Sheraton-Park Hotel, Washington, D. C. Sponsors: American Institute of Electrical Engineers; National Electrical Manufacturers Assn.

Dec. 8-9—First Aerospace Finishing Symposium, Hotel Texas, Fort Worth, Tex. Sponsors: Society of Aircraft Materials and Process Engineers; Dallas-Fort Worth Branch of the American Electroplaters Society.

Dec. 9—East Coast Branch Meeting, Survival and Flight Equipment Assn., Mitchell AFB, Garden City, N. Y.

Dec. 16—Army Aviation Contract Services Symposium, Mayflower Hotel, Washington, D. C. Sponsor: Aeronautical Training Society.

Dec. 17—23rd Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C. Dr. Alexander H. Flax, chief Air Force scientist, will speak on "High Temperatures in Hypersonic Flow—Physical Principles and Experimental Techniques." Dr. Flax will repeat his lecture on Dec. 18 before the IAS Cleveland Section, on Dec. 21 before the IAS Los Angeles Section, and Dec. 22 before the IAS Texas Section.

Dec. 26-30—Sixth King Orange International Model Plane Meet, Miami, Fla.

Jan. 11-13—Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D. C.

Jan. 12-16—16th Annual Technical Conference, Society of Plastics Engineers, Conrad Hilton Hotel, Chicago, Ill.

Jan. 14-20—Sixth Annual Meeting, Ameri-

(Continued on page 6)

AVIATION WEEK Including Space Technology

November 30, 1959

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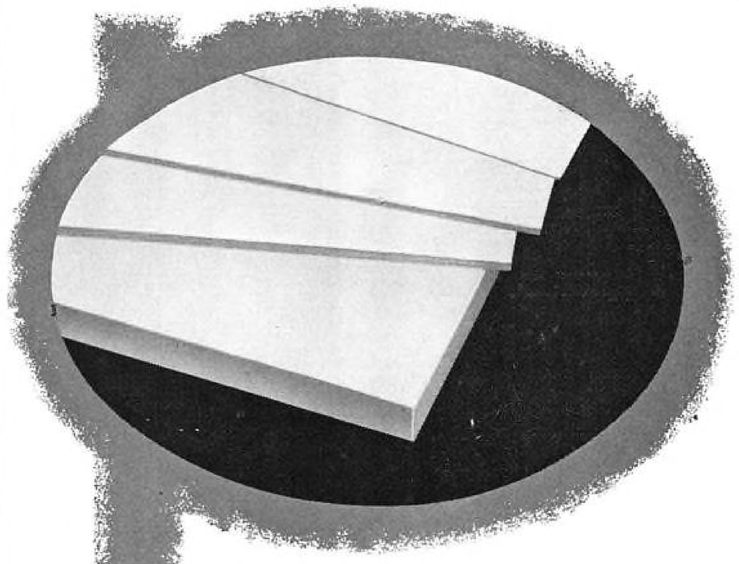
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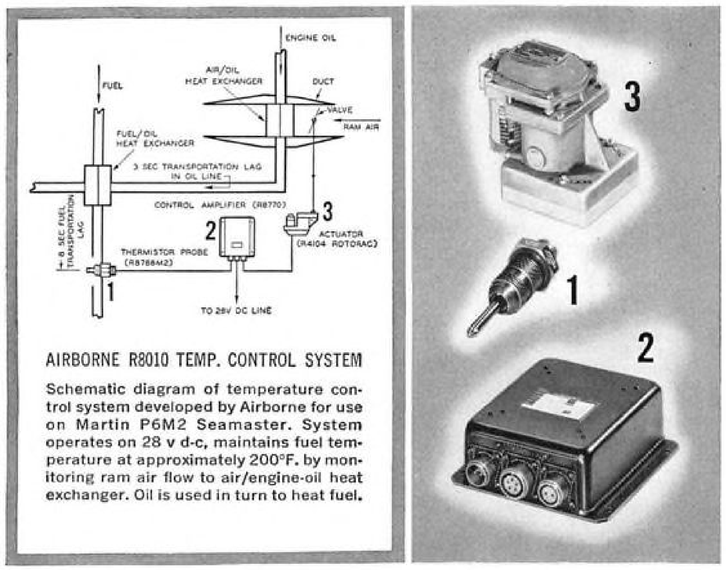
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AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine-oil heat exchanger. Oil is used in turn to heat fuel.

Airborne electromechanical system regulates jet fuel temperature

An integral part of each main engine installation on the Martin P6M2 Seamaster is an Airborne R-8010 custom-engineered temperature control system. By regulating air flow through a heat exchanger, this system maintains supply line fuel at 180-220°F.

As developed for the P6M2, the R-8010 system consists of a thermistor probe, a control amplifier and a rotary actuator. The probe (mounted in an MS10057-12 fitting) is in direct contact with the temperature-regulated fuel and presents to the control box a resistance which is proportional to fuel temperature. In response, the control box energizes the actuator to change the setting of a ram air intake valve, thus regulating volume of air flow through an air/fuel heat exchanger. This sensing and response continues until prescribed fuel temperature is attained, at which point the system reaches a state of electrical balance.

A fail-safe feature is also provided. In the event of power failure, a magnetic clutch in the actuator is released, permitting the air valve to be pushed open by the force of the ram air.

This application* on the P6M2 illustrates only one of many possible adaptations of the Airborne R-8010 system for temperature control functions on aircraft, missiles and related equipment—cabin temperature control, engine temperature control, temperature regulation of fuel, oil, electronic cooling packages, etc. If you have requirements in these areas, we will be happy to make a proposal. Contact any of our offices.

*Described in detail in new Bulletin PS-4A, available on request.

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AVIATION CALENDAR

(*Continued from page 5*)

can Astronautical Society, Statler-Hilton Hotel, New York, N. Y.

Jan. 25-28—28th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 26.

Jan. 28-29—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Feb. 1-4—Winter Conference & Exhibit, Instrument Society of America, Rice Hotel and Sam Houston Coliseum, Houston, Tex.

Feb. 3-4—Sixth Annual Midwest Welding Conference, Illinois Tech Chemistry Bldg., Chicago, Ill. Sponsors: Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society.

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Feb. 16-18—First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Mar. 10-11—National Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

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

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

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

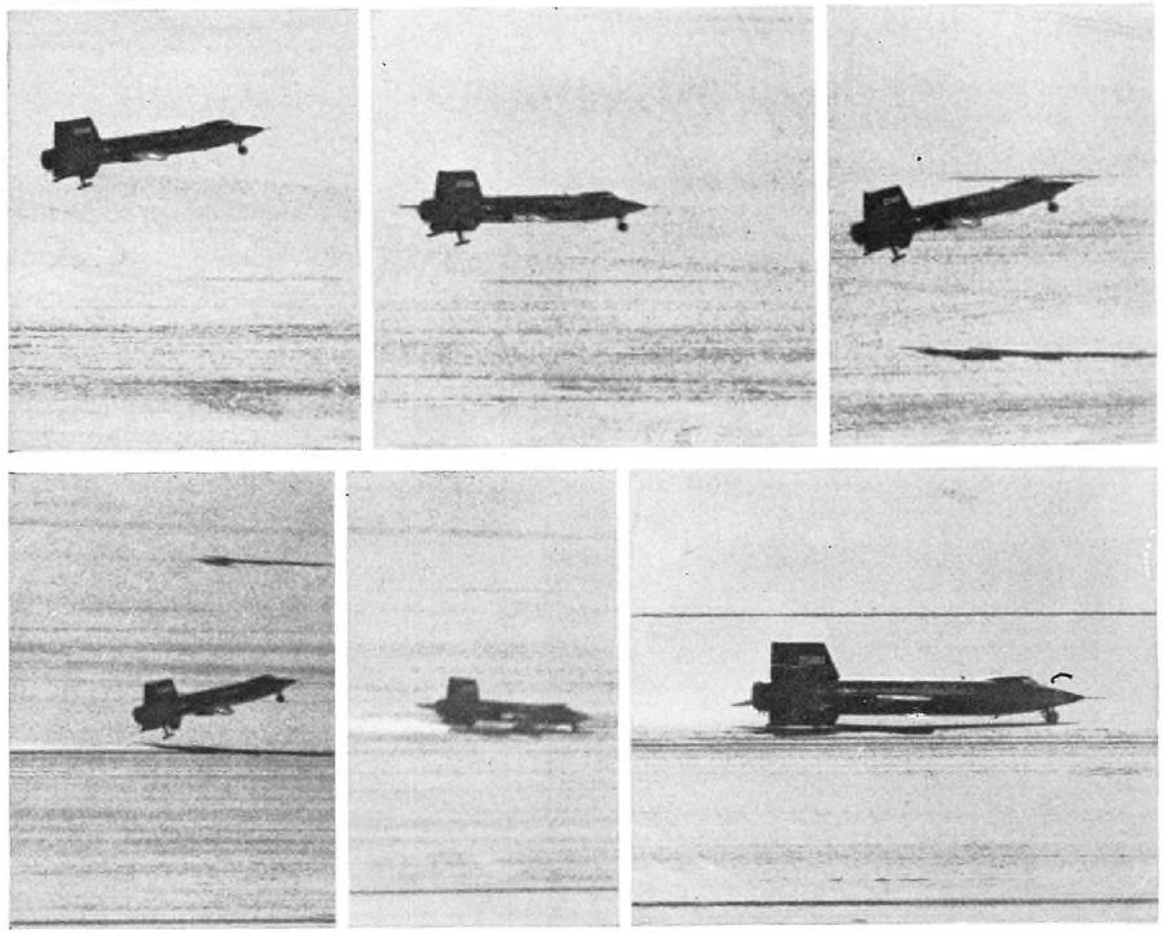
Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: National Aeronautics and Space Administration; the Rand Corp.

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

Apr. 25-29—41st Annual Convention and Exposition, American Welding Society, Biltmore Hotel and Great Western Exhibit Center, Los Angeles, Calif.

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

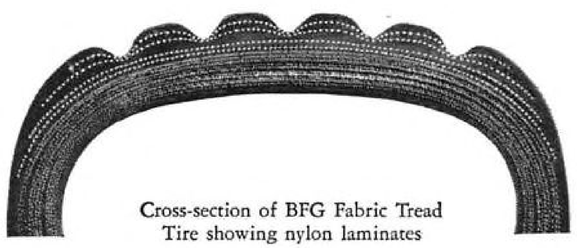
B.F.Goodrich



Fabric Tread Tires invented by B. F. Goodrich help land X-15

When the North American X-15 comes in for a landing, the B.F.Goodrich Fabric Tread Tires on its dual nose wheel touch down at about 200 mph. As X-15 comes to a stop, these special tires must withstand tremendous friction and heat build-up. Yet they can take this rugged pounding because nylon laminates are sandwiched right into the tread stock. These laminates reduce distortion under load, equalize modulus between tread and carcass and check "shock wave" formation.

The same construction now goes into BFG tires for today's newest commercial jets. For further information on these and a variety of B.F.Goodrich products you can use in space, in the air and on the ground, write to *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Co., Dept. AW-119B, Akron, Ohio.*



Cross-section of BFG Fabric Tread Tire showing nylon laminates

B.F.Goodrich
aviation products

FABRICATION TESTS SHOW...

New Titanium alloy takes the lead in rocket case construction

...in strength...in weight...in reliability...in price

Titanium rocket-motor cases can be built at least 30 percent stronger (or lighter) than best available alternate metals; provide permanent corrosion resistance without protective coatings; withstand temperatures from −400°F to +800°F; will not absorb moisture which distorts critical parts in storage.

Completed assemblies give a spectacular two-way pay-off . . . immediately; provide a growth potential virtually unlimited.

The alloy: Ti-13V-11Cr-3Al, the beta titanium alloy. Now available from Titanium Metals Corporation of America at commercial lead-times (billet, 2-3 weeks), beta may well become the metals story of the year.

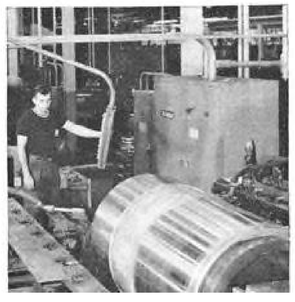


Welding of titanium at P&WA is based on the company's experience in production of more than 5800 jet engines containing titanium parts. Weld strength of beta titanium alloy is considerably improved by cold working the weld.

End Closure Titanium Forgings produced by Wyman-Gordon Company and machined by P & WA, will be *girth welded* to the flow-turned cylinders. Bosses are an integral part of the closures.



Flow-turning from roll-forged rings, makes feasible production of full-scale titanium rocket cases, since it yields integral cylinders, eliminates need for longitudinal welds, conserves input metal.



Pilot rocket-motor cases manufactured by Pratt & Whitney Aircraft from beta titanium alloy Ti-13V-11Cr-3Al have been consistently burst-tested at levels in excess of 235,000 psi — a burst strength/density ratio of 1,340,000.

So successful has been its titanium program that Pratt & Whitney Aircraft considers that production of full-scale titanium cases can be easily realized. Estimated initial burst strengths: a conservative 180,000 psi — a burst strength/density ratio of 1,000,000. Readily attainable: 1,250,000.

Reasons for optimism, spelled out by P&WA's engineers are:

1. **"The welded beta titanium alloy is capable of considerable plastic deformation prior to rupture. As welding has improved, the failure origins have moved into the thin wall (of the case itself). With beta titanium, the case tears, but doesn't fragment.**

2. "We have successfully tested small scale titanium cases with a steel equivalent yield strength well beyond the 300,000 psi point. Considering that the metallurgy of metastable beta titanium alloys is not far beyond its infancy, conservatively one would predict strengths substantially higher than the 320,000 psi equivalent as being quite possible.

3. **"Beta titanium has to develop (only) 140,000 psi to be equivalent to 220,000 psi steel (which is almost near steel's top limits). But titanium's great potential above other alloys is reflected in the high figure for practical (based on 5% elongation) yield strength. At 180,000 beta titanium is equivalent to steel at 280,000 psi; at 200,000 psi, beta titanium is equivalent to steel at 320,000 psi. 200,000 psi in beta titanium is possible, and obviously would mean substantially increased payload to the moon or out into space.**

4. "Apart from the strengths attainable in the beta titanium alloy, there is another property of considerable significance. Like other titanium alloys, it has excellent resistance to corrosion under normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long time storage problems with rocket cases — a pit in a thin-walled casing can be catastrophic — we would regard the beta titanium alloy, as the outstanding material under consideration."

PRATT & WHITNEY AIRCRAFT SURVEY OF ROCKET CASE MATERIALS

GENERAL PROGRAM

The goal: "A material capable of reaching 300,000 psi yield strength in steel, with a considerable development margin."

The result: "While this goal had to be modified for steel cases, we have successfully tested small scale titanium cases with a steel equivalent yield strength well beyond the 300,000 psi point."

Conclusions: 1. "By exercising reasonable care, the development of full scale (steel) cases at 240,000 psi is perfectly feasible.

2. "Small scale (titanium) cases have been burst at stress levels as high as 260,000 psi . . . we are convinced that reliable cases can be manufactured (from titanium) at yield strength levels of 180,000 psi and over . . . at 180,000 beta titanium is equivalent to steel at 280,000 psi.

"At 200,000 psi beta is equivalent to steel at 320,000 psi. 200,000 psi beta is possible and obviously would mean substantially increased payload to the moon or out into space."

SPECIFIC COMPARISON: Corrosion Resistance

Steel: "All of the low-alloy constructional steels which have been discussed are subject to general rusting and, far more serious, to pitting type corrosion during machining, welding, heat treatment, pressure testing and final storage. Corrosion pits can act as severe stress-raisers and, in conjunction with hydrogen, have been demonstrated to cause catastrophic failure. It therefore goes without saying that pitting corrosion is a serious hazard."

Titanium: "Like other titanium alloys, the beta titanium alloy has excellent resistance to corrosion under normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long-time storage problems with rocket cases—a pit in a thin-walled casing can be catastrophic — we would regard the beta titanium alloy as the outstanding material under consideration."

SPECIFIC COMPARISON: Strength

Alloy	Density	Practical Yield Strength (5% elongation)
Ti-6Al-4V	0.161#/in.³	155 ksi = steel at 270 ksi
Ti-13V-11Cr-3Al (Beta)	0.175#/in.³	180 ksi = steel at 280 ksi 190 ksi = steel at 305 ksi 200 ksi = steel at 320 ksi

Burst Test Results show titanium has provided consistent burst strengths of 235,000 psi — a burst strength/density ratio of 1,340,000. Failure occurs in the wall of the case itself — not the weld zones. Titanium cases do not fragment.



• Reliability and growth . . . the parallel

Pratt & Whitney Aircraft data reveal rocket-cases can *now* be built from beta titanium at strengths 17 percent greater than alternate metals, with beta titanium's strengths bounding forward under a minimum of development.

A striking parallel exists in liquid-fueled rocketry where titanium alloy Ti-6Al-4V was selected for helium storage bottles in the Atlas missile because of its strength/density ratio. Airite Products, Inc., a leading supplier of the titanium vessels, reports:

"Minor modifications in processing techniques and continuous tightening of tolerances and other variables have shown an increase from the original 5400 psig average burst pressure to the present average which is in excess of 9000 psig.

"This has been done without increasing the weight of the article by one ounce. Weight of the unit, incidentally is controlled to a tolerance of plus or minus one-half pound, on a weight of 79 pounds, and volume is controlled and guaranteed to plus or minus one percent."

While the performance of the titanium pressure vessels has been almost doubled, the price has been reduced almost 50 percent — and the missile has become operational.

• When a case fails, so does the missile

The price of completed beta titanium rocket-cases is now estimated at 2½ times the price of other metals, with titanium cases virtually in their infancy. Should the titanium cost difference remain, the pay-off would still be two-fold:

1. **Cost:** engineering time, would be greatly curtailed; expensive fuels (for example, 30 pounds of fuel are required in earlier stages for each additional third-stage pound) would be saved.

2. **Reliability:** titanium cases simply will not pit, rust, deliquesce, or become hydrogen embrittled.

Added together, these elements mean feasibility—feasibility supported by the commercial availability of the metal itself. Beta titanium alloy Ti-13V-11Cr-3Al is available from Titanium Metals Corporation of America at these lead times: billet, 2-3 weeks; bar, 3-4 weeks; flat-roll, 5-6 weeks. TMCA's metallurgical experience with the alloy is yours for the asking.

For further information, write for TMCA Data Bulletin *All-Beta Titanium for Solid Rocket Pressure Chambers.* Extensive welding information is included.

TIMET®

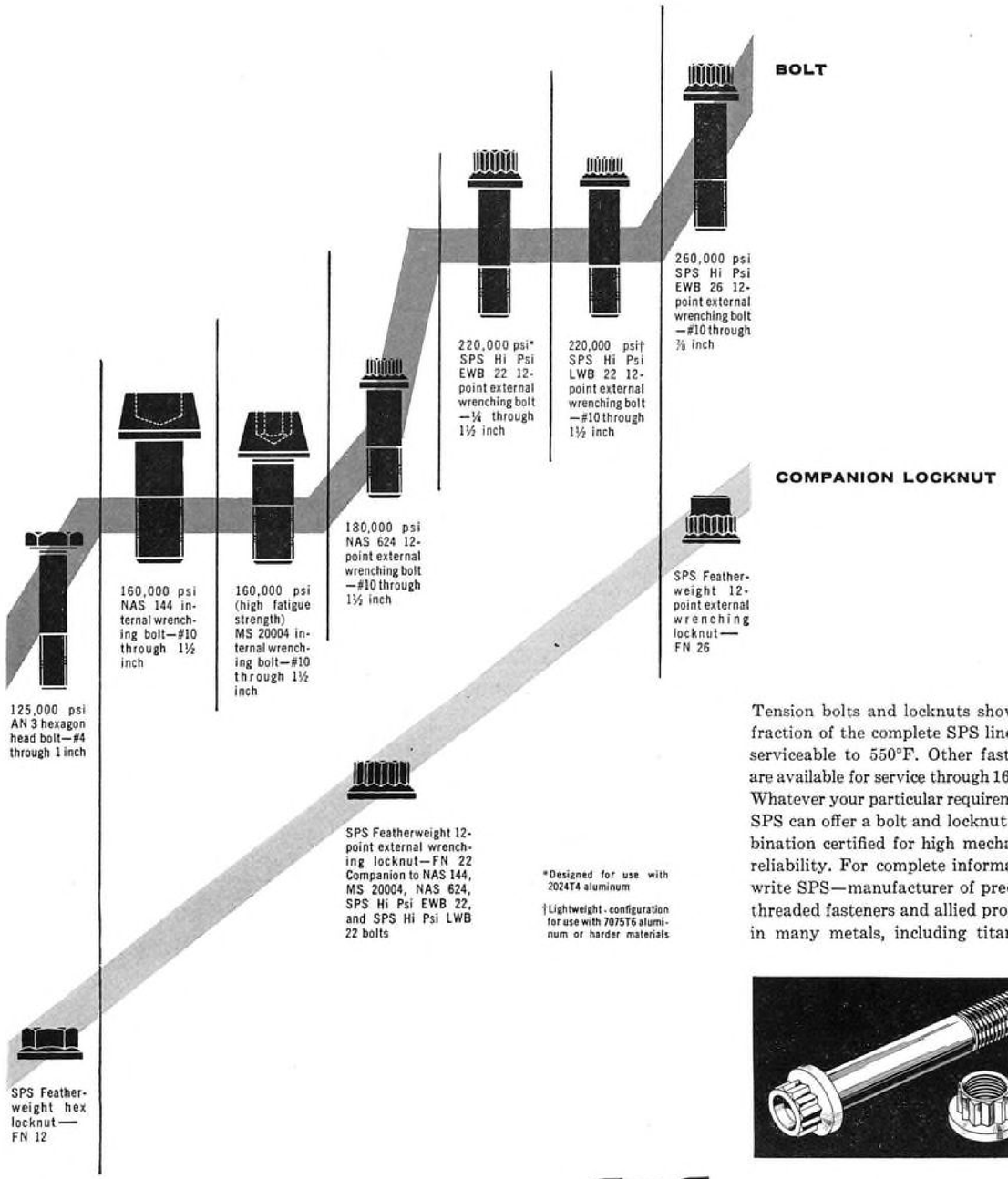
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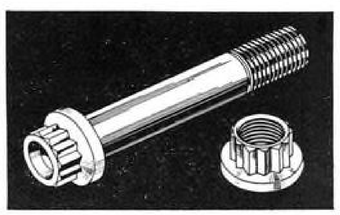
SPS offers a tension bolt and companion locknut for every application up to 260,000 psi



*Designed for use with 2024T4 aluminum

†Lightweight-configuration for use with 7075T6 aluminum or harder materials

Tension bolts and locknuts shown (a fraction of the complete SPS line) are serviceable to 550°F. Other fasteners are available for service through 1600°F. Whatever your particular requirements, SPS can offer a bolt and locknut combination certified for high mechanical reliability. For complete information, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium.



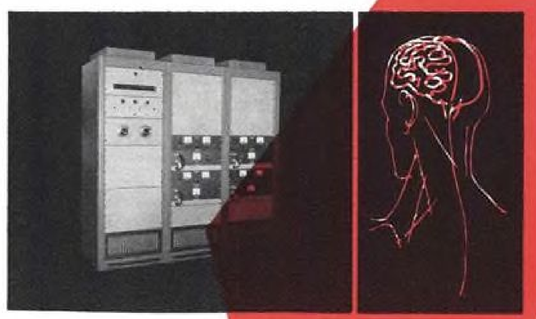
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TO BETTER THE REAL THING





A missile once launched is committed. The system required to accomplish this launching must be maintained at a level of peak effectiveness at all times.

Malfunction in time of need could spell disaster. Predetermination of possible malfunctions and the training of personnel to detect, analyse, and correct rapidly is essential to preventing systems failures.

Under contract to General Electric, ERCO has developed and built equipment to provide familiarization and proficiency training for Air Force crews who operate the Atlas ICBM guidance systems. This equipment has been designed to provide personnel with:

Basic Training in guidance system equipment... Overall familiarity with the system for each of the crew members... Recognition, analysis and correction of the system's malfunctions.

The ability of our modern weapons to fulfill their defensive missions rests largely on the men who operate and maintain these systems.

Training equipment systems, such as the one described, are designed to permit the man to live and re-live an experience hundreds of times before it happens.

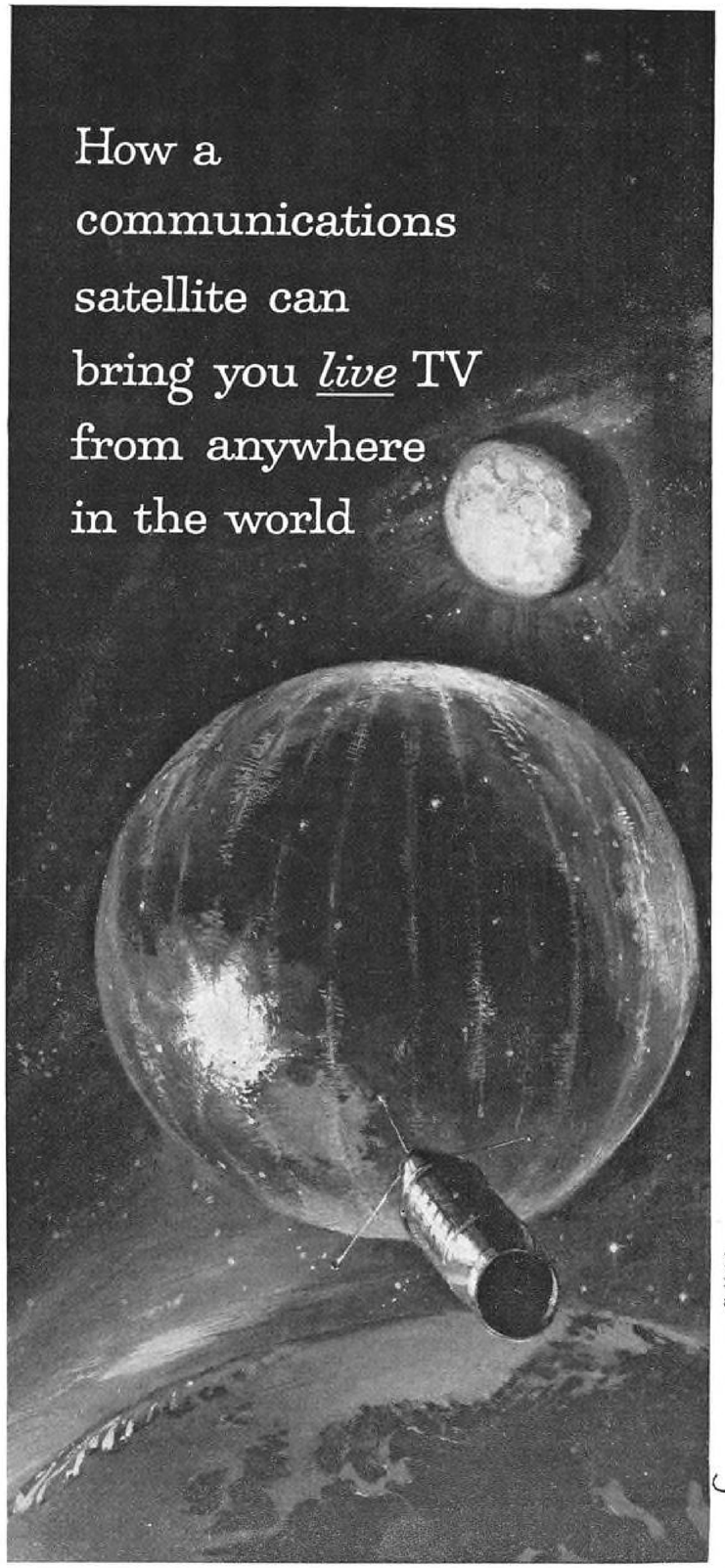
ERCO creates experience

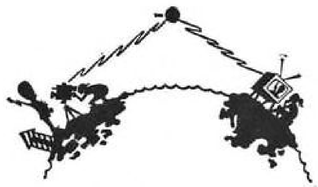
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World-wide live TV, with no cable or radio relay costs, can develop from outer-space research by government and industry

Among the peaceful applications for scientific break-throughs being made in the study of outer space is a communications satellite.

Using inflated plastic satellites, boosted toward orbit by the Air Force *Thor* rocket, a global TV network could be established. TV signals would bounce to satellite and back to your station, giving you a front-row seat at events anywhere in the world. Cost should be a fraction of coaxial cables and microwave relays now used.

Practicality of *Thor* for this purpose is based on its demonstrated reliability. With Douglas responsible for airframe fabrication and assembly and test of the entire system, *Thor* has helped launch 84% of all payload weight put into space by the U. S.; is the key booster in the Air Force "Discoverer" firings; launched the first nose cone recovered at ICBM range.

Thor is another product of the imagination, experience and skills which Douglas has gained in nearly 20 years of missile development.

Foil-covered satellite, folded like a pocket raincoat, would balloon out in orbit as an inexpensive TV relay station

DOUGLAS

Builders of the DC-8 Jetliner

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • TRANSPORT AIRCRAFT • AIRCOMB • GROUND SUPPORT EQUIPMENT



How do you want your digital data?

Norden Converters offer varied outputs

Converter Disc	TYPICAL MODELS					
Code	Binary*	Binary	GRAY	Binary-* Decimal	Degree-* Counting Binary-Decimal	Latitude/* Longitude Binary-Decimal
Number of Models	9	3	4	7	6	2
Total Count Range	2^7 to 2^{19}	2^7 to 2^{19}	2^8 to 2^{16}	10^2 to 10^5	360 to 360,000	36,000
Available Counts per Turn	128, 256, 512, 1,024	128	256, 512, 1,024	100, 1,000	100, 360, 360,000	10
Diameter	1¾″	1¾″	1¾″, 2¼″, 3¼″	2¼″, 6¼″	2¼″, 3¼″, 3⅜″	2¼″
						

* V-brush logic included within encoder.

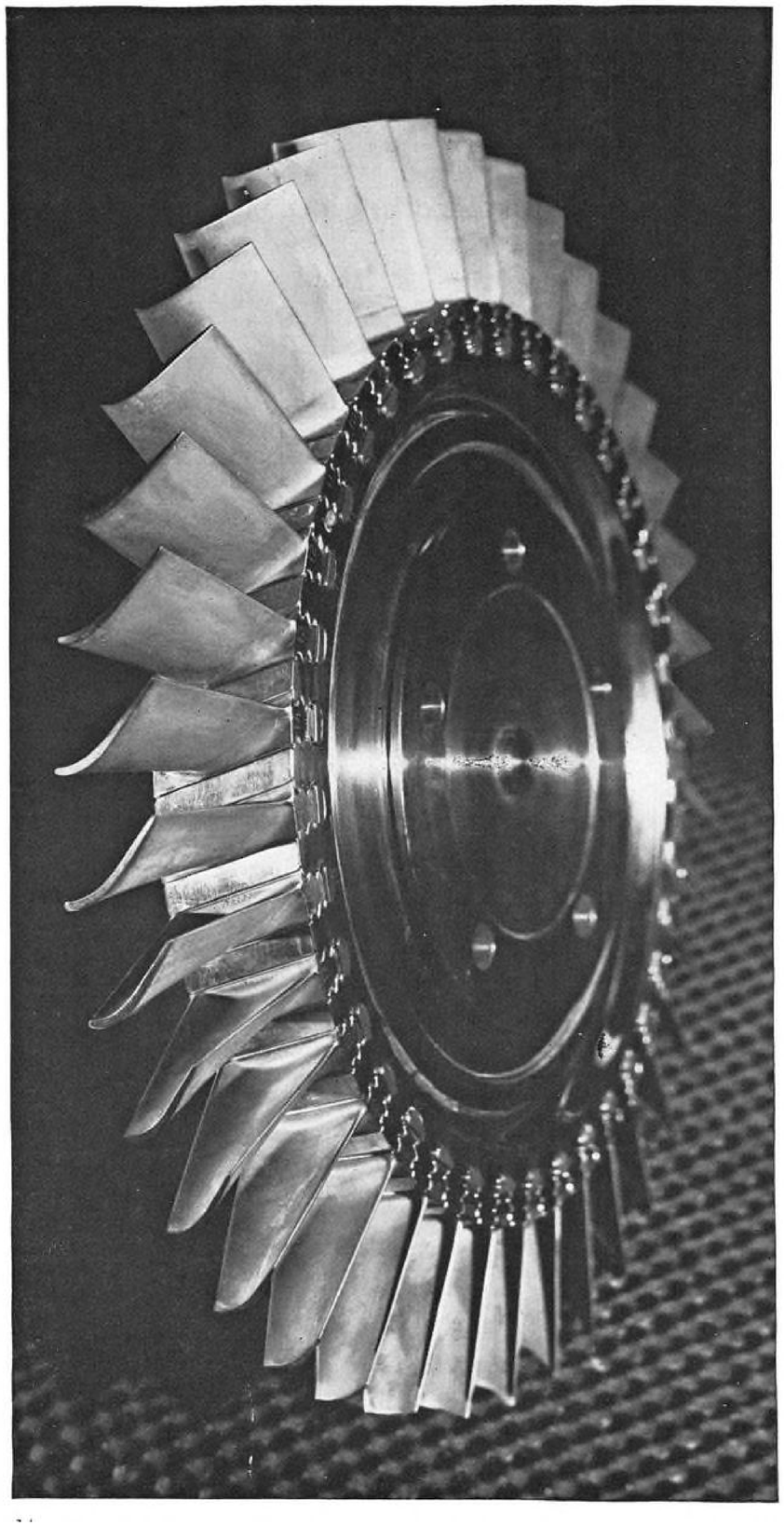
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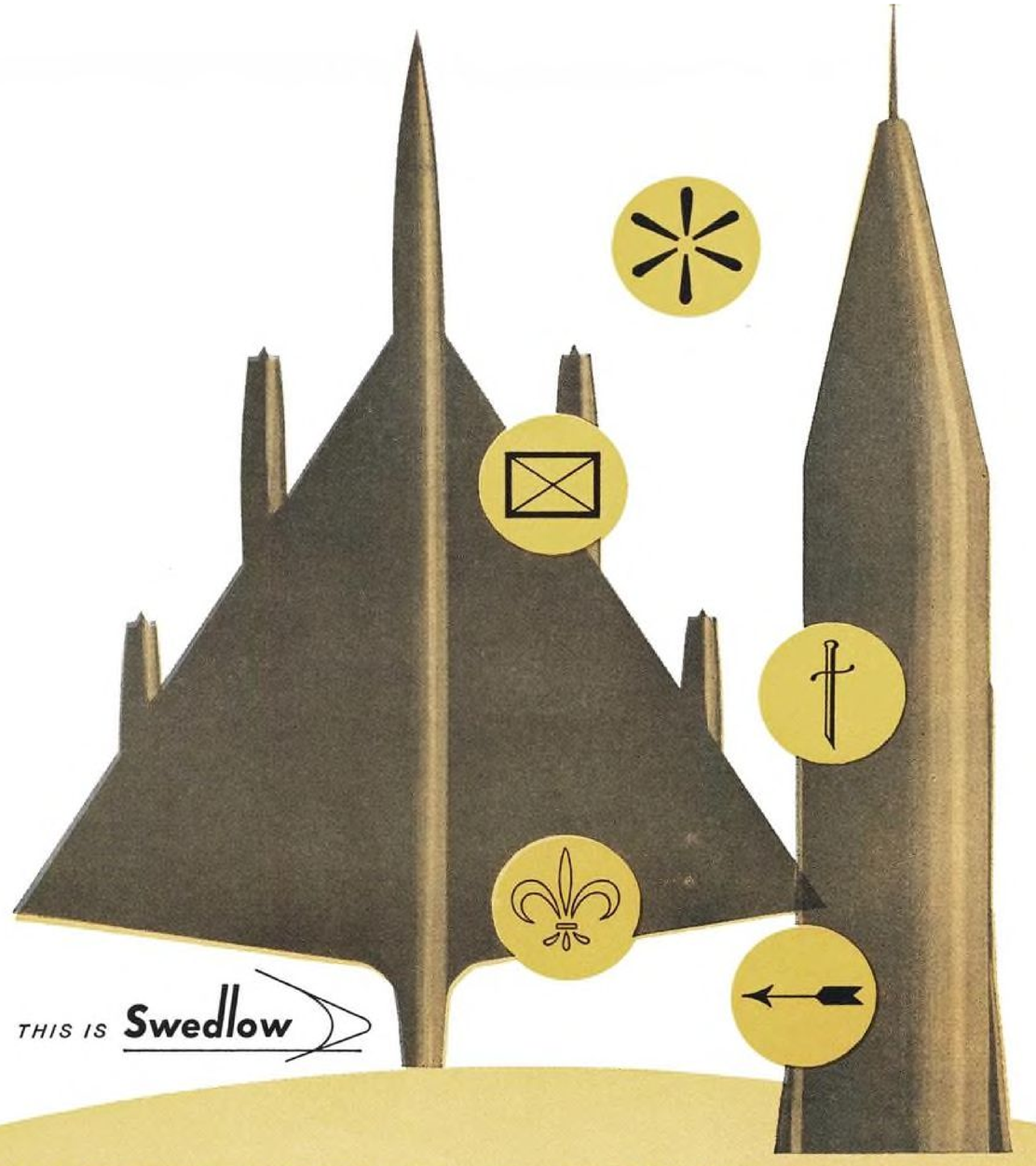
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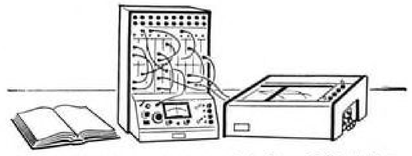
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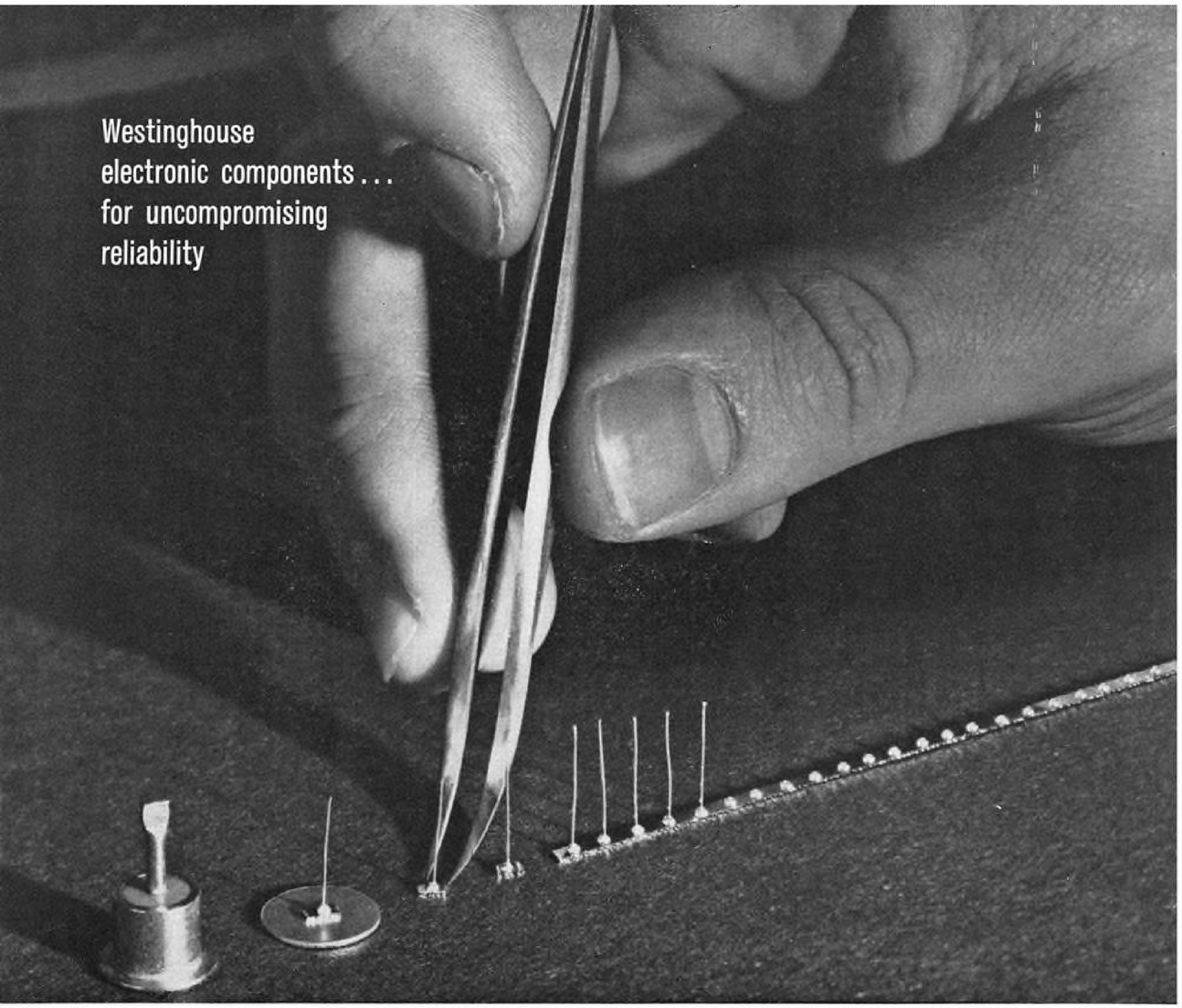
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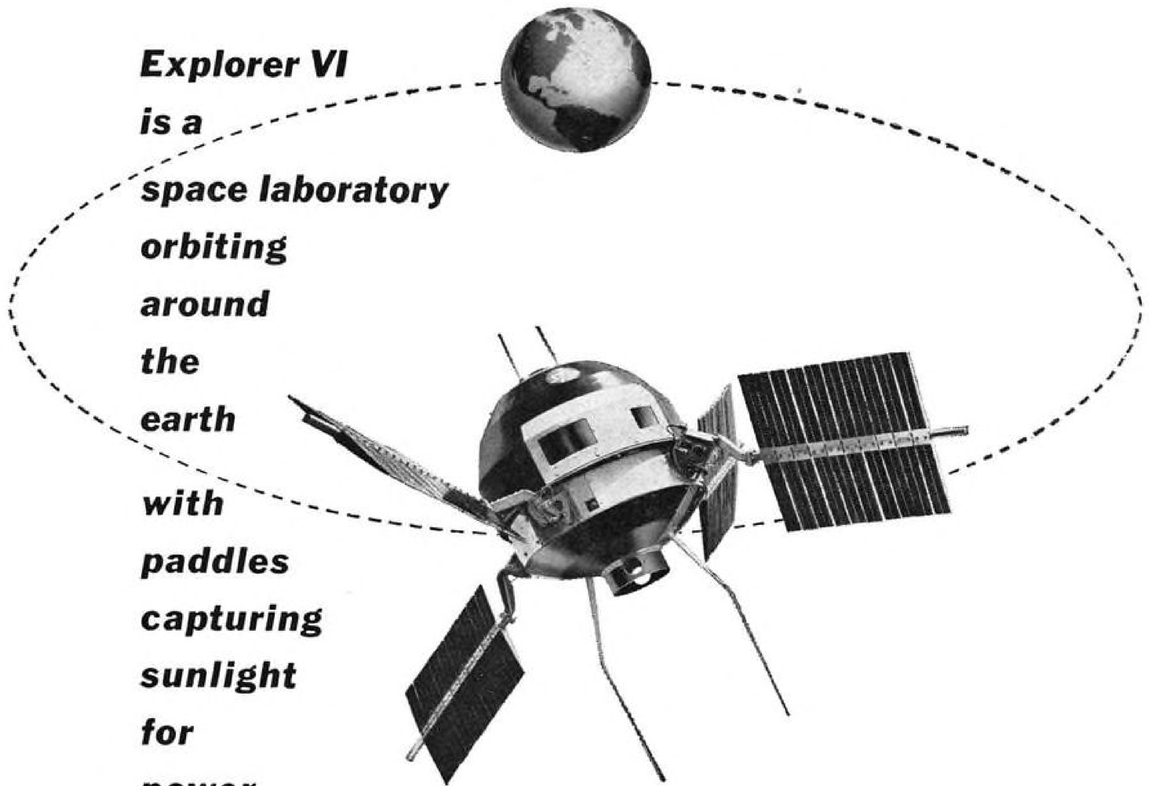
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COVER: Multiple Axis Test Inertia Facility (MASTIF) is used at National Aeronautics and Space Administration's Lewis Research Center to simulate manned space flight conditions. Installed in the Altitude Wind Tunnel, MASTIF is gimbaled to simulate yaw, roll and pitch attitudes. Altitude and temperature factors of space flight can also be simulated. Facility was used to test the Project Mercury capsule used in Big Joe re-entry tests, and Mercury pilots will fly the system as part of their training program.

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Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power

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EDITORIAL

Military Space Problems

The requirement for a military space program and the methods by which such a program should be organized, financed and executed will be a subject of increasing interest in the next session of Congress. This subject will be closely scrutinized not only in the double-barrelled investigations of the entire space research effort by the House and Senate space committees but also by appropriations committees as part of the defense budget.

The recent public speeches of Lt. Gen. Bernard Schriever, chief of USAF's Air Research and Development Command, and Brig. Gen. Homer Boushey, USAF director of Advanced Technology in the Pentagon, leave little doubt that USAF, which now has the major military space role, is growing increasingly restive under the limitations of the current organizational, financial and policy guidelines laid down by the White House in contrast to USAF's responsibility. It is also evident that the White House has not changed its attitude toward the military significance of space since President Eisenhower's first post-Sputnik statement that the initial Soviet satellite had not "one iota" of military importance. It is also evident that members of Congress concerned with these problems feel an increasing need to resolve this disparity of opinion through new legislation.

Perhaps the most difficult problem confronting the military in organizing a significant military space program is the lack of proper representation at any of the higher levels of governmental space policy-making groups. Current space policy is actually made in the White House and Budget Bureau. The National Aeronautics and Space Council, charged by law with this job, has fulfilled earlier predictions that it was doomed to sterility and impotence by the very nature of its composition. This group has had seven meetings in the year since its creation by the Space Act, but its activities have been cloaked by the invocation of executive privilege by the White House.

There is no military representation on the Space Council except through the Secretary of Defense, who is really a transient civilian and is outnumbered eight to one on the council. In contrast, the old National Advisory Committee for Aeronautics had between four and six military representatives on the 17-man policy-making committee. The current NASA-Defense Department liaison committee had its futility as either a policy- or decision-making group fully exposed before the last session of Congress by the testimony of its own members.

The longtime effective working relationship between the old NACA and the military also has been eroded by other considerations created in the formation of NASA. In the pre-Sputnik era, the old NACA functioned primarily as a service organization for both military and civilian technology within its field. Considerable military support, particularly in bailment of aircraft and other military equipment and joint financing of experimental research aircraft, was provided to NACA outside its own budget because the military knew this was a sound investment that paid them significant dividends. Now, by the very nature of the law that created it, NASA is competitive with the military for funds, programs and prestige. Although the research dividends may still be forthcoming, the immediate abrasion of budget problems is a more tangible and immediate issue. As the financial requirements of both the NASA and the military space programs increase, as they inevitably must, and as the over-all federal budget strictures get tighter, this competition will inevitably get rougher.

At the working levels, NASA and the Pentagon are getting along reasonably well under the circumstances and there is a prevailing optimism that this relationship will eventually be stabilized at a mutually acceptable policy. However, the White House policy of increasing emphasis on space technology as a civilian scientific enterprise and the continued strong denial of its military potential will make it difficult to achieve this type of relationship.

Military technology in propulsion, guidance and materials has already provided the engineering base from which space research must operate for many years to come. There is little doubt, even on the basis of the few experiments in military space technology, that there is considerable military potential already visible in space from reconnaissance, navigation and communication satellites. As to what the future holds beyond that, only further research and exploration can yield the answers. But, if other countries get those answers first our military position will hardly be enhanced.

The biggest problem in achieving a sound, hard-driving space research program for both military and civil goals still lies beyond these intricate organizational problems and cannot be solved by any administrative or legislative reorganization. This is the lack of top-level leadership in establishing clear-cut national goals and generating national vigor and determination for the effort to reach them in a significant time scale. Almost any organization will operate well when stimulated by this type of leadership. And even the most administratively perfect chart of boxes and lines of authority cannot function well when this type of leadership is lacking.

Congress will do well to examine the entire structure of our space research effort when it returns in January. In this inquiry, the role of a military space technology program, and methods of organizing, financing and executing it, should get special attention.

—Robert Hotz



Johns-Manville Announces... **MIN-KLAD INTERLOK**

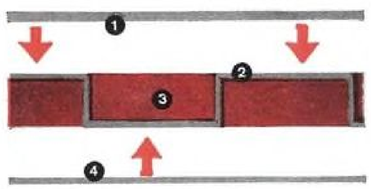
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. . . plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state, and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air.



1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K formulations, and 4) Inner facing.



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WHO'S WHERE

In the Front Office

Armand J. Thieblot, director of engineering, Aircraft & Missiles Division of Fairchild Engine and Airplane Corp., Hagerstown, Md. Pursuant to Mr. Thieblot's appointment, **F. E. Newbold, Jr.,** formerly vice president-engineering and marketing, has been named vice president in charge of planning.

Col. J. C. Pitchford (USAF, ret.), vice president-engineering, Benson-Lehner Corp., Santa Monica, Calif.

Carl Pilnick, vice president and director-research and development, Consolidated Avionics Corp., Westbury, N. Y., subsidiary of Consolidated Diesel Electric Corp.

Jerome Belsky, vice president-manufacturing, test, and building and grounds, Grand Central Rocket Co., Redlands, Calif.

Frank Lynott, executive vice president-operations, The Flying Tiger Line, Inc. **Neil Berboth** succeeds Mr. Lynott as vice president-operations. Also: **Constantin Moldaw,** assistant vice president.

Gordon A. Carlson, executive vice president, Hofman Laboratories, Inc., Hillside, N. J.

William C. Holmes, vice president and manager, Space Communications Division of Radiation, Inc., Mountain View, Calif.

Aaron Bloom, vice president-engineering, Sierra Engineering Co., Sierra Madre, Calif.

Rear Adm. Roy L. Johnson will relieve **Rear Adm. William Miller,** retiring, as Assistant Chief of Naval Operations for Plans and Policy. **Rear Adm. Robert E. Dixon** relieves Adm. Johnson as Commander Carrier Division Four. Also: **Rear Adm. Clifford H. Duerfeldt** will become chief of Naval Air Basic Training at Pensacola, Fla., replacing **Rear Adm. Joseph M. Carson,** now Commander Naval Forces, Philippines. **Rear Adm. R. D. Hogle** will relieve Adm. Duerfeldt as deputy to the Commander in Chief, U. S. Naval Forces, Eastern Atlantic and Mediterranean. **Rear Adm. Louis J. Kirn** will become chief of Naval Air Advanced Training at Corpus Christi, Tex.; he will relieve **Rear Adm. Joseph C. Clifton** who will become Commander Carrier Division Seven. Adm. Clifton will relieve **Rear Adm. William E. Gentner,** whose new assignment has not been announced.

Honors and Elections

Ronald L. McFarlan, consultant to DATAmatic Corp. and Raytheon Manufacturing Co., has been elected president for 1960 of the Institute of Radio Engineers succeeding **Ernst Weber,** president of the Polytechnic Institute of Brooklyn.

W. Delaney Dilworth has been elected president for 1960 of the Air Traffic Conference of America, a division of the Air Transport Assn.; **William J. Mitchell** was elected first vice president, and **William L. Morrisette, Jr.,** second vice president. Mr. Dilworth is director of traffic administration and assistant secretary of United Air Lines; Mr. Mitchell, vice president-traffic and sales, Bonanza Air Lines; Mr. Morrisette, vice president-traffic and sales, Eastern Air Lines.

(*Continued on page 102*)

INDUSTRY OBSERVER

► Scale models of propellant tanks for National Aeronautics and Space Administration's Centaur and other space vehicles that will carry cryogenic fluids through long coasting periods in space will be flown along Keplerian trajectories in a USAF-Convair C-131 from Wright Air Development Division to determine behavior of the fluids under conditions of weightlessness. Similar flight tests already have been made with liquid oxygen and liquid nitrogen in small plastic tanks. Eventually liquid hydrogen, which will fuel the Centaur, will be tried. Effect of weightlessness on hydrogen, particularly if part of the fuel already has been burned off, could cause severe problems in areas of pumping and venting. Problems are expected to be more severe with hydrogen than with nitrogen, but work so far has turned up no physical problems that seem incapable of solution.

► Soviet Union now has at least six ballistic missile submarines operating within range of the continental U. S.: three in the Atlantic and three in the Pacific. The submarines (AW June 15, p. 26) are modified versions of the conventionally-powered "Z" class with a cruise range of approximately 12,000 mi. Missiles are believed to be housed in the conning tower.

► Planning Research Corp., in a ballistic missile early warning system study for the Radio Corp. of America, is analyzing the effects of countermeasures and counter-countermeasures, ramifications of false alarms and the relation of the operability status to mission performance, the variations in scan mode to detection capability and the missile ascent profile to surveillance zone.

► Air Force is studying requirements for hydrazine storable propellants (N_2H_4) for possible use in operational versions of the Martin Titan ICBM and surveying the extent of the facilities that would be needed to meet anticipated propellant quantities.

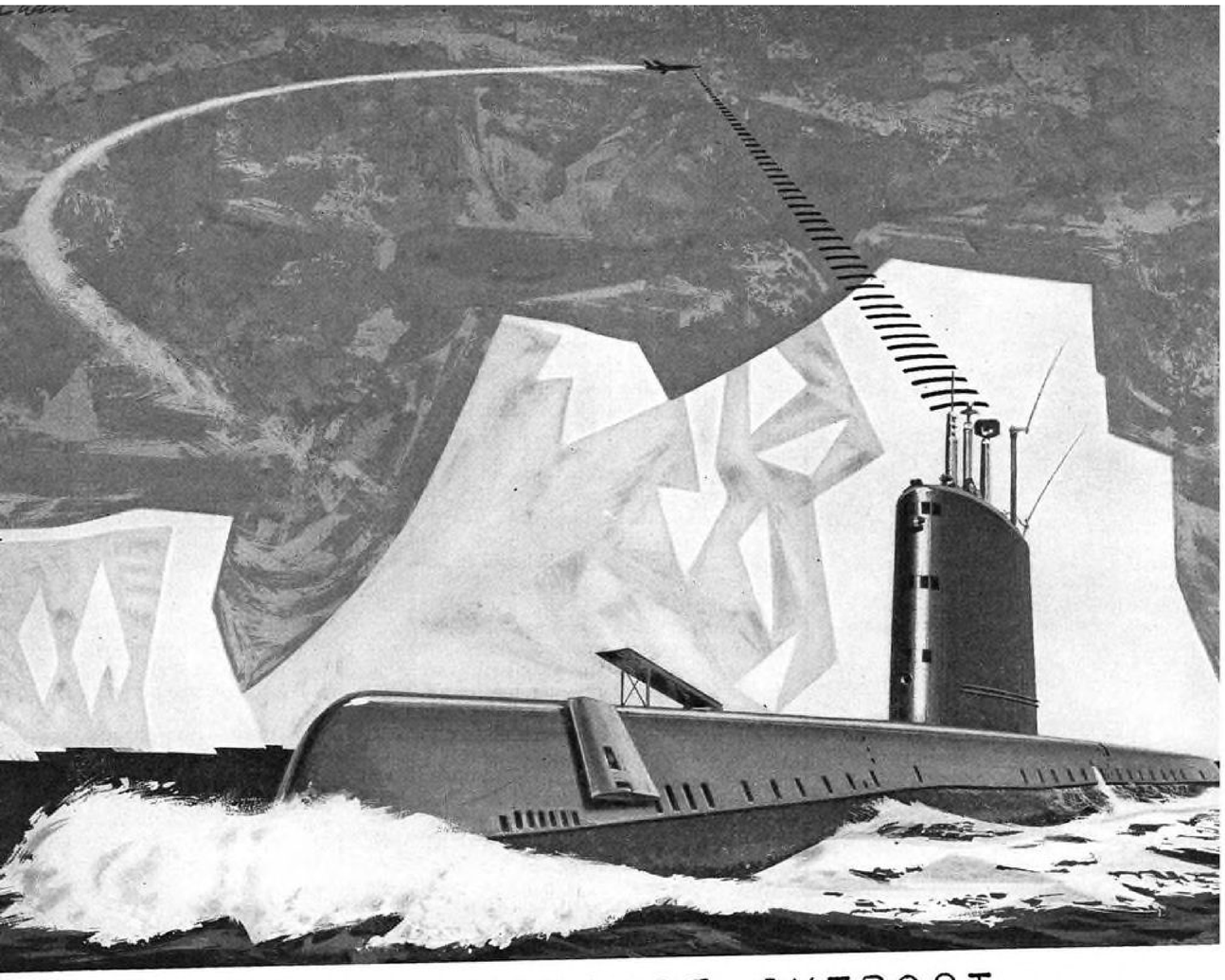
► San Diego Division of General Dynamics Corp. is contemplating the use of Sidewinder infrared head as a seeker for its Red-Eye surface-to-air missile, which is fired from the shoulder (AW Aug. 10, p. 36).

► Advanced Research Projects Agency contractors working on the development of high energy solid propellants have been told not to discard any promising high energy storable liquid propellants they might discover in the course of their work. ARPA program now appears more likely to produce a high energy storable liquid than the high energy solid rocket propellants at which it was originally aimed.

► Production model of the F-106A incorporating Hughes Aircraft MA-1 fire control system, automatic flight control function and data link recently made its first flight. Effect of automatic flight control function and data link is that the pilot manually lifts the aircraft from runway, retracts gear, puts aircraft in automatic or ground controlled intercept flight control mode, then does not have to touch controls again until he is ready to extend speed brakes and landing gear on final approach and accomplish the landing flare. Vector out, attack, steer to base and descent can be done by outputs from the SAGE air defense system operating through the data link to the automatic flight control system. Aircraft also incorporates WADC Phase II pilot display panel.

► Airborne digital computer to be used in Titan inertial guidance system is expected to weigh only 30 lb., be able to perform 6,000 mathematical operations per second. Computer is being developed by International Business Machines Corp. for use with an inertial platform being manufactured by AC Spark Plug Division of General Motors. Complete system is expected to weigh less than 100 lb.

► Grand Central Rocket Co. claims an over-all reliability of better than 99% for its Viper polysulfide-ammonium perchlorate solid rocket in more than 600 firings. Rocket is used primarily in clusters to propel sled vehicles at USAF test tracks at Holloman AFB, N. M.; Edwards AFB, Calif., and at Hurricane Mesa, Utah.



....MISSILE GUIDANCE OUTPOST.....

The Radar Course-Directing Centrals designed and produced by Stavid for the REGULUS missile provide the Navy a means of pin-pointing tremendous striking power against targets in hostile territory. Submarines now operational are capable of command-guiding the missile in flight, and provide missile crews with an automatic presentation of bearing and range information through data-stabilization and course computers.

Stavid's electronics capability is strikingly demonstrated in this task which required design and manufacturing skills ranging from the antenna to the computers – all developed and produced within our facilities.

The Stavid capability ranges from original research to system redesign for mechanized production. Recent accomplishments include:

- Gun Fire Control System Mark 70
- Radar Beacon for X-15 Aircraft
- Beacon Telemetering System



Stavid Section Engineer, Richard Holmberg, has 12 years' experience in electronics development, including project direction of guidance systems, electronic simulators and fire controls.

STAVID Engineering, Inc. Plainfield, New Jersey

Imaginative Electronics...

Outstanding engineers and scientists are invited to inquire into opportunities on Stavid's advanced systems engineering teams.

Washington Roundup

McCone Backs Single Space Agency

Single agency concept to manage both civil and military space efforts is supported by Atomic Energy Commission Chairman John A. McCone. Discussing the national space problem on the National Broadcasting Co., Meet the Press television program, McCone said he isn't sure such an agency should be patterned exactly after the AEC, but "I think that a civilian space agency to handle all phases of space activities should be the correct thing to do."

McCone disagreed with contentions that the U. S. should admit it is in a space race with the Soviet Union, but he said that clear objectives should be defined and pursued. "I don't think this is properly defined as a race," he said. "What I think we should do is to clearly define our objectives in space from the standpoint of the benefits that are to come to science and to the people, and then we should pursue those objectives aggressively."

Commenting that the Russians have gained a scientific advantage "that sort of feeds on itself," McCone said he expects that "we are going to see some rather spectacular things done by the Soviets in the next year, two or three, in space." He also observed that the Russians are organized in a way that permits them to select objectives and then marshall scientific and technical resources to accomplish their objectives in a minimum time. "I think that they are better at that than we are."

McCone also said that during his recent trip to Russia, Soviet progress in developing an atomic-powered aircraft was "in a classified field" and not a subject for discussion. "However," he said, "I got the impression that they are working on it." McCone said the U. S. nuclear aircraft program has "traveled a rough road" and presents a difficult problem, contending the U. S. should make up its mind whether it is worth the effort and "if we decide to go forward we should go forward with very intense effort."

Military Space Role

Meanwhile, a plea for a significant military role in the national space effort was made last week by Lt. Gen. Bernard A. Schriever, commander of Air Research and Development Command. He said the nation cannot afford to concentrate solely on scientific exploration of space and ignore its "vast extension of the air as a theater of military operations." He said the Soviet Union is not limiting its space efforts to peaceful exploration but is mounting a total effort, concentrating intellectual and productive sources toward a single purpose—"the strengthening and extension of communism, through the coordinated power of scientific, industrial, economic, political and military means.

"For this reason," Schriever said, "we cannot afford to set our military services apart from the scientific and industrial community, confining our use of the techniques and facilities which we have developed solely to the refinement of existing weapon systems. Our two great objectives—to increase human knowledge and to defend human freedom—are inseparable. If we are not merely to catch up with the USSR, but to gain the lead ourselves—at the earliest possible moment—we must marshall all our resources to the fullest, in a concerted drive to master the challenge of space."

Comparing civilian and military incentives in exploring new fields, Schriever pointed out that scientists are attracted to new areas by the desire to enlarge their fund of knowledge while the military explores them with a life-or-death urgency. He said the military explores new regions—on the earth or in space—because they must be exploited if possible before a potential enemy seizes them for a military advantage. "This is a built-in incentive to progress, of the highest order, which is peculiar to the military."

U. S.-Hawaii Fare Probe

Common fares to Honolulu, Hilo and other points in Hawaii from the U. S. mainland, already a controversial issue in the hearings on the Transpacific Route Case (AW Nov. 23, p. 39), will be investigated by the Civil Aeronautics Board to determine whether they should be adopted by scheduled airlines. Although the Board previously ruled that such rates were "unduly preferential and unreasonable" for scheduled airlines, it has not suspended a revised common fares tariff filed last week by United States Overseas Airlines for its operation into Hawaii. Both USOA and Transocean Air Lines have been serving Hawaiian points with a common fare structure since 1953—a practice the Board will allow to continue because the two airlines, being supplemental carriers, "are not required to serve the Hawaiian points in any particular sequence. . . ." But as the result of the USOA filing, the Board wants to take a fresh look at the common fare structure to determine whether all U. S.-Hawaii carriers should offer equal fares between the mainland and all Hawaiian cities served by air.

New Defense Comptroller

Franklin B. Lincoln, New York lawyer and former Navy counsel, was named by the President last week to succeed Wilfred J. McNeil as Assistant Secretary of Defense (Comptroller). McNeil, who had held the post since the armed forces were placed under the single Defense Department in 1947, recently resigned to become president of the Grace Line in New York (AW Sept. 21, p. 25). Lincoln, who served as Navy counsel during World War II, will serve under a recess appointment until his nomination can be sent to the Senate for approval.

Patent Policy Hearings

Patent policies of government agencies directing scientific research will be closely scrutinized during the next two weeks by congressional investigating committees. Patents and Scientific Inventions Subcommittee of the House Science and Astronautics Committee is scheduled to open hearings today on the patent provisions of the National Aeronautics and Space Act (AW Nov. 16, p. 39). Purpose of the hearings, according to subcommittee chairman Rep. Erwin Mitchell (D.-Ga.), is to determine whether the present provisions are adequate or if changes in the legislation should be recommended. Next week, the Monopoly Subcommittee of the Senate Small Business Committee, headed by Sen. Russell B. Long (D.-La.), will look into the effect federal patent policies have on the rate of scientific advance, and particularly the problems which might be created for small business concerns.

—Washington staff

NASA Reorienting Research Emphasis

Decline in manned military aircraft systems plus missile, space prominence cut aeronautical role.

By Evert Clark

Washington—Decline in the need for manned military aircraft systems and the increasing prominence of missiles and spacecraft are rapidly diminishing the role of conventional aeronautical research by the National Aeronautics and Space Administration, successor to the government agency that spearheaded this work for 43 years.

Only one U. S. manned military aircraft designed for flight wholly within the atmosphere is now being developed--the Mach 3 USAF-North American B-70 bomber. Except for the air-breathing supersonic transports that are almost certain to evolve from the research done on the B-70, no other examples of what NASA officials sometimes call "the ordinary airplane" lie on the research horizon.

At the near end of the speed-altitude-range spectrum, NASA is doing extensive work with vertical and short takeoff aircraft. At the far end lies the USAF-NASA Dyna-Soar research vehicle and the hypersonic boost-glide transports that may follow it.

The usual subdivisions of aeronautical research—aerodynamics, propulsion, guidance, structures and materials, stability and control, etc.—will continue to be vital elements in all those vehicles and in the missiles and spacecraft that now claim more and more of NASA's attention.

But NASA officials say the over-all need for aeronautical research definitely has decreased. The only question is how much. Measuring this is difficult, because the more basic the research the more widely applicable it is. When NASA was being created a little more than a year ago, officials of the old NACA pointed out that 50% of the work that had been done in NACA laboratories in recent years was applicable to space flight. Only in application does the difference become clear.

An example of the kind of transition period that NASA finds itself in is the closing of the 8 ft. transonic tunnel at the Langley, Va., Research Center, which was the first to be built in this country. It had been declared surplus to the agency's needs, but it later had to be reopened to study the aerodynamic characteristics of the Mercury manned space capsule and the combination of the capsule with its various boosters.

What clearly is reaching an end is research on the turbojet engine and the problems peculiar to the types of aircraft that use it. This does not mean that NASA will do no more turbojet research—only that it feels the research problem will soon be well enough in hand that NASA can pass the task along to industry and the military, who have been building up facilities and skills since the advent of the turbojet, and move on to higher priority items just as it moved from piston engines to turbojets.

Research information that is now in hand or will be when currently planned work is completed should allow designers to carry the turbojet-powered aircraft up to speeds of about Mach 4, according to Ira H. Abbott, director of aeronautical and space research for NASA, and Milton B. Ames, Jr., Abbott's assistant for aerodynamics and flight mechanics. This appears to be about the top limit for turbojets.

Beyond this, the ramjet might be pushed to Mach 6, although it presents a number of research and operational problems. To carry it above Mach 6 requires going to hydrogen fuel, which multiplies the operational problems manyfold.

The question of whether any air-breathing aircraft for the Mach 6 to 12 range will be built is "still very much up in the air," Abbott says. In addition to needing some other type of powerplant to get it into the air and up to ramjet speeds, it would require many hundreds of millions of dollars in new facilities and development and might not be useful as a bomber because of reaction time.

These arguments will not stop the research necessary to give the information that is still needed before firm conclusions can be drawn, Abbott says, but the effort aimed at trying to change the picture will be limited.

Current thinking is that the best way to go beyond a speed of Mach 4 is to abandon the conventional approach and go to the boost-glide vehicle, which uses a combination of the ballistic toss and the glide provided partly by centrifugal force and partly by the lift of wing surfaces.

The test of this theory will come with the boost-glide Dyna-Soar, which is being designed specifically to explore the speed-altitude corridor from landing velocities to 18,000 mph., with particular emphasis on heating problems that occur around 12,000 to 14,000 mph.

While a shift in military priorities brought about by advancing technology is largely dictating the fact that conventional aeronautical research is declining, the rate of decline will be affected somewhat by the amount of interest in supersonic civilian aircraft.

NASA believes the most likely speed for the supersonic transport is about Mach 3, where the kinds of efficiencies that characterize current subsonic transports can be found.

A jump to Mach 2.2, which some manufacturers have considered, would allow the continued use of aluminum skins and preserve the usefulness of the skills and facilities that already have been built up. But, because the Mach 2 to 2.4 region probably is the upper limit for aluminum, such an aircraft would have no speed growth.

The choice between a Mach 2 or Mach 3 transport may eventually be a management decision for manufacturers and airlines to make rather than a technical choice.

Other factors which must be considered are:

- **No all-supersonic cruise** aircraft has yet been flown.
- **If national prestige** is a factor, a Mach 2 aircraft might quickly be superseded by another country's decision to go to Mach 3 instead.
- **If a Mach 3 aircraft** is of interest, how soon will the B-70, which is now under budget review but is the only prospect for pioneering this region, fly and how long afterward would manufacturers, airlines, the Federal Aviation Agency and others who would have a voice be ready to go forward?
- **If the B-70** is built and flown, will it be operated in large enough numbers to give the development and operational utilization information needed to base a transport on this type of design? Current subsonic jet transports drew heavily on the many thousands of hours of operation of Boeing B-47s, B-52s and KC-135s, of which a total of more than 2,000 have been built.

A similar problem of determining the national need for, and interest in, a type of aircraft exists in the VTOL-STOL area. Currently, Army's interest is high, and the low speed aircraft it is interested in may have potential for short distance feeder lines. Supersonic VTOL and STOL aircraft, while they are technically possible, again get into a question of economics. There is no sign, NASA says, that the services are willing to pay for aircraft that are larger, heavier, more costly, less efficient and probably just as vulnerable as conventional aircraft, just to get the advantages inherent in aircraft that use no runways.

Work done thus far on vertical and short takeoff aircraft has produced research information for NASA and technical information for Army, and has produced testbeds of a number of different configurations. NASA and Army now must fly these to help establish the general flying and handling qualities that are needed, and these vary radically with the various types. This should produce the kind of technical information that will allow design teams to design usable vehicles. NASA may have to continue to help as these are built and flown.

The optimum VTOL-STOL aircraft may end up being 50% heavier and demanding about twice the power of a conventional aircraft, but still might pay for commercial use if either time or cost could be competitive with that of conventional aircraft—for example on a run from Washington's National Airport, near the center of town, to a landing area near the center of Philadelphia.

Another possible use would be ferrying passengers to supersonic transport terminals. A small part of NASA's work is aimed at the higher end of the subsonic speed range. If speeds of 300 to 400 mph. can be obtained, a straight-wing VTOL, which might not require heavy fuel loads for hauls of the type demanded, should be efficient and economical. Here the military and civilian demand for, and support of such research, determines to a large degree how far it will go.

Although VTOL and STOL aircraft are low-speed vehicles, they have demanded entirely new aerodynamic research, just as missiles and space vehicles have. After years of avoiding stall and large areas of separated flow in entire aircraft designs, researchers found that in all these newer vehicles, other considerations dictated shape and created what one researcher described as "lousy flows that we had to live with."

Separated flow was a problem no one had studied, and the result was that NASA was, and still is, working actively on aerodynamics through the entire speed range but on different types of problems.

While NASA does not believe aerodynamics will occupy the predominant role in the aeronautical research picture that it has enjoyed for the past 25 years, it believes aerodynamics will continue to be important since the great majority of vehicles will still continue to use the atmosphere if only for departure and return.

One recent manifestation of the decline in the relative role of manned aircraft was the reduction in size of NASA's flight research program and the shifting of all the aircraft engaged in this from the Ames, Langley and Lewis centers to its base at Edwards, Calif., whose name had been changed from the High Speed Flight Center to Flight Research Center.

Most of the high-speed flight research recently has not been in flight test of the aircraft themselves. Increasingly, they have become testbeds for advanced systems, components and techniques. Their higher speeds made Edwards' long runways desirable.

Primary activity at the Flight Research Center for some time will be the North American X-15 program, in which a joint NASA-USAF-Navy team determines objectives and flight schedules.

The Bell X-1B and X-1E have been retired, and X-15-type reaction controls that were tested for as long as possible on the X-1B are now being tested on a Lockheed F-104.

NASA has three X-15s and expects to get a McDonnell F4H. When the X-15 program permits, it hopes to do advanced work on one type of Convair B-58. Two North American F-107s and a Republic F-105 are being released, and three Chance Vought F8U-3s were released to Navy recently. An F-104B and a North American F-100 with variable stability are being transferred from Ames.

Increasing cost and complexity have affected research aircraft directly as they affect the manned weapon systems that usually follow them. The only one programed beyond the X-15 is the Dyna-Soar, which again is a single government flight program requiring a joint team to pick objectives.

Dyna-Soar has two main objectives—to test parts of weapon systems and to determine the military potential of boost-glide vehicles and to produce technical research data leading to design, development and operation of whatever system evolves.

Soviets Claim Helicopter Record

Moscow—New world helicopter speed record of 166.5 mph. over a 100 km. closed course has been set by a twin-jet Mi-6 helicopter, according to Soviet aviation officials. The Soviets say the helicopter reached a top speed of 176.5 mph. over the last leg of the course in the Nov. 21 trial. This was considerably below the "better than 200 mph." mark that designer Mihail Mil told U. S. delegates to the Federation Aeronautique Internationale conference here he expected to reach (AW June 22, p. 91).

Present certified helicopter speed record for the 100 km. closed course of 141.5 mph. was established by a piston-powered Sikorsky H-34 flown by U. S. Army Captains Claude E. Hargette and Ellis D. Hill on July 12, 1956. On the same day, the two pilots also established helicopter speed records over the 500 and 1,000 km. closed courses with respective speeds of 135.5 mph. and 132.5 mph.

F-104 Drone Planned

Washington—Air Force probably will convert some of its Lockheed F-104 fighters into drones. F-104 drones, which have been requested by Air Research and Development Command for flight test purposes, could be used for such jobs as development testing of instrumentation and as targets for air defense missile testing. USAF has not decided how many F-104s will be converted.

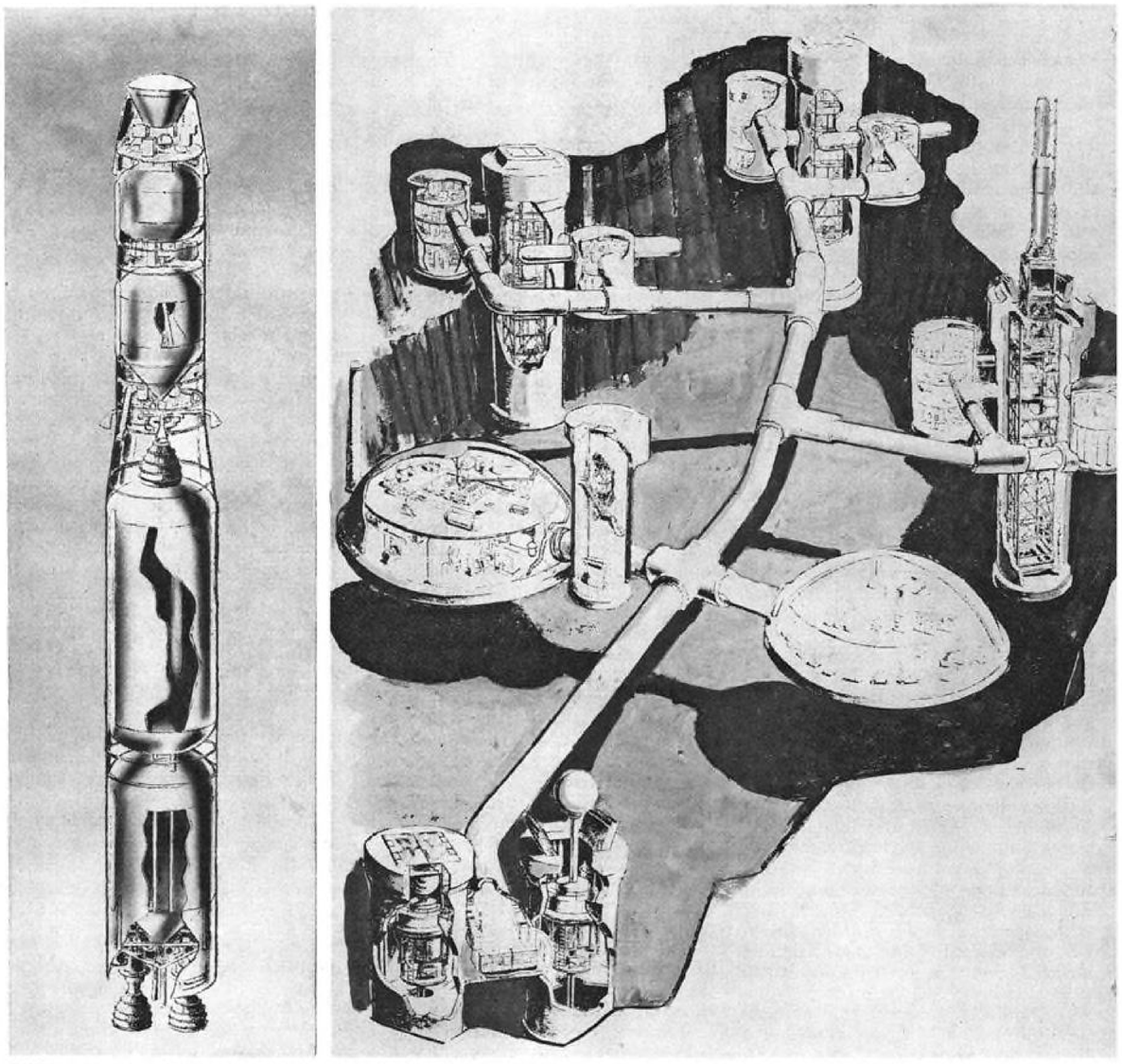
North American Sales Again Exceed $1 Billion

Los Angeles—North American Aviation sales topped the $1 billion level in its 1959 fiscal year, and the company expects business to exceed the $1 billion mark again in the current fiscal year.

Sales reached $1,044,899,580 in the year ending Sept. 30, a 16% increase over the previous year's sales but still under the $1,243,767,483 record set in the company's 1957 fiscal year. Profit after taxes was $30,726,134 in 1959, $26,786,294 in 1958 and $33,864,462 in 1957. North American directors voted a 50 cent quarterly dividend last week for the current quarter, the first in the 1960 fiscal year. Dividends were 40 cents a quarter in 1959 for a total of $1.60 a share.

Backlog at the end of the 1959 fiscal year was $662 million, a substantial increase over the 1958 level of $513 million, which marked the lowest backlog since 1950. The backlog at Sept. 30, 1958, did not include an estimated $846 million under negotiation but not yet funded. Employment increased 19% during the year to a Sept. 30 total of 64,220.

North American reports a substantial increase in non-aircraft business in the past four years, including sales in missiles, electronics and electromechanical equipment, rocket engines and atomic energy. These activities accounted for 20% of total sales in 1955 when six new divisions were established to handle them, and their share has grown to 43% in 1959.



CUTAWAY view of Titan intercontinental ballistic missile shows layout of fuel tanks and engines. Underground arrangement for operational-training setup is at right. Control center and powerhouse domes on top center buildings are above ground; silo is exit-entry portal.

Eight Bidders Compete for Titan Complex

Bids have been submitted to Army Corps of Engineers for construction of Titan intercontinental ballistic missile facilities Base T-4 at Larsen AFB, Moses Lake, Wash. Eight prime contractors submitted bids for the project, which will encompass three complexes—1A, 1B, and 1C. Each complex will be comprised of three launchers (missiles), coupled to a control center and powerhouse.

The three complexes will afford a total of nine missiles.

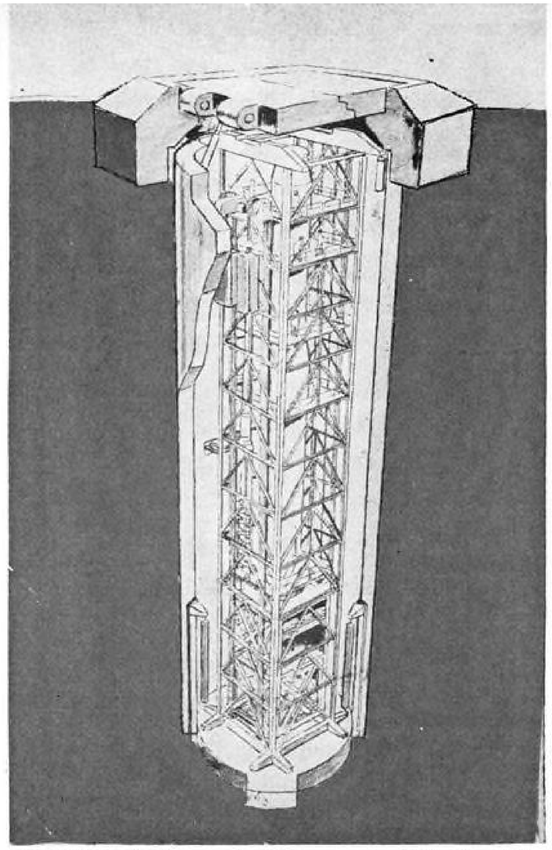
It is expected that the facilities will take approximately two years to build—about the same period of time involved for the construction of the 18-missile Titan facilities at Lowry AFB, Denver, Colo., which will be completed before the Larsen AFB missile installation.

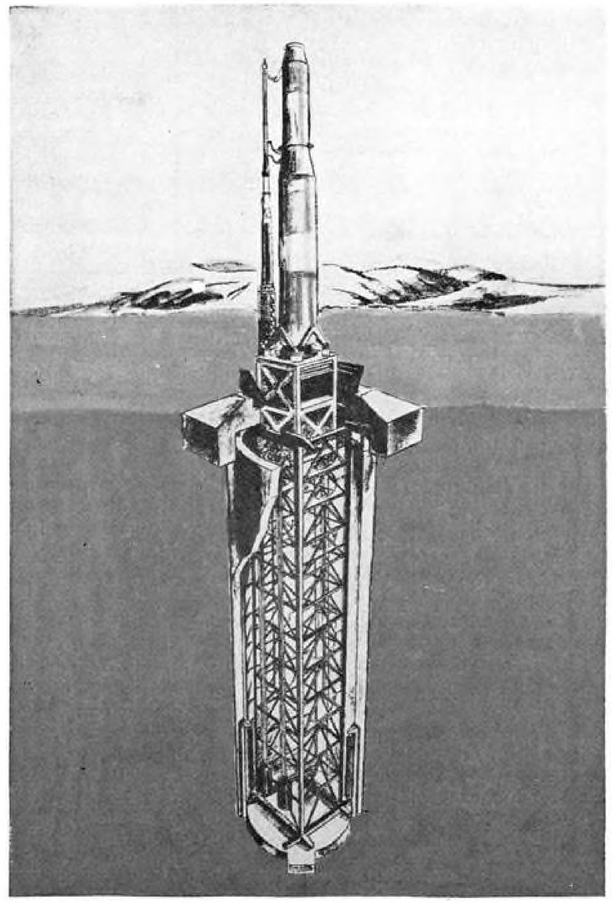
Larsen Complexes

Each complex at Larsen will include underground installations encompassing:

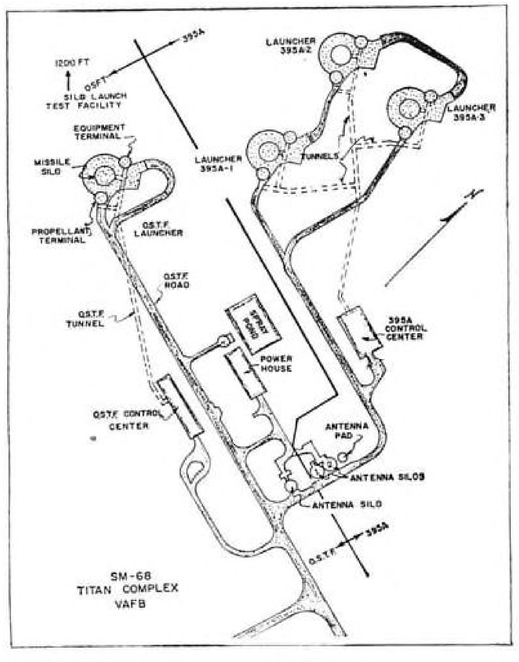
- **Three missile silos,** each with a wall thickness of 2 to 3 ft. of concrete.
- **Propellant terminal.**
- **Equipment terminal.**
- **Tunnels connecting** the silo with these terminals.
- **Antenna silos** housing two extensible antennas.
- **Central network** of personnel tunnels leading from the silos and antenna site.
- **Control center.**
- **Powerhouse.**
- **Blast locks** and escape hatch at the junction of the tunnels from the three silos.
- **Entry-and-exit portal.**
- **Road,** which comes in past antenna silos and forks to loop around the three silo sites of the complex.

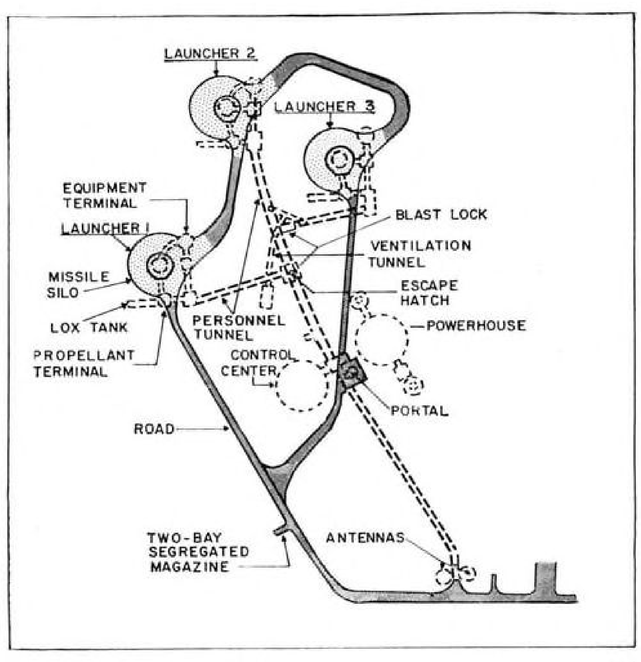
General dimensions of Titan facility installations include a missile silo depth





RECTANGULAR framework which supports rails for the platform elevating Titan to the surface is shown above; heavy closure doors are hinged. Drawing at right shows Titan and its umbilical mast raised to the surface for launching. Sketch at lower left outlines Vandenberg AFB operational-training arrangement. Larsen AFB plan view is at lower right.





of approximately 160 ft. and an inside diameter of 40 ft., accommodating a personnel elevator and stairway. Powerhouse is a dome configuration measuring about 100 ft. in diameter at the base, while control center has a similar configuration but is smaller. Radar antenna silos are about 25 ft. in diameter and 65 ft. deep.

Propellant Terminal

Propellant terminal also will be about 25 ft. in diameter and approximately 25 ft. deep. Equipment terminal will be about 40 ft. in diameter and about 60 ft. deep. Personnel tunnels will measure about 10 ft. in diameter while ventilation tunnels for the network of personnel tunnels will be about 5 ft. in diameter.

Included in the plans for the Titan facility at Larsen AFB is the transfer of Boeing-occupied Air Force Plant 53 at the Larsen site. In addition to use by Strategic Air Command in connection with the operational Titan system, the plant will be used by military and civilian contractor personnel associated with installation and checkout of the over-all Titan facilities. Boeing Airplane Co. personnel are scheduled to vacate Plant 53 by the end of March, 1960.

Under consideration for Titan operations is the use of storable liquid fuels. A study now is being made to project the amount of hydrazine which will be required to support an operational capability for Titan. (The missile now is using JP-1 fuel and liquid oxygen.) At the same time the facilities for producing the projected quantities of hydrazine are being analyzed to determine the degree of present capability and the degree of expansion which will be required. Use of a storable fuel would vastly simplify the supply problems involved at deployment sites.

Titan facilities at Vandenberg AFB are a special arrangement, not actually a prototype of an operational facility, but generally similar. The Vandenberg facility accommodates an Operational Suitability Test Facility (OSTF) for system proving. While generally similar to an operational scheme, the OSTF installation has its own control center and antenna silo.

USAF Speed Attempt

Washington—Air Force will choose one of its Mach 2 fighters for an attempt to set a new closed course 100 km. speed record under Federation Aeronautique Internationale auspices at Edwards AFB, Calif., within the near future. Aircraft under study for the attempt are the Convair F-106, Lockheed F-104 and Republic F-105.

A common powerhouse services the OSTF installation and other adjacent Titan facilities which are designated TF395A-1, -2, and -3. Although these installations are primarily training facilities, they will have operational capability and encompass three complexes each having its missile silo, equipment and propellant terminals. Tunnels and road are very similar to the operational plan for Larsen AFB and Lowry AFB.

In its generally typical arrangement, the Vandenberg AFB missile silo houses a rectangular truss-type structure for supporting the rails for the platform on which the Titan missile will be raised to above the surface for actual launch. The missile itself is supported on the elevator platform by a group of four triangular-brace structures. The mast carrying umbilicals for the missile is raised out of the silo along with the missile, which weighs in excess of 220,000 lb. and stretches approximately 90 ft.

Titan missile encloses two tanks—liquid oxygen and RP-1—extending practically the full length of the first stage to the bottom of the cone-frustum interstage structural fairing. Second stage contains a similar arrangement but propellant tanks are less than half the size. The second stage houses guidance equipment and supports the nose cone warhead.



Canadair CL-44 Prototype Makes First Flight

Canadair CL-44 prototype turboprop transport, one of 12 cargo-troop side loading transports ordered by Royal Canadian Air Force and designated CC-106 (AW Nov. 2, p. 52), makes its first flight. Ninth CL-44 off the production line will be the first of five swing-tail versions ordered by Seaboard & Western Airlines, and will be delivered early in 1961. Ten of these models also have been ordered by Flying Tiger Line and two by Slick Airways. Powerplants are four Rolls-Royce Tyne 12s, generating 5,730 tehp. each.

Missile Mix Broadens Interceptor Role

Washington—Greatly increased versatility and flexibility which Air Force all-weather interceptors gain from the combined use of infrared and radar guided air-to-air missiles was highlighted at the recent Weapons Meet at Tyndall AFB, Fla. (AW Nov. 9, p. 34).

The ability to carry a mix of infrared and radar-guided missiles, and to select the type fired, enables all-weather interceptors to better cope with a variety of enemy tactics. If, for example, an enemy bomber employs jamming that is effective against the interceptor's radar, the infrared-guided missiles can be fired. The infrared missiles also may prove effective at low altitudes where ground reflection of radar energy limits the usefulness of radar guided missiles.

In IFR-type weather, where infrared visibility is seriously limited, the radar-guided air-to-air missile comes into its own. At high altitudes above the weather, and in the absence of enemy jamming, both types of missiles can be effectively employed.

Contrary to early reports, the one "scored hit" achieved by an infrared-guided Sidewinder during the recent Tyndall meet occurred during a heavy overcast but at an altitude where the pilot had a visibility of approximately one mile.

Air Force's F-102, F-101B and F-106 all-weather interceptors are designed to carry a mixed load of radar and infrared guided missiles.

This year's meet at Tyndall marked the first USAF competition to employ infrared-guided missiles. Impressive scores were racked up by both the GAR-2 Falcon developed by Hughes Aircraft Co. and the GAR-8 Sidewinder, developed by the Navy and produced by General Electric and Philco, despite bad weather resulting from two hurricanes.

The number of target-drone kills would have been even more impressive if the Air Force had not taken special precautions to minimize drone destruction for economy reasons. For example, infrared-radiating flares attached to the Firebee drones were mounted on the ends of 15-in. rods extending from the wingtips. This made it possible for an infrared-guided missile, homing on the flare, to knock it off without destroying the drone, in many instances.

As an added precaution to hold down loss of drones, each F-102 was limited to a load of only two GAR-1 (radar-guided) or two GAR-2 (infrared) missiles. F-100s and F-104s were limited to a single GAR-8 Sidewinder each.

Firepower Limited

The six teams of F-102s competing at Tyndall flew six missions each, with two aircraft per team. For five of the six missions, aircraft were armed with GAR-1 radar-guided Falcons, while the sixth mission employed GAR-2 Falcons. If the target drone was destroyed by the first aircraft to fire, which occurred twice for the infrared Falcon, the second aircraft did not fire.

Of the total of 17 GAR-2 infrared missiles fired by F-102s, there were five direct hits on the target drones or their flares. One of these was disallowed because the pilots on the team had swapped aircraft for the mission. Of the 108 radar-guided GAR-1 Falcons fired during official missions, there were seven direct hits.

In another competition for clear-air-mass-fighters, there were two teams of F-104s and one team of F-100s, using Sidewinders for all six missions. Of a total of 36 GAR-8 Sidewinders fired, there were three direct hits. One of these was disallowed because the pilot deviated slightly from competition rules.

There is a natural tendency to make a comparison between the scores of the two different infrared missiles, particularly since one was developed by the Air Force, the other by the Navy. Tyndall officials say, however, that this is "like trying to compare apples and oranges." They see an important role for both the GAR-2 and GAR-8. A comparison of radar and infrared guided missiles also is impossible on the basis of scores because of the much more adverse weather in which the former were fired.

Tyndall officials point out that no one would attempt to compare the performance of a clear-air-mass-fighter, such as the F-100 or F-104, with an all-weather interceptor such as the F-102 because each is designed for a different mission. For similar reasons, the GAR-8, originally designed for clear-air-mass-fighters and the GAR-2, designed for use by all-weather interceptors, are not directly comparable.

These differences in basic missions are reflected in the capabilities, complexities and costs of the respective infrared missiles.

Even the ground rules under which the interceptor and fighter aircraft operated preclude any effort to compare the performance of the two infrared missiles on the basis of their respective scores, Tyndall officials point out.

For example, each F-102 fired its two infrared Falcons almost simultaneously. If both missiles had been equipped with Parami, the electronic transponder used to establish lethal near-misses, there would have been radio interference between the two attacking Falcons. For this reason, only one of the two infrared Falcons fired from each F-102 was outfitted with Parami. This meant that, unless the Falcon without a Parami scored a direct hit on the drone, it could not possibly achieve a point-scoring near-miss.

The F-100s and F-104s, on the other hand, each fired only a single Sidewinder. This meant that every GAR-8 could be equipped with a Parami transponder and could score an "area hit" (near-miss).

The foregoing partially explains why the GAR-2 Falcons scored no "Area 1 hits"—near-misses recorded by means of Parami—whereas the GAR-8 Sidewinder scored 14 "Area 1 hits" in addition to

William Tell Winners

Winning teams in the three competitions staged during recent William Tell II interceptor weapons meet at Tyndall AFB, Fla., include:

- **Northrop F-89s, firing unarmed MB-1T Genie nuclear-warhead rockets: 319th Fighter Interceptor Squadron, Eastern Air Defense Force, Bunker Hill AFB, Indiana. Col. James H. Hancock, team captain.**
- **Convair F-102s, firing GAR-1 (radar-guided) and GAR-2 (infrared-guided) missiles: 460th Fighter Interceptor Squadron, Western Air Defense Force, Portland Airport, Ore. Col. Younger A. Pitts, Jr., team captain.**
- **North American F-100s, Lockheed F-104s, firing GAR-8 (infrared-guided) missiles: 538th Fighter Interceptor Squadron, Western Air Defense Force, Larson AFB, Washington. Col. Leon W. Gray, team captain.**

Minuteman Refit Sites

Washington—First of several assembly and recycle (maintenance or refitting) sites for Air Force's Minuteman solid-propellant ballistic missile program will be selected within the near future. Possible locations include Hastings, Neb., and Ogden, Utah, Air Materiel Area headquarters at Hill AFB.

Minuteman assembly and recycle sites will have to be within easy airlift and rail or road access to missile deployment sites which are likely to be located only in remote areas. In addition to meeting this condition, Ogden also would be convenient to the Brigham City, Utah, facility of Thiokol Chemical Corp., contractor for Minuteman's first stage propulsion system. The Ogden Air Materiel Area also is acting as the logistics support manager for Minuteman.

three direct hits out of a total of 36 missiles fired. The F100s and F-104s fired all 36 Sidewinders carried aloft. The F-102s fired only 17 out of 24 GAR-2 Falcons. Reason for some of the unfired rounds: The first man on two of the F-102 teams completely destroyed the target leaving the second F-102 pilot without a target.

Ground-based radar was used to vector all aircraft to the vicinity of their targets. The F-104 pilots had a small airborne search radar to aid them in locating the target but used an optical gunsight to make their attacks. The F-102 automatic radar fire control system locked onto the target drone and a computer determined the optimum attack path, providing the pilot with steering commands on his radar scope and automatically indicating the optimum range at which to fire the infrared Falcons.

Because the GAR-8 Sidewinder is designed for use by clear-air-mass-fighters which are not equipped with automatic fire control systems, its infrared scanner is aimed dead ahead and the fighter must maneuver into a position where the scanner can see the target before it will lock on and the missile can be fired. Normally the attack is made in the target's tail quarter where the chances of target lock-on and kill are greatly enhanced.

The GAR-2 Falcon is designed so it can be carried internally in an interceptor and can be fired without requiring the interceptor to be aimed directly at its target. While the Falcon is still in the interceptor's bay, its infrared scanner is automatically oriented in the direction of the target by the interceptor's radar. Lock-on does not occur until after the Falcon emerges from the interceptor.

The infrared Falcon's remotely controlled scanner gives the all-weather interceptor greater latitude in the types of attacks that can be made on its target. For example, the Falcon can be fired in a snap-up type attack, where the target is many thousands of feet above the interceptor, with reasonable assurance that the missile will lock onto the target after launch, according to Hughes Aircraft Co.

This added feature is provided to fully utilize the flexibility and capability which exists in the interceptor's fire control system and in the radar-guided Falcon. This enables the interceptor pilot to employ essentially the same tactics in his attack, regardless of the type of missile he intends to fire.

This additional capability of the infrared Falcon is not without the normal consequences, i.e. increased complexity and cost. Although exact cost figures are not available for security reasons, the infrared Falcon reportedly costs about two to three times the cost of a Sidewinder.

Chute Failure Blocks Discoverer Recovery

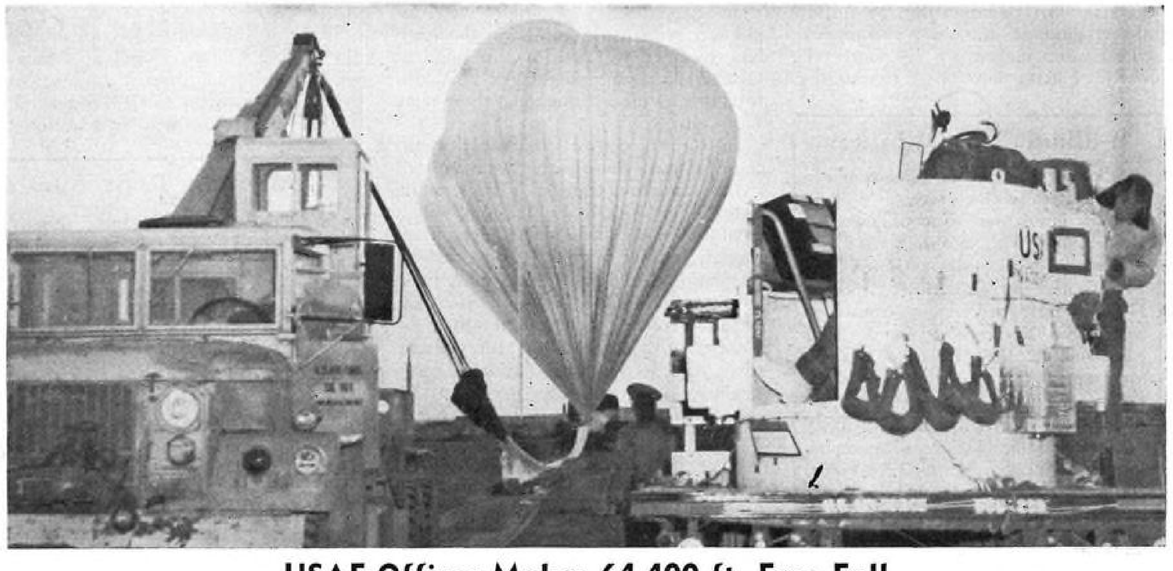
Vandenberg AFB, Calif.—Air Force last week failed to recover the capsule of its Discoverer VIII polar orbit satellite when its parachute apparently failed to open in the final stage of descent.

Retrorocket for the early phase of descent operated properly, but separation was slightly late, causing the 300-lb. re-entry capsule to fall south of the planned impact area southeast of Hawaii. Several aircraft and the Dalton Victory recovery ship reported receiving Discoverer beacon signals briefly after separation.

While there was no positive indication that the recovery parachute opened, there can be no certainty that it failed until telemetry data is completely reduced—a process that will require several weeks. Aircraft and surface vessels continued to search the estimated impact area. It is highly unlikely the capsule would survive a free fall into the sea.

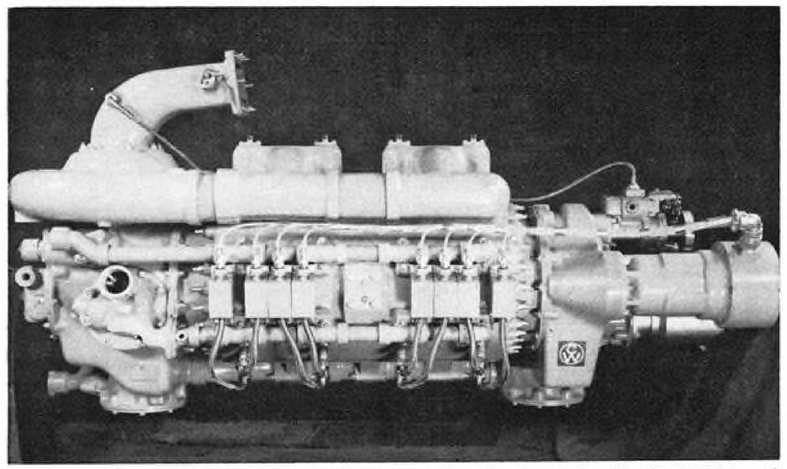
Capsule was ejected on command from an Alaska-based transmitter 26 hr. and 15 orbits after launch. Air Force originally intended to eject on orbit number 17, but, due to a guidance error, apogee was higher than nominal, and the orbital period was 103 min. instead of 93 to 95 min. that previous Discoverers have averaged. The seventeenth pass would have placed the capsule too far west for recovery. Fifteenth pass put the planned impact area slightly south and east of the originally selected one.

This was the fifth attempt to recover one of the 27-in.-long 33-in. diameter capsules. If one should survive impact on the surface of the sea, it would have enough buoyancy to float for a prolonged period and sufficient battery capacity to transmit beacon signals for 10 hr.



USAF Officer Makes 64,400 ft. Free Fall

Final avionics check is being made to gondola from which Capt. J. W. Kittinger, Jr., made a free fall from 76,400 ft. to 12,000 ft. at White Sands, N. M. test range. At center is 2 million cubic ft. balloon, about one-third inflated. Kittinger fell to 12,000 ft. in 2 min. 58 sec. when his parachute opened automatically. Gondola was automatically cut loose and was recovered.



SERIES of new, 100-hp. rotating combustion engines developed by Curtiss-Wright and NSU Werke, are joined in tandem to make the YRC 600 supercharged engine. Curtiss-Wright is developing the engine for aircraft and similar high horsepower applications.

Engine With Two Moving Parts Developed for Aircraft-Auto Use

New York—Curtiss-Wright Corp. and NSU Werke (West Germany) have developed a new, lightweight, internal combustion engine that has only two moving parts. Scheduled for production next year, the engine will compete with both conventional reciprocating units and gas turbines for powerplant applications ranging from aircraft to motorcycles.

First YRC 600 model to go into production will have a capability of delivering from 100 to 700 hp. For aircraft application, individual engines can be harnessed in tandem to produce the required horsepower. Two other models of the engine are under development: one in the 750 to 5,000 hp. range and the other in the 5 to 100 hp. range.

The new powerplant, called a rotating combustion engine, combines the best features of the reciprocating and jet (gas turbine) engines, Roy T. Hurley, Curtiss-Wright board chairman and president, said here last week. One of the new engines, he said, can deliver twice the power of a conventional piston engine while taking up only half the space.

Weight-to-power ratio for a rotating combustion engine made out of cast iron was reported to be 1 lb./hp. Moreover, said Hurley, there is no reason why lighter metals such as aluminum can't be used to improve this ratio.

Unlike conventional engines, the new powerplant is not subject to any extreme temperatures or stresses that limit its use, the designers claim. In particular, the engine does not develop the usual hot spots on pistons or exhaust valves—it has no valves, pistons, springs, camshafts or connecting rods—that limit conventional engines. The hottest part in this engine, Hurley said, reaches only 200-300F.

The powerplant will run on low octane automotive fuels and standard lubricants. Fuel consumption was reported to be .45 pounds of fuel per horsepower/hour. It can be started with a simple auto starter and can be operated with gearing and supercharger or blow-down. It can be either air-cooled or liquid-cooled. Noise level is said to be low, with the engine producing only a relatively quiet humming even without a muffler. Cost of the engine will be competitive with the powerplants it is designed to replace.

Unlike a turbojet, the rotating combustion engine does not lose power at high temperatures and altitudes, according to Hurley. Full power rating for the unit can be based on a 5,000-ft. altitude and a 100F day rather than on sea level and a 68F day.

NSU Werke, whose Felix Wankel invented the principle upon which the engine is based, is developing the smaller models which it plans to install in its own small automobiles, motorcycles and scooters, possibly by 1961.

The rotating combustion engine works on a trochoid principle. Its only moving parts are a triangular shaped rotor inside the engine chamber and a crankshaft which runs through the center of the rotor. The rotor touches the engine chamber only at its three apexes so the rotor's three sides, in effect, form individual compartments with the chamber wall.

In operation, an automotive carburetor supplies a mixture of gasoline and air through a side wall intake port to one of the compartments formed by the rotor side and chamber wall. As the triangular rotor turns, it compresses the gas-air mixture which is then fired by a single spark plug. The combustion gases expand, delivering power to the crankshaft (to which a flywheel is attached) by pushing against the side of the rotor. As the rotor continues around, the spent gases are exhausted through another side port in the chamber wall.

All three compartments formed by the sides of the triangular rotor are filled with an air-gas mixture during one complete rotation of the crankshaft and perform the same operation sequentially. In other words, for each revolution of the crankshaft there are three power sequences which in effect maintain an almost continuous intake-compression-ignition-expansion-exhaust cycle. This, it was said, gives the new rotating combustion engine the continuity of gas turbine operation in combination with the high efficiency of piston engine performance.

Polaris Contract

Washington—Westinghouse Electric Corp. has been awarded an additional $5.25 million by Navy for Polaris missile-launching systems for second generation Polaris submarines. Equipment is being made by the company's Sunnyvale, Calif., division. Contracts to Westinghouse for development and production of Polaris equipment now total $45 million. These cover at least nine Polaris submarines.

Japan's Missile Plans

Long range study based on Japan's planned defense power buildup projects missile production as follows:

- Nike or Hawk class missiles will be produced in Japan beginning in 1962 with assembly of 20 units manufactured in the U.S. and shipped to Japan in a "knockdown" state. By the end of 1967, 600 units will be produced.
- Bomarc class missiles will be produced in Japan beginning in 1965, with the initial 10 produced in the U.S. and assembled in Japan. By the end of 1967, a total of 249 units will be produced.
- Sidewinder class missiles will be produced in Japan beginning in 1961. By the end of 1967, 8,050 missiles of this class will be produced.
- Little John class missiles will be manufactured in Japan beginning in 1964. By the end of 1967, 400 units will be produced.

Russians Criticize Boeing 707; Rap Noise, High Density Seating

Moscow—Russia, which may soon be in serious competition with U. S. carriers and U. S.-built transports operated by foreign airlines on world air routes, is continuing its carping criticism of American jet transports.

The Boeing 707 is taking the brunt of the Soviet press attack. Latest swipe at the U. S. jet appeared in the newspaper Sovetskaya Aviatsiya, official organ of the Soviet Union's Ministry of Defense.

A Sovetskaya Aviatsiya reader, Maj. V. Dvornikov, asked the editors to describe the 707's design features. Chief engineers B. Petrov and V. Bogdanov, who wrote the reply to Dvornikov, declared in part:

"When you look at the cabin, one of the plane's characteristic features strikes you sharply: there is maximum use of fuselage space for payload at the expense of reduced convenience and comfort for second-class passengers. . . .

"In our opinion, the plane's piloting has been complicated . . . by the stabilizer design. . . .

"The fuselage's low position relative to the ground and the short, light landing gear attract attention. But this landing gear requires that the wings be deflected upward so that the engine nacelles, which are hung beneath the wings, won't brush against the ground.

"The swept-back wings with the big positive dihedral have produced excessive lateral stability in the aircraft. During flight, even in quiet air, the engine nacelles (particularly the outboard ones) have a constant rocking motion in the vertical plane.

"This has its effect on the passengers: they feel a bumping. The general looseness (lack of rigidity) in fuselage and wing construction is felt in the air."

Petrov and Bogdanov also charged that "during takeoff, when there is forced water injection, noise is very great." The Soviet engineers then reviewed the 707's mishaps and concluded with the statement: "All this speaks of the Boeing 707's insufficient refinement."

Pilot Comments

Last summer, the captain of the first Russian four-turboprop Tu-114 to fly Moscow-New York and New York-Moscow nonstop also was sharply critical of the 707.

Pilot A. P. Yakimov said he inspected and flew the 707 at the invitation of Pan American Airways' chief pilot. The Russian reported that the Boeing jet, like other new American transports, "didn't depart from the principle of business first."

Yakimov said that "American designers, in their chase after the maximum number of passenger seats, cramped the cockpit to a great degree. The cockpits are narrow, stuffy and difficult to turn around in. When the American pilot got up from his seat during the Boeing 707 training flight, his shirt was wet with perspiration. I, too, was very hot. Out of habit I wanted to turn on the fan, as I would have done on the Tu-114. But there was none on this plane. It is hard to explain why American pilots are denied the most elementary conveniences in flight."

Yakimov continued that besides having narrow cockpits, "even the very newest Pan American and Eastern Air Lines' planes have very small instruments.

"Of course, this circumstance makes the pilots' work harder and more fatiguing."

Khrushchev Reviews Missile Potential

Moscow—Text of Soviet Premier Nikita Khrushchev's speech at a reception during the All-Union Congress of Soviet Journalists, in which he referred to the production of "250 rockets with hydrogen warheads" by one factory in a year (AW Nov. 23, p. 35), includes these statements:

"Speaking of our economic potential, of the Soviet Union's defense capacity, it should be pointed out that this year we had the shortest military parade in our history, although this year the Soviet army is at the height of its invincible might.

"A few years ago I said in a speech that an intercontinental ballistic missile had been developed in our country. Then, many public leaders in capitalist countries stated that Khrushchev was probably just boasting. When we started production of these rockets, I said that in our country intercontinental rockets were on the assembly line. Again they began to say that this could not be, that Khrushchev was boasting again."

Deputy Premier Anastas Mikoyan interrupted at this point to say: "Let them make such a boast themselves!"

"You can boast," Khrushchev continued, "but you must boast in such a way that all the world should see what you are boasting about. When we made such a 'boast' all the world saw how our rocket soared to the moon and landed there!

"So this is no empty boast; these are real facts. I think, dear comrades and members of the Presidium, that I will reveal secrets, and at the same time I want to be understood correctly: we do not want to frighten anyone but we can tell the truth—now we have such a stock of rockets, such an amount of atomic and hydrogen warheads, that if they attack us we could wipe our potential enemies off the face of the earth.

"During a visit to one of the plants, we saw how the workers, engineers and scientists build rockets. Seeing this process we experienced a dual feeling—the feeling that the most lethal, the most destructive weapon is produced there, and on the other hand, the feeling of pride that we have it. People may say that Khrushchev is becoming contradictory—he says he favors peace, he receives the Lenin Peace Prize, and then he takes pride in the production of means of destruction. I am proud because this weapon is possessed by the most peace-loving state, by the Communist Party, by the people who are defending the cause of peace. It is a dreadful weapon for those who would like to unleash a war. Consequently, it is an asset in the struggle for peace.

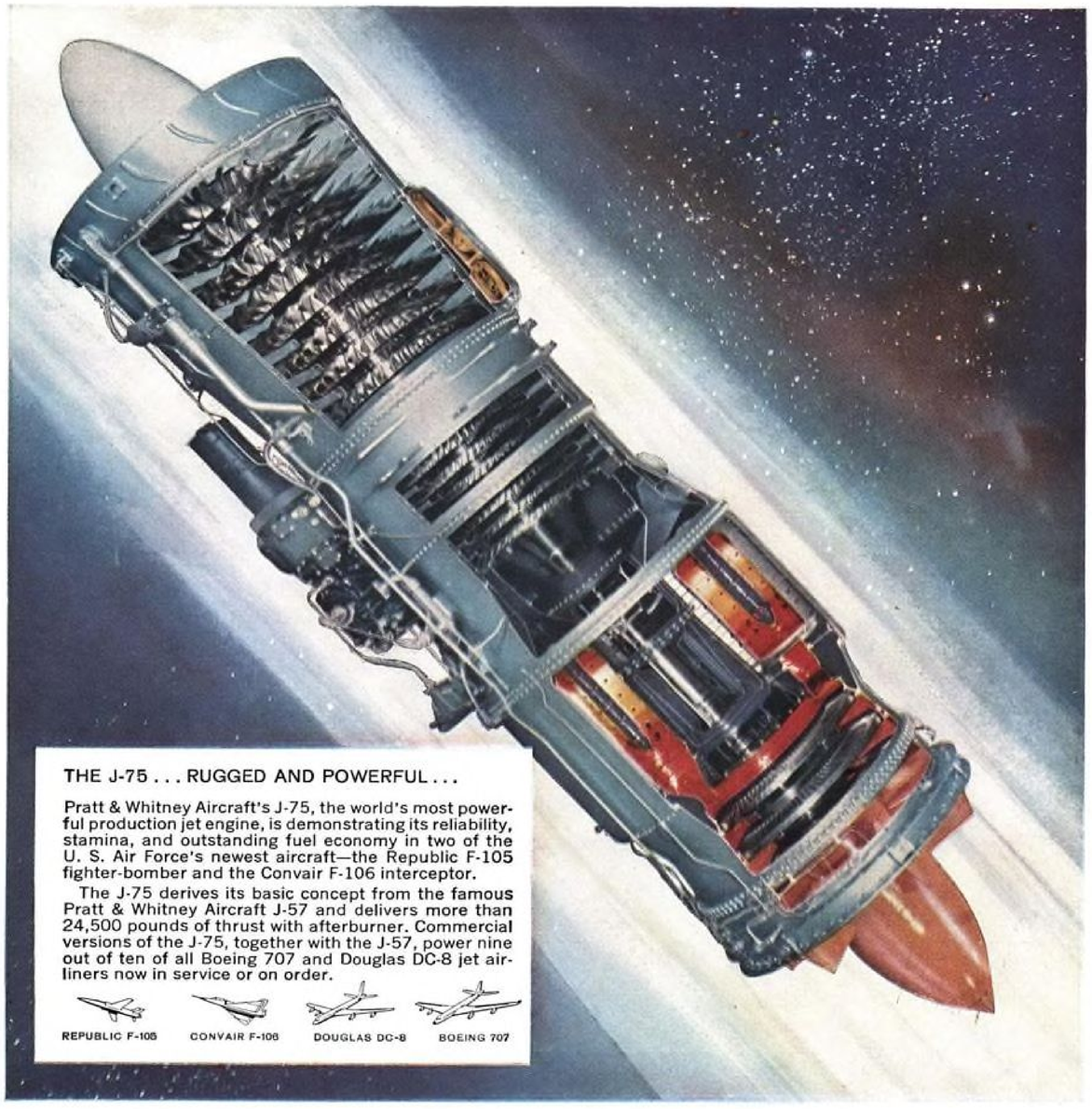
"Our policy is not a position of strength policy. We proposed total and universal disarmament at the UN General Assembly this year and we are ready to dump all rockets.

"By the way, I shall reveal—and let the people abroad know it, I am making no secret of this—that in one year 250 rockets with hydrogen warheads came off the assembly line in the factory we visited. This represents millions of tons in terms of conventional explosives. You can well imagine that if this lethal weapon is exploded over some country there will be nothing left there at all.

"Such are the mighty weapons which we have at our disposal for protecting our motherland. Possessing such weapons we declare that we are ready to sink all this in the sea in the interest of ensuring peace on earth, in the interest of the future, so that all people of our generation and future generations might live in tranquility, so that they should know that we not only do not want war, but that we do not even want to have means of waging war. We are ready to destroy all these weapons of ours at once, if other countries will follow our example.

"But things are going well with us. Our economy is developing, the might of the Soviet Union is rising.

"Such is our life, comrades! Not a bad life, comrades!"



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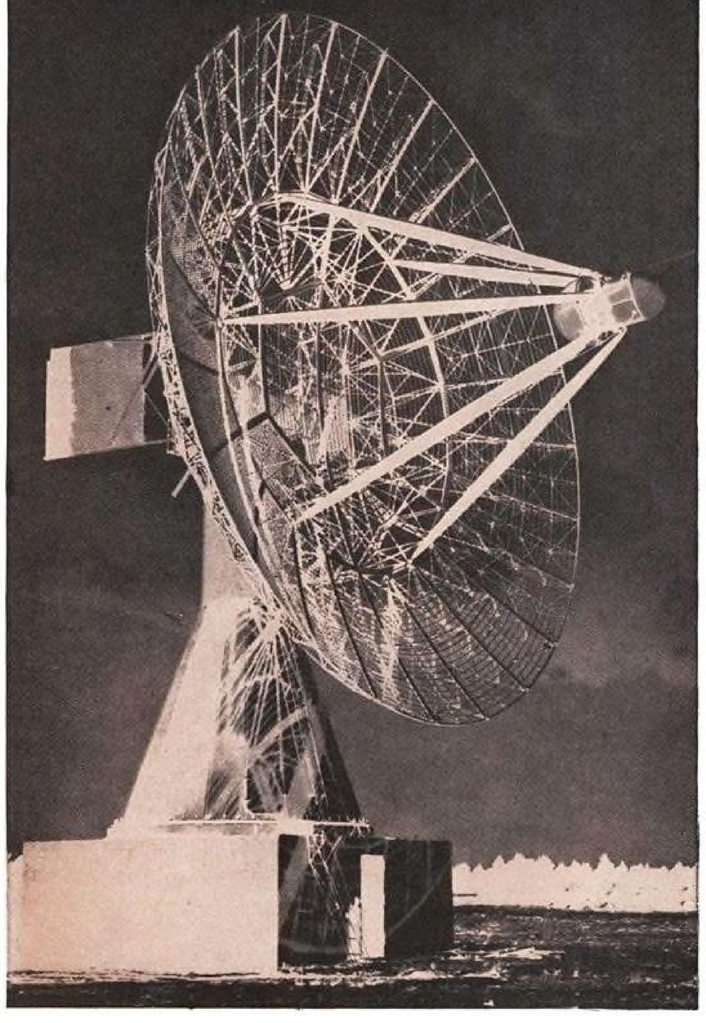
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The powerful TLM-18 telemetry antenna now in service at the Air Force Missile Center, Cape Canaveral, Fla., is used for the automatic tracking of missiles and earth satellites. This huge "mechanical ear," specifically designed by Radiation, Inc., Melbourne, Fla., has an effective data reception range of over 1000 miles.

One of the key parts of this highly sensitive device is the ⅞", 50 ohm, aluminum sheathed Styroflex® coaxial cable that links the 60-foot parabolic reflector to the receivers. The task of carrying missile-to-earth signals from the antenna to the control building demands a low-loss, high frequency cable with a high signal to noise ratio.

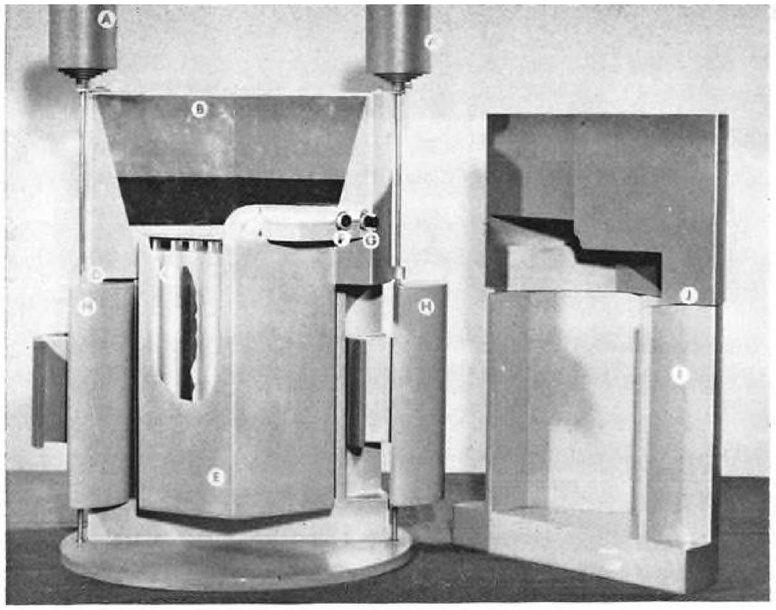
The remarkable characteristics of Styroflex® cable not only meet these rigid specifications but also have extra operational advantages, including long operating life under severe conditions and stable electrical properties during wide temperature variations.

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SNAP Nuclear Power System Model Details

Full scale model of SNAP small nuclear power system experimental reactor (AW Nov. 23, p. 35) has portion of reflector (I) and shielding (J) removed at right above. Model is 14 in. in diameter and 18 in. high. Cylindrical fuel elements (C) are contained in hexagonal core vessel (E). Liquid metal coolant is passed through inlet pipe (F) and outlet pipe (G). Two control drums (H) are segments of reflector (D) and are operated by control drive motors (A). Shielding (B) is at top of core vessel. System weighs 220 lb.

Aerojet Develops Hydrogen Pump

Washington—A hydrogen pump that makes 500,000-lb. thrust hydrogen-fueled rocket engines feasible has been developed by Aerojet-General Corp. and used to fire an engine at thrusts "well above 100,000 lb.," according to the company. Most of the equipment used in the firings was flight weight hardware.

Thrusts as high as 10 million lb. eventually could be produced, according to Dr. John C. Moise, head of preliminary design at the company's liquid rocket plant in Sacramento, Calif.

Moise said the large hydrogen pump was the last breakthrough needed for development of very high thrust rocket engines that could enable the U. S. to be ahead of Soviet Russia in space exploration in three years if industry were ordered to build them.

Only liquid hydrogen engine now being developed in the U. S. outside the nuclear engine program is the XLR 115-P-1, rated at 15,000 lb. thrust, which Pratt & Whitney Division of United Aircraft Corp. now has in the static firing stage for NASA's Centaur vehicle.

Aerojet has almost completed work begun in 1958 under a USAF contract to study feasibility of firing hydrogen engines to and above 100,000 lb. It has been developing pumps and other components for comparable thrust ranges on company funds and estimates it has invested $450,000 in facilities and development work for hydrogen engines.

Aerojet recently briefed NASA and Defense Department on a concept for large liquid rocket design that it reportedly believes could bring development of engines in the 1 to 20 million lb. thrust range in about half the usual time and with savings of 20 to 40% for development through first flight test. It is not known whether this concept, which the company calls Project Cosmos, is applicable to liquid engines using hydrogen as a fuel, but presumably it would be.

Some Aerojet officials believe that a 500,000-lb. single chamber hydrogen engine could be developed in about three and one-half years and that a smaller engine—which could be clustered to make a total thrust of 500,000 lb. or more—could be developed in two and one-half years for about half the development cost of the 500,000 lb. single chamber version.

WADD Organization

Washington—Wright Air Development Center's new group designated the Wright Air Development Division (AW Nov. 16, p. 26) will have a nucleus of civilian and military personnel that is expected to grow to a force of between 100 and 125 technical staff members. Three projects have been assigned initially to the group for its engineering development cognizance—the Douglas GAM-87A air-launched ballistic missile, North American B-70 Mach 3 bomber and the Boeing/Martin Dyna-Soar.

News Digest

Trans World Airlines Lockheed 1049H all-cargo Constellation crashed last week in a heavily settled residential area two blocks from the southeast corner of Chicago's Midway Airport while making an emergency landing 6 min. after receiving takeoff clearance. Crew of three and at least eight residents of the area were killed. Plane returned for landing after Capt. Claude W. Helwig told the tower he had a fire warning on the number two engine.

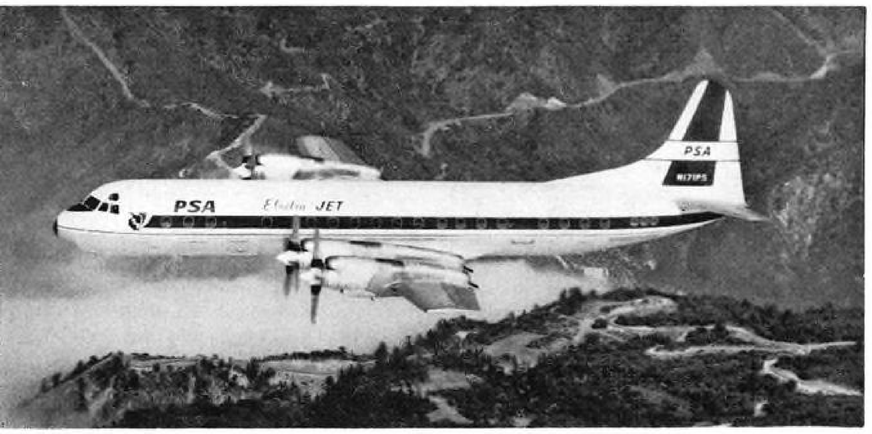
Radioplane Division of Northrop Corp. is being awarded a contract exceeding $7.5 million by the Los Angeles Army Ordnance District for RP-76 solid propellant rocket target drones. Order probably will cover 400 of the targets, which have a speed of about Mach .94 at 60,000 ft. Contract will include flight services such as launch, flight control, tracking, maintenance and repair. Deliveries are scheduled to begin in January. Nike Ajax and Nike Hercules missiles will be fired against the target by the Army Air Defense Command from the McGregor Range, Fort Bliss, Tex.

Ansett-ANA, Australian airline, has ordered an additional Lockheed Electra turboprop transport for delivery in 1960. Order will increase the airline's Electra fleet to three.

Atomic Energy Commission has established an Aerospace Nuclear Safety Board consisting of AEC staff members. Board will consider safety problems associated with use of nuclear energy in space.

Chicago Helicopter Airways is ordering three additional Sikorsky S-61 twin-turbine 25-passenger helicopters for early 1961 service, bringing total order to six. Powerplants will be 1,250 shp. General Electric T58-8s. Price for each will be about $650,000, including engines.

Del Webb Construction Co., Phoenix, Ariz., will construct six million pound thrust stand at Edwards AFB, Calif. (AW Oct. 26, p. 35). Stand, designated 1-B, is scheduled to be completed in October, 1960.





FIRST of four Lockheed Electras operated on a lease arrangement by Pacific Southwest Airlines accommodates 92 passengers with lounge fitted for six more. At right, seated in the Electra's cockpit, is Kenneth G. Freidkin, Pacific Southwest's chief executive.

Hilton Leases Electras to Intra-State Line

Pacific Southwest signs 3½ year pact with Hilton subsidiary for four Electras, with purchase option.

By William S. Reed

San Diego—First all turbine-powered airline fleet in the U.S. will be operating in time to take Californians between this city, Los Angeles and San Francisco for the Christmas rush. Pacific Southwest Airlines, operating intra-state only, received the first of its four Lockheed Electras Nov. 10; two more are scheduled for delivery during the first week in December, and the fourth in May.

Thus, when the holiday season comes to a close, Pacific Southwest will have phased out its present fleet of four Douglas DC-4s and will have accomplished a complete re-equipment program.

Immediate question arising is how an airline with a four-plane fleet and a gross of about $3.5 million in 1958 can afford a re-equipment program involving more than $10 million. Answer is that Pacific Southwest has not purchased the Electras. Instead, the airline has entered into a leasing arrangement for both the aircraft and the engines.

Kenneth G. Freidkin, president of Freidkin Aeronautics, Inc., of which Pacific Southwest Airlines is a division, has a leasing arrangement with Barron Hilton, under terms of which Hilton makes the purchase of the Electras.

Hilton, son of hotel tycoon Conrad Hilton, is the originator of the Hilton Carte Blanche credit card plan. He set up Electra-Hilt Corp. specifically to lease the planes to Pacific Southwest.

Pacific Southwest will lease the aircraft from Hilton's corporation for about $32,000 per month per aircraft. Duration of the lease is 3½ years at the expiration of which Pacific Southwest can exercise an option to buy the equipment. Providing the option on the fourth Electra is exercised, Pacific Southwest will pay Hilton about $5.4 million over the 3½ year period for four aircraft.

With the addition of the fourth Electra in May, 1960, Pacific Southwest will have increased available seating capacity from 280 seats in four 70-seat Douglas DC-4s, to 392 in four 98-seat Electras, a 40% increase. Also, Electras nearly halve the flying time of the DC-4, 20 min. between San Diego and Los Angeles, versus 40 min. for the DC-4, and 55 min. between Los Angeles and San Francisco, versus 1 hr. 40 min. in the DC-4.

Further conservation of capital has been realized by entering into a lease arrangement with Allison Division of General Motors for the Electra turboprop engines. Pacific Southwest's assistant to the president, J. Floyd Andrews, said that the airline will maintain five quick engine change packages on hand. Andrews also said that replacements for scheduled engine overhauls will be started from the Allison factory in time to reach Pacific Southwest's San Diego maintenance base prior to the actual removal time. The five spares kept on hand will be used for unscheduled engine removals.

One fact emerges in considering Pacific Southwest's re-equipment program: Hilton must figure that Freidkin Aeronautics and Pacific Southwest are in the airline business to stay or such a lease arrangement would not be possible. Andrews told AVIATION WEEK that the main reasons for Pacific Southwest's continued growth are:

- **Fare structure** which averages 20% less than the competition.
- **Frequency of service** which is increased during heavy holiday demands and operates during hours of highest traffic density.
- **Elimination** of all superfluous paperwork.
- **High morale** among company employes including flight crews, station personnel and maintenance workers.

Pacific Southwest is an all-coach airline. Starting with a leased DC-3 in May, 1949, the airline operated a total of four DC-3s in a 31-seat configuration. In November, 1952, 70-seat DC-4s purchased surplus from Capital Airlines were put into service. Lockheed Electras with which Pacific Southwest is re-equiping are in a 98-seat configuration. Main reason Pacific Southwest can remain competitive with United Air Lines and Western Air Lines, operating on the same routes, is that its fare averages 20% below the Civil Aeronautics Board regulated fare. For example, United and Western charge $14.96 round trip coach fare between Los Angeles-San Diego, versus $12 for Pacific Southwest. Similarly, Los Angeles-San Francisco cost $33.11 against $25 and San Francisco-San Diego is $45.87 as compared with $37.98 for Pacific Southwest. All fares quoted here are inclusive of 10% federal tax.

Andrews says strict conformance is demanded of Pacific Southwest by Federal Aviation Agency in regard to safety regulations, maintenance of aircraft, etc. The airline also must conform to CAB regulations pertaining to safety of operation of passenger-carrying aircraft. But since Pacific Southwest operates intra-state only, and has no franchise to carry mail and receives no government subsidy, it is not bound by CAB economic regulations.

Extra cost items such as meals are not a part of Pacific Southwest service, another reason for the lower fare. Since the longest flight stage is 1 hr. 40 min., meals en route are not considered necessary. Coffee or orange juice generally is available on most flights and the early morning departures feature a continental breakfast consisting of orange juice, coffee and pastry.

Andrews is reluctant to discuss load factors primarily because he does not think load factors are a good yardstick for measuring the economics of the operation. (Freidkin considers 60% his breakeven point and Pacific Southwest runs consistently above 70%.) One example Andrews uses to show why he is against load factor figures is this: cutting 10 seats from the 70-seat DC-4s would have increased the load factor but would certainly not have increased the amount of revenue per flight. He says Pacific Southwest averages 100 flights per week between San Diego and San Francisco and expects to carry nearly 350,000 passengers in 1959. The airline flew 98,029,315 passenger miles in 1958 and expects to fly more than 101,320,000 passenger miles this year. Judging by the expected increase in passengers carried in 1959, the 1958 gross income of $3.5 million should exceed $4 million in 1959.

Credit Cards

Pacific Southwest also is in the swing with the increasingly popular credit card field. In addition to honoring Hilton Carte Blanche (AW Oct. 26, p. 39), the airline issues its own credit cards.

Schedules are built around demand and since schedules are not subject to CAB regulation, they may be changed to cope with foreseeable fluctuations during holidays or during certain seasonal trends. Although the normal schedule calls for slightly more than 100 round trips between San Francisco and San Diego weekly, holiday schedules reflect an all-out effort to accommodate passengers. Normal number of flights from Wednesday through Sunday is 60 round trips between San Diego-San Francisco. However, during the recent Thanksgiving holiday, from Wednesday to Sunday, 140 flights were scheduled. The no-mail, no-subsidy type operation makes schedule flexibility possible. Pacific Southwest publishes four separate schedules per year plus eight additional holiday schedules.

Normally, three aircraft are utilized during the week with all four aircraft operating on the heavier weekend schedules. Total flying time for the four DC-4s was about 9,950 hr. in 1958, for an average daily utilization of 7.1 hr. Andrews estimates that the airline will fly nearly 12,000 hr. this year for an average daily utilization of 8.2 hr. unless the Electra phase-in causes a significant change. In addition to regularly scheduled passenger runs, Pacific Southwest operates from two or three charter flights per month.

Aircraft Use

Such frequency of service is possible because the airline flies at peak traffic times and performs all maintenance at San Diego. Except for rare holiday instances, three of the four aircraft will lay over in San Diego each night. One aircraft always remains overnight in San Francisco ready for an early morning takeoff on a southbound flight. All maintenance on airframes and engines is done by Freidkin Aeronautics, which also handles contract overhaul work on engines for other airlines.

The maintenance setup is one of the more important aspects in the economy of Pacific Southwest's operation.

One more personalized touch to scheduling is reflected by Pacific Southwest's slogan, "The World's Friendliest Airline." Frequently, when a sizable number of passengers are waiting at the gate to board the aircraft several minutes before departure time, it is customary for airline personnel to allow the passengers to enter the aircraft, select a seat, get comfortable and be served with a cup of coffee.

It is not uncommon, also, to find the pilot standing at the foot of the boarding stairs to greet the passengers with a smile and a nod as they file into the aircraft.

One other touch which Pacific Southwest feels is important in passenger relations is the commentary by the pilot informing passengers of some of the "mysteries of flight." On occasion, if weather and traffic permit, aircraft approaching to land at Lockheed Aircraft Terminal in Burbank make a ground controlled approach and have the GCA operator's instructions piped into the cabin. This is always done during VFR weather and with the cognizance of GCA and tower operator personnel to avoid unnecessary alarm to passengers should an emergency occur in the area. Pacific Southwest's management insists on debunking myths surrounding the complexity of flight and insists that the door from cabin to cockpit be open when the passengers board the aircraft.

Ticketing Simple

Buying a ticket is like buying a theatre ticket or a bus ticket. Only one small card-size piece of paper is issued for each ticket sold and this is collected by the stewardess en route. Additional copies are not necessary for government reports or to establish the number of meals boarded. Simplicity of this kind of ticketing procedure makes for simple bookkeeping operations.

Similarly, extensive weight and balance forms need not be filled out for each flight since the fuel load of the aircraft and the baggage and passenger weight generally varies little from flight to flight. It is only necessary for the crew to establish that the passenger load is properly distributed so that the center of gravity comes within limits of the mean aerodynamic chord of the aircraft.

Flight plans and departure times also are so similar from day to day that their execution is worked out with a minimum of effort and computation. With each succeeding addition to the fleet or change in equipment. Freidkin has sought to cut down overhead costs by eliminating paperwork.

One more method of cutting down on overhead was installation of a company-owned printing plant. With this plant, the airline prints its own tickets, schedules, brochures, payroll checks, newsletters, etc.

Employe Morale

Andrews claims another reason for Pacific Southwest's continued growth is high employment longevity. The hostess group averages approximately twice the longevity other airlines experience. One explanation is that most of the hostesses are residents of San Diego and are required to spend only one night in 11 away from home. Marriage is historically the main reason for the short term of employment of airline hostesses. But exclusive survey by AVIATION WEEK reveals that a lack of marriage offers is obviously not a factor in the relatively long employment time of Pacific Southwest hostesses.

Spending the one night in 11 away from home also is attractive to the rest of Pacific Southwest's flight crews. Although wages are comparable with the rest of the industry, as are other fringe benefits, flight crews are not members of the Air Line Pilots Assn. or the Flight Engineers International Assn.

Employes number 220 of whom 57

are flight crews; 23 pilots, including a chief pilot, 23 stewardesses, including a chief stewardess, and 11 flight engineers. Station personnel number 12 or 13 each in San Diego, the same number in Los Angeles and Burbank, and approximately 26 in San Francisco. Management is quite proud of the fact that turnaround times in Los Angeles and Burbank run between 7 and 15 min. and approximately 20 min. in San Francisco, including refueling.

Another indication of the "World's Friendliest Airline" approach is a public relations gimmick which Pacific Southwest employs occasionally. During the summer, small groups of 10 to 12 school children are brought to the airport and taken on a conducted tour through the hangar and operations facilities at Lindbergh Field. The tour usually is concluded with a taxi-ride in an airplane and a running commentary by a pilot explaining the functions of the various controls in a cockpit.

Flying School

Freidkin started in the managerial end of aviation in the immediate pre-war years when he ran a flying school in Bakersfield to train American volunteers for the Royal Air Force. When the U. S. entered World War II, he set up and ran a flying-training school for Womens' Air Force Service Pilots (WASPs) in Sweetwater, Tex. The close of World War II found him flying for Con Airways—a contract airline run by Consolidated Vultee for the military. He founded Freidkin Aeronautics, Inc., in 1948 and commenced charter passenger service with a converted Cessna UC-78. Scheduled airline service was started in May, 1949, with a leased DC-3.

Freidkin nearly converted his airline fleet to the French Sud Caravelle jet transport. Approximately three years ago, Pacific Southwest executives, after having been favorably impressed by the Caravelle during demonstration rides, negotiated with the French government for the purchase of three aircraft. Andrews reports that the initial negotiations were plagued by language problems and difficulties concerned with obtaining the 92-seat configuration Pacific Southwest wanted.

Even though these barriers existed, negotiations were pursued because of Republic Aviation's announced intention of building the Caravelle in this country. Andrews emphasizes that the Electra was not a second choice since the negotiation for the Caravelle occurred before the Electra was available. He said that negotiations for the Caravelle were discontinued because "we couldn't work out a mutually satisfactory arrangement with French authorities."

As for expansion, Pacific Southwest has no immediate plans for increasing the number of route miles. It is possible, Andrews reports, that the airline may commence service into Oakland in about two years but at present there is sufficient traffic on its present routes to keep it busy. If and when a decision is made to expand service, there will be no need for a long, hard-fought route case because no certificate of necessity is required. All that need be demonstrated to the CAB is that the airline is capable of conducting the service in accordance with prescribed safety standards.

Allegheny Planning Mixed Fleet; To Convert Convairs to Turboprop

Washington—Allegheny Airlines will lay the ground work for a combined Convair 340-540 transport operation by purchasing 11 Convair 340s from Lockheed Aircraft Corp.

Allegheny will convert four of the 11 Convair 340s to the 540 turboprop configuration with Napier Eland powerplants under an agreement recently signed with Napier Engines, Inc. (AW Nov. 16, p. 42).

These four aircraft were turned in on Lockheed Electra turboprops by National Airlines.

With the Convair 540 Allegheny is currently leasing from Napier, these four converted Convairs will give the carrier five 540 turboprop transports and seven piston-engine Convair 340s by the end of 1960. Airline also has an option with Napier which could provide the carrier with 10 additional 540s, bringing the Convair fleet to 22 aircraft. Allegheny's present fleet includes 13 Martin 202s and 10 Douglas DC-3s.

Aiming at an eventual all-Convair fleet, with piston-engine equipment on short stage lengths and turboprop equipment on longer segments, the airline is pushing the sale of its present aircraft and recently sold two Douglas DC-3s plus spares to William C. Wold Associates of New York at a reported price of $129,000.

Actual cost of the aircraft and financing details have not been released by the carrier, but Allegheny's cost study on the Convair 540 leased from Napier since last July has been predicated on an assumed cost of $900,000 per aircraft. Almost $600,000 of this figure represents conversion of the aircraft to Napier engines plus installation of airborne weather radar, integrated flight systems and automatic pilots and modification of the interior to a 52-passenger seating configuration. Addition of spare parts and auxiliary equipment could raise Allegheny's financing needs to between $10 and $12 million.

The airline has not filed an application with the Civil Aeronautics Board for Guaranteed Loan Act backing and will probably meet its purchase costs through private financing.

Allegheny has not decided who will do the conversion work on the four 540s, but tentative schedules call for the first aircraft to enter the conversion cycle by Dec. 15 for completion by May 1, the second to be in the shop from Mar. 15 through June 1, and the balance to average two-three months in conversion.

Lease Payments

Allegheny's decision to make the Convair 540 the backbone of its turbine-powered fleet follows the company's success with a three month lease of a Napier-owned 540, which has since been extended through the end of December to provide a full six-month experiment (AW Oct. 5, p. 41). Airline's monthly lease payments apparently will be applied to the full purchase price of the Napier aircraft.

Steady decline in 540 direct operating expenses from $1.03 per plane mile in July to 94.5 cents in September, compared with Martin 202 costs of 91.2 cents and DC-3 costs of 61.5 cents per mile in September, has convinced Allegheny that the turbine-powered aircraft can be operated far below a conservative 82 cents per plane mile on stage lengths comparable to its present Philadelphia-Pittsburgh routing. Convair 540 load factor hit 55% on this route in July, then dropped considerably because of the steel strike, but it climbed back to 48% in October and is expected to go higher. The airline has indicated it will place a second 540 on this route by Jan. 15 with a five-to-seven hour daily utilization.

Revenue Record

During September, the 540 earned $57,511 on 33,775 revenue plane miles to produce operating revenues of $1.70 per plane mile, compared with $1.72 for the Martin 202 and $1.24 for the DC-3. The 540 yielded an average revenue per passenger of $19.98 in the month, compared with $13.69 for the Martin and $10.36 for the DC-3.

Price spread between a new Convair 540 at $1.4 million and a converted aircraft at an estimated $900,000 price tag, plus the turboprop's 900-mi. flight range, probably have been the major deciding factors in the Allegheny choice. Depreciation costs on a converted aircraft are 13 cents per plane mile and insurance costs an additional 3.5 cents per mile lower less than for a new aircraft, while the maintenance expense would be little more than one cent per plane mile higher for the Napier-converted plane than for a new aircraft.

Full payload range of the Convair 540, which can fly 500-mi. stage lengths before refueling, permits significant savings by permitting a choice of refueling stops on the Allegheny system where aviation fuel prices vary from a low of 18 cents per gallon at Newark, N. J., to a high of 39 cents per gallon at Wilkes Barre, Pa.

Combination Convair 340 and 540 fleet also would permit the carrier to expand 540 service to hoped-for Pittsburgh-Buffalo and Pittsburgh-Washington routes now pending before the CAB. Piston-engine equipment would be placed on such routes as Cleveland-Detroit, which the airline hopes will be granted by the Board. Stage length on this route is only 92 mi., and Allegheny feels the heavy traffic between the cities would be ideal for a "shuttle" type operation at a fare within 50 cents of existing bus fares.

Durfee Says Proposed Standards Would Crimp CAB, Boost Backlog

By Katherine Johnsen

Washington—Outgoing Civil Aeronautics Board Chairman James R. Durfee told a Senate Judiciary Subcommittee that procedural requirements which slow down CAB actions to a snail's pace are "a cancer that can destroy the regulatory process if not promptly corrected."

Durfee, who is scheduled to be appointed to a federal judgeship, asked the subcommittee headed by Sen. John Carroll (D.-Colo.) not to further hamper Board machinery with additional procedural requirements in the name of ethics. The subcommittee is considering legislation designed to raise the ethical standards of quasi-judicial regulatory agencies.

Durfee added that "ways and means must be found to expedite the handling of the Board's workload. . .I am sure the solution does not lie in the dissection and dismemberment of the independent regulatory agencies. . ."

Expanding Backlog

Although the Board has devised ways to accelerate the processing of cases, Durfee said it is still falling farther and farther behind in its workload because of the constantly increasing influx of new cases coming from an expanding industry. He told the subcommittee:

"We are turning out more cases, I think we have increased our efficiency in the area of disposing of the work backlog. But . . . in the tremendous expansion of this industry . . . we are finding that the new cases which are coming in in every conceivable area of regulation by the Board are increasing faster than we are able to keep apace."

Durfee was adamant against proposed legislation backed by the American Bar Assn. that would convert CAB and other regulatory agencies into courts of law and establish the same partition between the Board and industry as there now is between judge and court litigants. He termed the legislation "a judicialization of the regulatory agencies . . . which would take the 'quasi' out of their functions . . . and which would incur delays which are inconsistent with the public interest and cannot be tolerated." He added:

"Congress must choose between a greater emphasis of rigid courtlike procedures or flexible, but expeditious procedures which will permit the prompt dispatch of agency functions with a minimum of delay. The Board is very much concerned over the growing emphasis today on the . . . strict due-process procedure rather than the lack of emphasis on efficiency."

Durfee expressed confidence in the basic organization of CAB, recently challenged by Louis J. Hector in his letter of resignation as a Board member to President Eisenhower (AW Sept. 21 p. 36). After presenting statistics on the growth of air transportation since the establishment of CAB in 1938, Durfee said:

"Surely, progress such as this is tangible evidence that the CAB has been competent and is competent to regulate this vital national industry. . . . The governmental policies, which have played a large and indispensable role in the development of the air transport industry, have been evolved just as Congress intended them to be—under flexible statutory standards . . ."

During his service as CAB chairman since 1956, Durfee said CAB's fairness —its "due process procedure"—has been challenged "in only one case." The statement apparently referred to the Hector letter. He also said that in all of the 81 cases the Board has submitted to the White House during his tenure, the President has affirmed the Board's decision. Responding to a question by Sen. Philip Hart (D.-Mich.), Durfee said he did not know whether there is any communication on behalf of airlines after a case has been turned over to the White House by the Board.

Durfee discounted current criticism that regulatory agencies are operating without proper congressional surveillance in the public interest. In the last congressional session, he pointed out, "I testified 15 times before nine different committees. The committees of this Congress have certainly been duly vigilant in requiring the Board to report to it."

Durfee's Stand

On the specific legislative proposals pending before the Carroll Subcommittee, Durfee:

- **Opposed a requirement** that "all" adjudications be placed on the record after an opportunity for hearings, although a hearing is not presently required. "In the areas of transatlantic and foreign off-route charters and foreign aircraft permits alone, the Board handles approximately 700 applications a year," he said. "A requirement that these non-hearing adjudications be decided only after notice and hearing upon the basis of a record would necessitate a considerable number of additional personnel and would seriously and needlessly delay Board actions."
- **Endorsed legislation** that would impose criminal penalties for violations of the Code of Ethics that the Board has established. "While the Board believes that its rules and regulations constitute a reasonably adequate code of ethics, we recognize a deficiency in these rules which could be remedied by appropriate legislation" establishing legal penalties for violations, Durfee testified.
- **Opposed additional restrictions** on Board relations with industry which would go beyond the present Code of Ethics. Durfee objected that a proposal that all oral and written communi-

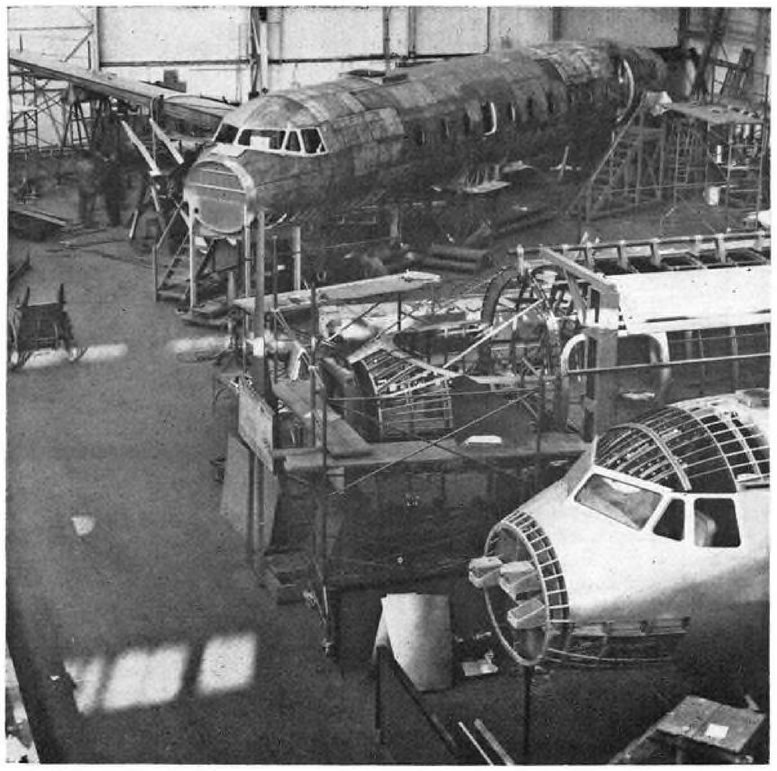
TWA Transatlantic Jets

New York—Trans World Airlines last week inaugurated transatlantic jet service with its Boeing 707-320 Intercontinental transports, which will provide an initial three weekly schedules from New York to London and on to Frankfurt. Service from New York to Paris and Rome will be added Dec. 3 with three weekly round trip schedules. Frequencies will be increased with daily service to the four European cities expected by Jan. 23.

The Nov. 23 inaugural flight made the nonstop crossing to London in 6 hr. 10 min., carrying 96 passengers. Configuration is 32 de luxe and 102 economy seats. TWA's 707-320 fleet now totals three airplanes, with deliveries of nine more to be completed early next year.

The airline's transatlantic jets connect at New York with its domestic jet services, which now provide daily 707-120 schedules to 11 cities.

cations in a case be circulated to all parties to the case would be "a substantial burden, particularly in route cases where there are a large number of parties in the proceeding." In the case of an oral presentation by an industry representative to a Board member, Durfee said, "the person making the oral presentation would not have an opportunity to see the written memorandum until after it had been circulated to the parties to the proceeding. If it were then contended that the memorandum did not properly reflect the oral conversation, fair play would require that an opportunity be given to correct the record since a criminal penalty would be involved. . . ." He said the requirement to circulate all communications to interested parties would have "a salutary effect" but "there would be a tremendous burden upon us until the effect is achieved."



Avro 748 Prototype Construction Advances

First prototype of Avro 748 turboprop transport has been soundproofed and aircraft systems are almost completely installed. Second fuselage, in front of first, is being built up in its jig. Nose of mockup is in foreground. Wing leading edges and engine mountings for the first prototype are nearing completion. Manufacture of other components has been distributed among members of the Hawker Siddeley Group: ailerons, Hawker Aircraft, Ltd.; tail units, Armstrong Whitworth; pilot seats and fuselage cones, Folland Aircraft; fuselage details and subassemblies, Gloster Aircraft. This work is on schedule, A. V. Roe reports. Second fuselage will be used for structural testing and is expected to be ready for installation in a water tank at Woodford, England, before the end of December. Powerplants are two Rolls-Royce Dart Mk. 514 turboprops (AW Sept. 14, p. 74).

Radiation Hazards Pose Little Jet Danger

Washington—Radioactive contamination of jet aircraft arising from nuclear weapons testing poses no significant danger to either crew or passengers.

Heaviest exposure rates, also believed to be relatively harmless, are being experienced by ground maintenance personnel, according to radiation specialists of the U.S. Department of Health, Education and Welfare.

Current data, compiled on the basis of previous Atomic Energy Commission, Air Force and Federal Aviation Agency studies, combined with in-flight radiation tests by the Department of Health, Education and Welfare, show that interior cabin level radiation readings are seldom higher than those ordinarily found at ground level because of the protection afforded by the aircraft skin.

Tendency of radioactive particles to build up on the exterior of the airframes has produced significantly higher readings at various locations on the aircraft, including the interior of the engines but is considered high only in relation to cabin interior readings.

At the same time, exterior radioactivity levels on an airframe do not appear to build up indefinitely and have been observed to decrease, since February, at a rate faster than could be attributed to natural decay. Weather conditions, such as flying through rain, apparently assists this process, the Department said.

Possibility of readings reaching a hazardous level has been further reduced by airline jet operators, who are following a program of washing each jet airframe at periodic intervals with solvents. Actual toxicity of external contaminated areas is even less than the highest-readings—which are taken within one inch of the aircraft skin—would indicate, according to Health spokesmen, who say that readings of the same spot taken from one or more feet rapidly drop in intensity.

Highest external readings have been found on surfaces where the air undergoes any abrupt change in direction, such as vent and valve fitting connections where air makes a 90 deg. turn.

Airline Credit Plan To Cover Restaurants

Washington—Credit facilities of the airlines' Universal Air Travel Plan, recently revised to cover hotels, motels and car rental services, will soon be expanded to include restaurants throughout the world.

Since launching the credit expansion program last month (AW Oct. 12, p. 48), the Air Traffic Conference of America has arranged for the acceptance of the air travel card for personal credit privileges with more than 300 hotel and motel organizations and car rental chains. The conference is now establishing the mechanism to work out similar agreements with restaurants.

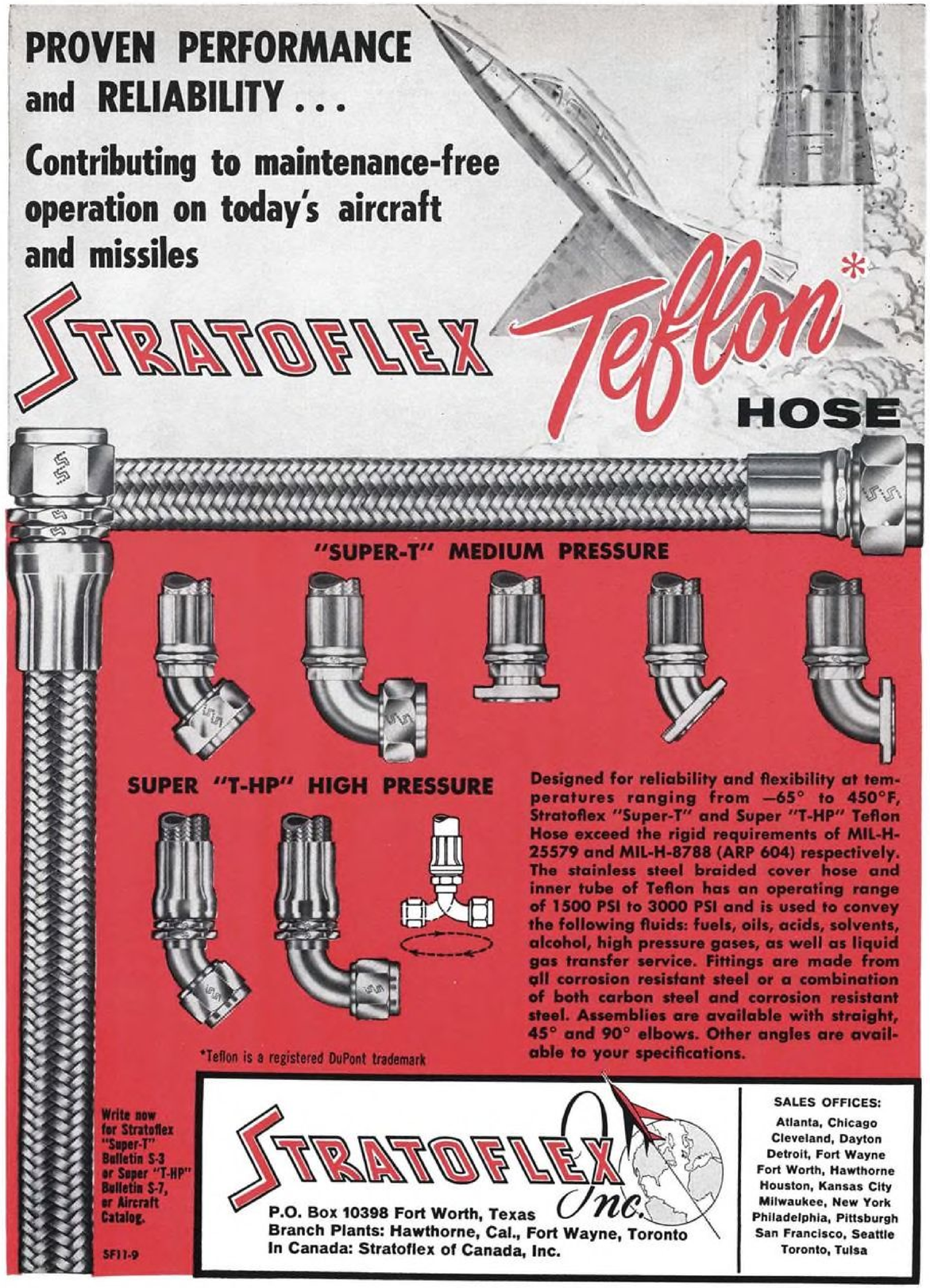
Other major moves endorsed by the conference—subject to approval by the Air Transport Assn. board of directors—during a three-day meeting in Seattle where the restaurant program was adopted include:

- **Expenditure of** $73,000 for a survey and operational analysis of interline reservation problems to be conducted by the Armour Research Foundation of the Illinois Institute of Technology.
- **Application of approximately** $150,000 to back an advertising program designed to expand the use of air parcel post.

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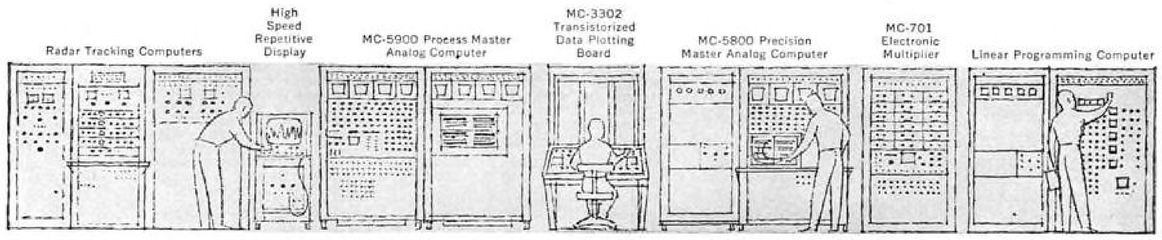


Airline Income & Expenses—September, 1959

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	31,716,487	655,543	384,157	2,186,471	.....	35,453,685	31,244,734	4,208,951
Braniff	4,994,800	135,242	58,885	197,928	51,625	5,528,041	5,127,974	337,181
Capital	8,765,214	201,085	143,555	155,395	15,936	9,415,030	8,829,050	585,980[3]
Continental	4,391,000	52,000	35,000	87,000	72,000	4,723,000	4,374,000	250,000
Delta	7,313,000	165,000	108,000	351,000	.....	8,121,000	7,963,000	198,000
Eastern	21,728,640	385,987	973,723[2]	.....	30,028	23,231,403	22,893,394	281,836
National	3,837,534	82,881	26,967	144,451	65,271	4,332,559	5,046,749	−786,405
Northeast	2,303,455	34,604	20,499	46,657	.....	2,460,054	3,127,165	−667,111
Northwest	6,942,351	180,300	586,232[2]	.....	11,744	7,774,443	7,141,578	562,878
Trans World	24,232,295	479,934	1,227,345[2]	.....	118,924	26,163,035	21,882,140	3,532,669
United	23,301,493	761,767	2,280,296[2]	.....	433,036	27,171,689	24,535,195	2,458,777
Western	5,276,928	101,722	38,000	95,030	14,943	5,593,687	4,458,240	1,246,468
INTERNATIONAL								
American	437,499	8,446	626	42,607	.....	518,705	566,825	−48,120
Braniff	609,926	13,220	.....	39,446	.....	707,143	727,919	−29,185
Caribbean Atlantic	191,238	2,369	8,933[2]	.....	40,428	245,043	214,404	30,586
Delta	437,000	4,000	.....	10,000	.....	470,000	451,000	17,000
Eastern	2,019,399	22,254	77,552[2]	.....	447,832	2,567,797	2,094,039	467,669
Mackey[1]	.....	.....	.....	.....	.....	.....	.....	.....
National	266,817	3,693	2,133	13,574	.....	294,469	310,121	−15,652
Northwest	2,282,102	581,673	455,059[2]	.....	−397	3,376,731	2,938,254	389,562
Pan American Combined	26,681,000	1,439,000	.....	3,208,000	1,129,000	33,398,000	30,643,000	2,400,000
Alaska	323,000	16,000	.....	41,000	.....	389,000	458,000	−71,000
Atlantic	14,269,000	668,000	.....	1,211,000	216,000	16,688,000	13,142,000	3,486,000
Latin American	6,165,000	194,000	.....	1,125,000	220,000	8,012,000	9,258,000	−1,243,000
Pacific	5,924,000	561,000	.....	831,000	693,000	8,309,000	7,781,000	508,000
Panagra	1,263,000	46,000	.....	185,000	13,000	1,665,000	1,734,000	−78,000
Resort	.....	.....	.....	.....	203,554[4]	210,837	259,788	−48,951[3]
Trans-Caribbean	314,407	.....	74,070[2]	.....	.....	445,914	490,800	−66,371
Trans World	6,417,954	445,460	446,242[2]	.....	1,348,403	8,908,003	8,020,647	863,458
United	1,430,744	41,234	23,853[2]	.....	.....	1,516,282	1,206,747	300,125
Western	393,855	8,606	.....	3,752	.....	410,878	339,091	66,802
LOCAL SERVICE								
Allegheny	707,571	7,906	11,836	23,406	2,754[4]	960,848	1,020,282	−59,434[3]
Bonanza	308,784	2,911	2,223	5,180	3,196	467,201	534,777	−85,514
Central	221,594	7,900	812	9,244	8,183	478,219	448,647	29,572[3]
Frontier	494,882	12,767	4,955	32,547	12,487	934,712	1,126,590	−206,889
Lake Central	247,964	5,043	10,626[2]	.....	733	411,358	388,237	23,120[3]
Mohawk	731,748	8,185	8,595	12,758	26,922	956,623	912,624	43,999[3]
North Central	1,117,534	27,995	22,000	21,080	31,022[4]	1,595,379	1,650,962	−55,853[3]
Ozark	635,840	288,810[5]	10,711	21,254	3,454	972,086	944,333	27,753[3]
Pacific[1]	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont[6]	650,995	8,520	6,782	11,059	35,875[4]	1,431,322	991,107	491,905
Southern	255,145	7,657	3,446	10,324	5,655	480,432	522,458	44,664
Trans-Texas	405,897	11,267	4,836	18,696	8,904	699,456	698,096	893
West Coast	496,582	8,672	3,179	9,538	.....	661,519	863,973	−202,454[3]
HAWAIIAN LINES								
Aloha	346,598	1,859	.....	4,990	288[4]	362,076	348,370	13,706[3]
Hawaiian	476,637	2,612	.....	69,712	1,799[4]	570,605	606,242	−54,345
CARGO LINES								
AAXICO[1]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana[1]	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	.....	12,519	1,423,581[2]	.....	1,394,118	2,832,175	2,494,590	270,717
Riddle	.....	.....	.....	426,076	.....	435,012	477,648	−42,636[3]
Seaboard & Western	.....	.....	.....	.....	.....	1,662,054	1,860,538	−198,484[3]
Slick	.....	.....	.....	.....	920,364	977,195	886,362	90,833[3]
HELICOPTER LINES								
Chicago Helicopter	138,285	146,854	.....	.....	.....	285,186	227,209	54,525
Los Angeles Airways	24,242	11,862	9,741[2]	.....	.....	121,065	113,461	4,134
New York Airways	76,413	3,363	1,041	1,460	.....	276,267	276,239	−1,855
ALASKA LINES								
Alaska Airlines	259,633	46,485	959	51,871	204,608	695,300	678,800	4,644
Alaska Coastal	88,027	9,523	.....	7,370	5,666	155,874	180,836	−24,962[3]
Cordova	17,856	12,545	.....	9,176	31,281	97,311	94,949	338
Ellis[1]	.....	.....	.....	.....	.....	.....	.....	.....
Northern Consolidated[1]	.....	.....	.....	.....	.....	.....	.....	.....
Pacific Northern	674,917	63,907	2,617	90,891	.....	985,173	907,714	63,941
Reeve Aleutian	126,452	36,166	.....	41,638[7]	19,426	234,511	194,851	186,236
Wien Alaska[1]	.....	.....	.....	.....	.....	.....	.....	.....

[1] Not available. [2] Property figure. [3] Net operating income. [4] Non-scheduled transportation. [5] Includes Federal subsidy.
[6] Airline division figures. [7] Freight & excess baggage.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.



Some people can prove man and mouse are identical

It's all according to the points of similarity you choose. *Differences* are what really *prove* the superiority of man over mouse. Computers have differences, too. In fact, it's in these differences that the CSI-designed MC-5800 obsoletes every other Analog Computer. The best proof lies in

cold
hard
Specifications

- Exclusive dynamic memory makes automatic iterative solution of statistical or optimization problems a reality.
- Stable amplifier operation over the entire feed-back range fr zero to infinity.
- Lowest amplifier grid-current $<10^{-9}$ ampere.
- Amplifiers provide lowest noise level output—less than one millivolt at unity gain.
- Amplifier frequency response—flat to 10,000 cps and only 3 db down at 28 kc.
- Real-time precision @ speeds to 60 solutions/sec.
- Exclusive electronic generators of the function of two-or-more variables may be programmed at patch-board in same time required for setup of single-variable generators.
- Will program 134 amplifiers, 30 electronic multipliers, 18 diode function generators, 2 time-delay generators, 8 relay amplifiers, and 6 servos from one 2128-hole patchboard.
- Highest performance electronic multiplier—flat to 10,000 cps and only 3 db down at 20 kc.
- Dynamic memory + high-speed quick-reset rep-op provide practical approach to solution of simultaneous partial differential equations.
- Dynamic memory with time-base accuracy of ± 10 μsec provides automatic parameter searching by iteration—an exclusive capability.
- Solution of problems with up to 15 amplifiers in closed loops.
- Plug-in dynamic components ease maintenance.
- Lowest computer cross-talk—rejection greater than 2,000 to 1.
- Selection of real-time, expanded-time or high-speed compressed-time without reprogramming.
- Passive networks stabilized at $<$ 1°C above room ambient—no oven required.
- EVERY SPECIFICATION IS GUARANTEED TO BE TRUE PERFORMANCE STANDARD—IN SUSTAINED OPERATION.
- Only diode function generators utilizing resistors, potentiometers, and diodes of equal quality to those in computing networks.
- Only diode function generators with individual hi-lo gain positions for *each* segment.
- Lowest function generator drift $<$ 5 mv/8 hrs.
- Lowest servo step-function overshoot—less than 1%.
- DC tachometer feedback on all servos.
- Complete control of all amplifiers, multipliers, dividers, and non-linear equipment at patchboard.
- Exclusive equipment-door packaging for free access and quick maintenance *without* shutdown.
- Insulated patchboard prevents costly shorting accidents.
- Power supplies eliminated from console—lowest, most stable operating temperatures—rise $<$ 3°C.
- Field expandable without mechanical rework or rewiring.

There are many more differences (over a hundred, in fact). Before you buy or lease your next analog computer, compare them all... and we think you'll agree with us when we say: The MC-5800 obsoletes every other analog computer made.

Computer Systems, Inc.—designers and manufacturers of the *highest* precision analog computers and computer accessories.

MAN IS A MOUSE



COMPUTER SYSTEMS, INC., 611 BROADWAY, NEW YORK 12, N. Y. • SP 7-4016
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SHORTLINES

► **Civil Aeronautics Board** held a hearing Nov. 20 on the application by British Overseas Airways Corp. for authority to operate a polar route between London and Los Angeles, and final CAB action is expected within a month. Polar route for a British airline is provided for in the U.S.-British bilateral.

► **Delta Air Lines** has taken delivery of its sixth and final Douglas DC-8 turbojet transport. The aircraft, powered by Pratt & Whitney JT3 engines, was the 14th delivered by Douglas Aircraft Co. and the 32nd off the assembly line.

► **Federal Aviation Agency** is installing a system of pancake runway lights protruding less than one-half inch above the surface pavement at the agency's Atlantic City, N. J., National Aviation Facilities Experimental Center. System will be tested as part of FAA's analysis of airport lighting requirements that has been under way at the center for the past six months. The lights were developed by FAA engineer Leslie C. Vipond and will be tested as runway centerline and narrow gage landing lights and as high-speed taxiway turnoff lights to guide pilots from the runway to taxiways. Lights were manufactured by Structural Concrete Products Corp. of New York and are being installed by Ole Hanses & Sons, Inc., Pleasantville, N. J.

► **Scandinavian Airlines System** reports it has flown more than 92,000 passengers 579,802,800 revenue passenger miles during the first five years of operation on the polar route between the U. S. West Coast and Europe. During the five year period, SAS carried a total of 4,623,310 lb. of cargo and mail over the route, and the carrier reports that during the 12 month period ending Nov. 15 it carried 1,101,169 lb. of cargo over the route. At the same time, SAS announced that when Douglas DC-8 airliners are introduced over the carrier's North Atlantic and polar routes, it will reduce air freight rates up to 80%. Beginning Apr. 1, 1960, and subject to individual government approval, the carrier will cut rates on minimum shipments of 1,100 lb. for some 20 types of products.

► **United Air Lines** will accelerate its transcontinental nonstop New York-San Francisco Douglas DC-8 service to two daily flights on Dec. 4. Also on Dec. 4, the airline will increase its Los Angeles-San Francisco nonstop DC-8 service from two to three daily flights.

AIRLINE OBSERVER

► United Air Lines and Western Air Lines common stock continues to show strength on the New York Stock Exchange in a market that has been actively fluctuating. TWA and Northwest Airlines listings have maintained a slight margin between the year's lows and current selling prices, but American, Braniff, Capital, Delta and Eastern prices are hovering close to their 1958 lows.

► **Odds against early adoption of a class mail rate formula for local service airlines (AW Nov. 23, p. 45) are rapidly increasing as a result of the recent shuffles in the five-member Civil Aeronautics Board. Until recently, chances that the plan would be approved by the Board no later than January were considered strong. However, chief supporter of the formula was Louis J. Hector, who resigned from the Board in September (AW Sept. 21, p. 36). Local service officials are now wondering if there is enough strength behind the plan within the CAB for its approval in view of the recent addition of two new members, Whitney Gillilland and Alan Boyd, who have not been close to the development of the formula. Most carriers feel the formula will create the earnings stability necessary to attract financing needed for new equipment.**

► Soviet Union has made its first successful breakthrough into the helicopter market outside the Soviet bloc with the sale of a Mil Mi-4 helicopter to an Austrian-Swiss hotel syndicate at a cost of $250,000. Price includes two sets of spare parts, plus crew training and technical support. Syndicate hopes to begin service this winter to resorts in the Alps. Helicopter will carry 11 passengers per flight.

► **Railroads, currently cutting freight costs in an effort to move back into markets lost to trucking and shipping, also will ask Congress next year for authority to move into the air transport field. Railroads will push for removal of Federal Aviation Agency Act prohibition against common ownership of airlines by surface carriers.**

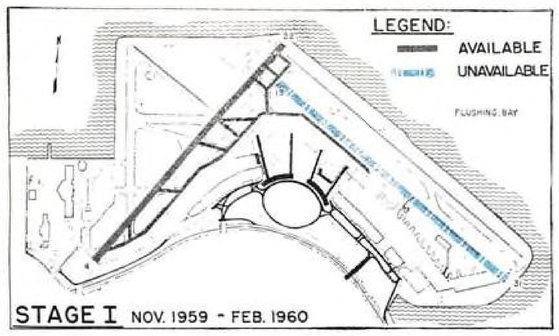
► Boeing Airplane Co. will establish a European pool store for Boeing 707 turbojet transport spares and parts at Paris' Orly International Airport to service carriers operating the 707s to and from Europe.

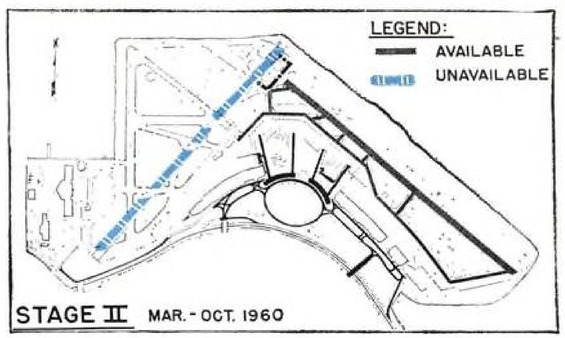
► **Russia claims that turbojet and turboprop equipment is now operating on 52 Aeroflot routes. New services include a Novosibirsk-Khabarovsk all-cargo run by An-10 turboprop transports carrying payloads in excess of 12 metric tons.**

► Real Aerovias, Brazilian airline, will operate a Rio de Janeiro-Los Angeles-Tokyo route next year when it takes delivery of the first of its four Convair 880 turbojet transports. Earlier this month the airline began its Rio de Janeiro-Mexico City-Los Angeles service with weekly flights using a Lockheed Super G Constellation. Under its bilateral agreement with Mexico, the airline is restricted to 43 passengers monthly in each direction between Mexico and Los Angeles.

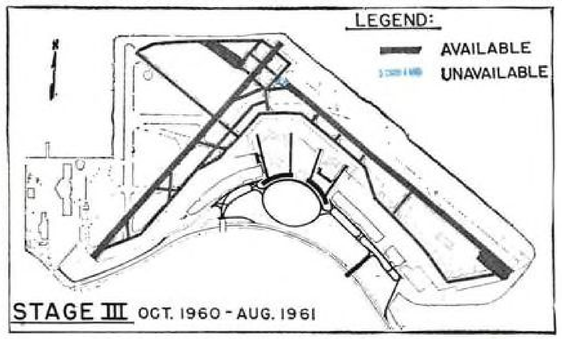
► **De Havilland Aircraft Co. negotiations with Misrair, Egyptian airline, on the sale of three Comet 4 turbojets to the carrier are still deadlocked after almost a year of discussion. Chief obstacle has been financing, but a new agreement between Egypt and Britain on Anglo-Egyptian trade may open the way for a contract.**

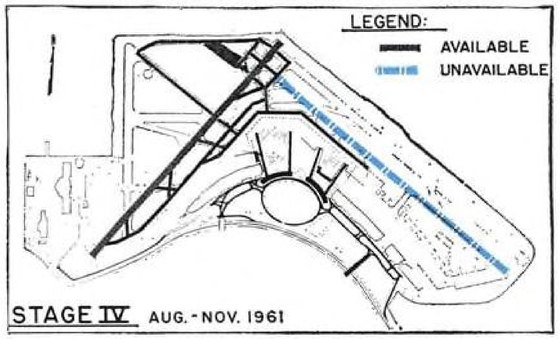
► Role of sales in airline management structure is taking on increasing importance as declining load factors on turbojet operations indicate that growing competition has brought year-long periods of prosperous high load factors on limited jet schedules to an end. Both Capital and Continental have substantially strengthened sales functions on management level. Americans' recent appointment of former sales vice president Marion Sadler to the position of vice president and general manager suggests the carrier intends to back its sales efforts with top management support.





REMODELING of LaGuardia Airport will involve three periods when one of its two runways is out of service. Runway 13-31 will be replaced by a new strip parallel to it and notheast toward Flushing Bay. Instrument Runway 4-22 will be rehabilitated. Terminal area shown here is represented as it will appear when new terminal building and fingers are constructed later in the rehabilitation program, not as it presently exists. During Stage III below, while both runways are operative, equipment and personnel working on the new 13-31 will be routed around the approach end of existing 31 with special ground control personnel directing this traffic to assure aircraft safety.





Remodeling Cuts LaGuardia Runway Use

By Glenn Garrison

New York—Airlines at overloaded LaGuardia Airport are in for some new operational headaches this winter as the Port of New York Authority's three-year, $56 million reconstruction program gets under way and the airport's two runways are alternately out of service.

Work on the first phase of the program—preparing the site for a new Runway 13-31—began this month and existing 13-31 will soon enter a three-month period of intermittent limited use and inactivity. In March, the construction schedule calls for closing Runway 4-22, the instrument strip, for rehabilitation over a seven-month period. Later in the program, 13-31 will be shut down again.

Razing of the old terminal and construction of a new one, construction of a new control tower, and major revamping of ramps, roadways and taxi strips can be expected to add some ground handling problems to the picture.

The six scheduled airlines using LaGuardia and the Port Authority reached tentative agreement on a smaller-scale rehabilitation in 1957 (AW June 24, 1957, p. 43), but it was only within the last few months that the exact details of the new program were agreed upon.

Airlines, Federal Aviation Agency and the Port Authority will work together to make the complicated project of running the airport and remodeling it at the same time as painless as possible, but all are agreed there may be some painful moments.

Through an Air Transport Assn. committee which has voluntarily restricted peak period schedules at LaGuarida for a number of years, the airlines have decided to cut back or shift to other airports a total of 90 scheduled flights, a sixth of the daily total at LaGuardia. But it may prove necessary to reschedule many more to compensate for the periods when LaGuardia will be a one-runway airport—particularly when the closed runway is the instrument strip and minimums go up. FAA Regional Administrator Joseph Blatt feels the planned traffic diversion so far is "token" and unless more radical action is taken, the public will suffer from diversions on an emergency basis.

ATA itself acknowledges that more schedules may have to be cut at LaGuardia and the problems may be worse than anticipated. All concerned are approaching the complex project with a "play it by ear" attitude.

Here is a breakdown of the rehabilitation schedule, subject to some change depending upon speed work progresses:

• **Stage I,** already begun, will run to February, 1960. During this period sand drains will be placed and fill laid for the new Runway 13-31, which will lie parallel to the existing runway and to the northeast, closer to Flushing Bay. Existing 13-31 was still in unlimited use as the program started and pile-driving crews began working northwest alongside the 31 end of the runway. When the piles reached a point 1,500 ft. from the approach end of 31, the runway was to be closed to landings at both ends but takeoffs will be permitted from 31. As the piles move up alongside the edge of 31, the usable runway threshold for takeoffs will follow 1,500 ft. behind. Reason: the 125-ft.-high piles do not represent a safety hazard at aircraft speeds attained during the first 1,500 ft. of takeoff roll. But the effect, of course, is to shorten the runway by increments as the piles move toward its center. At that point, the situation reverses and 13 becomes the restricted takeoff end. Thus Runway 13-31 will retain some limited use for takeoffs at low gross weights during part of the first stage of the program. But it will be closed entirely during this period, at various times, for other work. This work includes relocating the runway lights as existing 13-31 is reduced in width from 200 to 150 ft. By the end of the entire program, when the new 13-31 is in use, present 13-31 will have become a taxi strip 75 ft. wide.

• **Stage II,** from March to October, 1960, will include rehabilitation of Runway 4-22. It will be out of action during the entire period. During this time, the effective length of existing 13-31 will have been reduced from 6,000 ft. to 5,100 ft. at either end for takeoffs and 4,900 ft. at the 13 end for landings. This foreshortening is necessary because work will be going on at the intersection of 13 and 22. During this period, with the instrument runway out, circling minimums of 600 ft. and 1 mi. will apply.

• **Stage III,** October, 1960, to August, 1961. During this period rehabilitated Runway 4-22 will be back in operation and so will Runway 13-31, foreshortened and 150 ft. wide. Excess fill on the site of new Runway 13-31 will be removed and installation of paving and utilities for the strip will begin.

Second Shutdown

• **Stage IV,** August, 1961, to November, 1961, involves a second shutdown of existing 13-31 for completion of new 13-31 and installation of connecting taxiways. Old 13-31 now becomes a taxiway.

• **Stage V,** sometime in 1962, covers the completion of the project. New Runway 13-31 is 6,000 ft., as was the old runway, and 4-22 retains its 5,000-ft. length. Connecting taxiways, warm-up pads and high-speed turnoffs are operative, and the new passenger terminal is complete.

Airlines will adopt various makeshifts during the period of terminal razing and construction to handle their passengers. Temporary facilities will be built by the Port Authority. American Airlines, for example, expects work on its temporary passenger facility to begin immediately for Mar. 1, 1960, completion. It will be located in front of American's Hangar 3 at the airport, which is near the present terminal. Eastern Air Lines, for another example, will occupy temporary quarters already under construction outside its present gates in the terminal.

Because most temporary facilities will encroach on present ramp space, the New York Airways helicopter landing pad, now in this area, will be moved to a spot in front of the easterly hangars. There will be many other necessary adjustments during the terminal and ramp rehabilitation work. According to ATA, ramp activity at times will be seriously affected by rehabilitation and construction of the new finger buildings which will be part of the new, three-story passenger terminal. Sometimes ground movement of aircraft will be seriously hampered by unavailability of taxiways and it may be necessary to use such measures as one-way taxiing along the ramp area.

The runway closings were scheduled, according to the Port Authority, with community noise problems in mind and so 13-31, the preferred runway from this standpoint because it takes planes over water, will be in operation during the open-window spring and summer months next year. Additional traffic on 4-22 will be confined to the winter months of 1959-60, although it will be the single runway again from August to November in 1961.

According to Blatt, the schedule also is favorable from a traffic standpoint because wind conditions generally call for use of 4-22 during the winter months. Because it is the instrument runway, it is desirable to have it in operation during the winter when weather is worst.

In late spring, Blatt said, the prevailing wind shifts to the southeast when 13-31 will be back in use.

FAA's traffic control problems in connection with the rehabilitation program, Blatt said, will probably occur more often in handling the ground situation than in the air. Routing planes from ramp to taxiway, with some taxiways unavailable, will create headaches for the controllers.

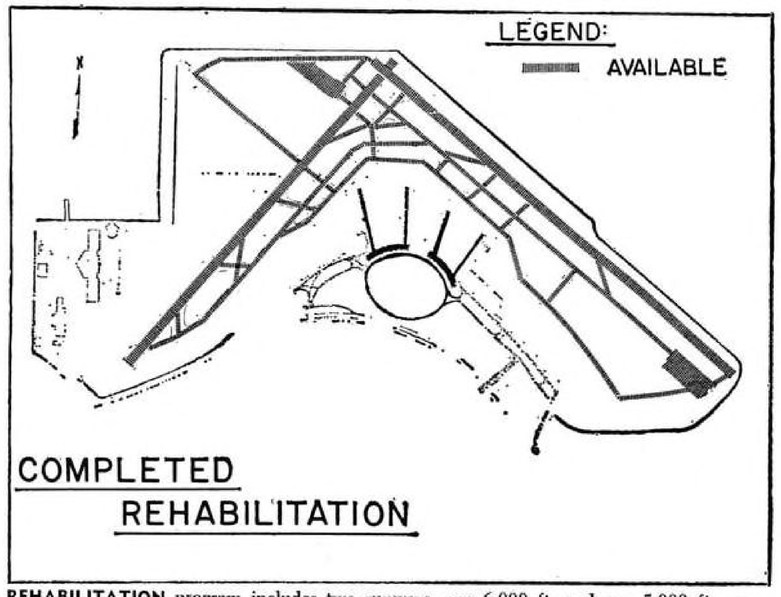
Idlewild and Newark air traffic control loads will be greater, of course, as the airports are required to handle more scheduled diversion of traffic and more spot diversions when LaGuardia is closed—and LaGuardia will be closed much more often while it is a one-runway airport. Blatt said the other airports could handle more scheduled diversions as far as traffic control is concerned. The over-all situation at LaGuardia, Blatt acknowledged, "is going to be impossible at times."

American Airlines' schedules will be most affected by the voluntary cutbacks and shifts. The airline now schedules 130 daily departures from LaGuardia, about 51% of the total passenger traffic. Under the scheduling committee agreement, 38 of American's daily flights (in and out) will be shifted from peak hours, with some of them diverted to the other airports.

Possible Delays

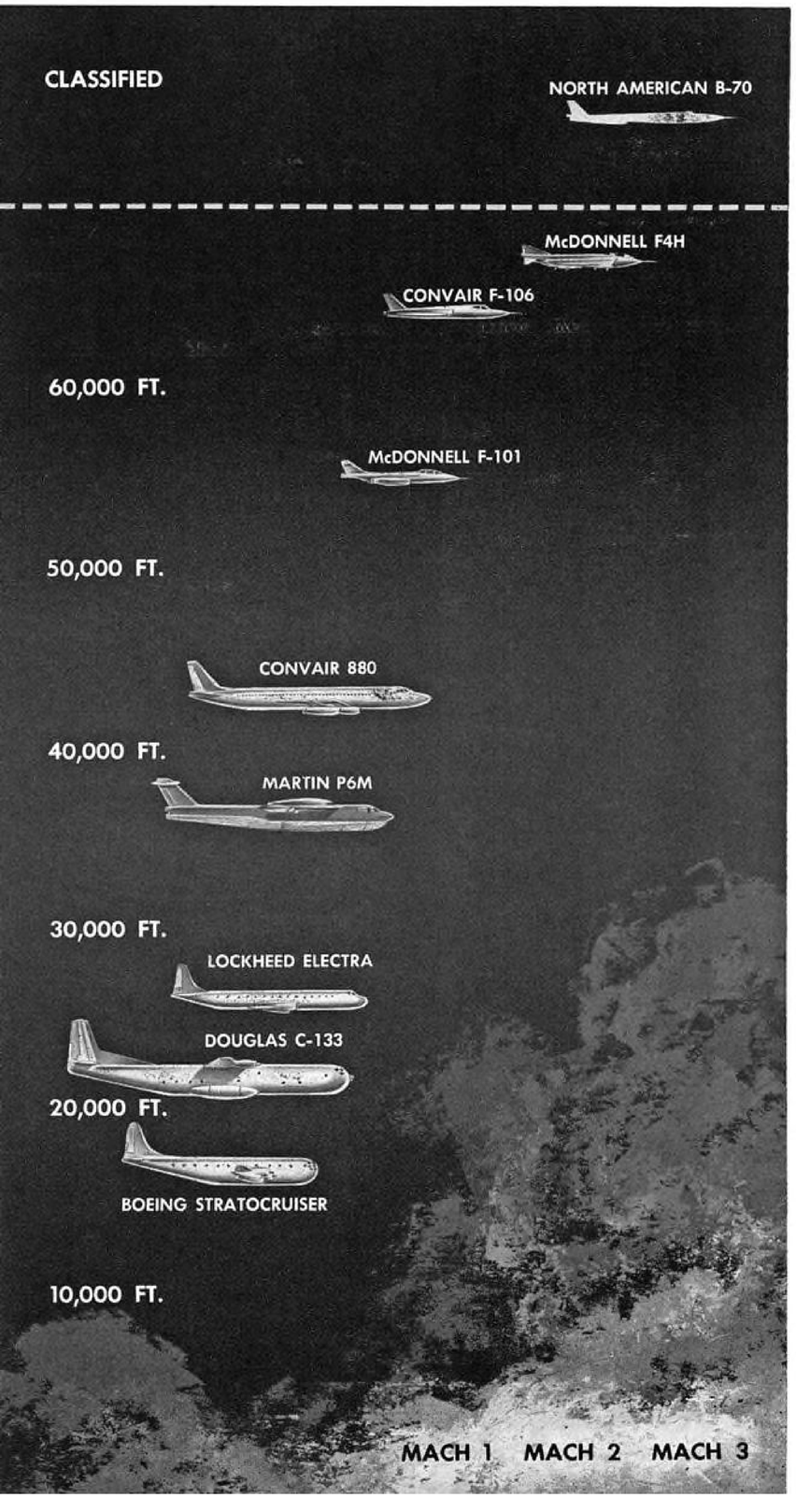
American says it now experiences an average time at Idlewild of 20 min. between ramp and takeoff position, partly because of traffic control delay and partly because of long taxi distances at the airport. With the scheduled diversions, delays may be longer. If it is necessary to shift more LaGuardia schedules, American will do so.

Northeast Airlines, as another example, will drop from 88 daily aircraft movements at LaGuardia to 76 beginning Dec. 1. The airline also will adjust scheduled times of 23 other flights. Its Viscount pattern to Boston and Washington will not be affected, but Douglas DC-3 service between New York and New England will be rearranged to funnel more traffic through Boston connections unstead of direct to New York. Northeast will not suffer much this winter by the adjustments, but expects more problems in the



REHABILITATION program includes two runways, one 6,000 ft. and one 5,000 ft.; new, three-story passenger terminal; and warm-up pads.

CONTINUED LEADERSHIP IN SECONDARY POWER EQUIPMENT



General generating

General Electric has been selected to supply the advanced-design secondary electrical power generating system for the North American B-70 Valkyrie, the Air Force's new MACH 3 multi-purpose bomber.* Designed for supersonic high-altitude operation with inherent long-range flight endurance and large load-carrying capability, the B-70 can be adapted to offense, defense, reconnaissance, or special airlift missions.

The new, specially designed G-E system consists of an Inductor-Lundell generator, controlled-rectifier regulator, and protective panel. The revolutionary generator, newly applied to aircraft systems, will provide extreme system reliability by eliminating normally required brushes, slip rings, commutators, rotating windings, and rotating rectifiers.

Development of this system for MACH 3 aircraft offers a challenge never before encountered in manned aircraft. New lubricating and insulating methods and new sturdy, compact construction are needed to stand flight stresses three times the speed of sound at altitudes previously unreached by operational aircraft.

Some equipment will be required to withstand temperatures of 600 F, vibration input of 15 g's (as much as 60 g's locally), and shock of 20 g's. Extreme reliability is, of course, a must.

In developing this equipment, General Electric is using experience and knowledge derived from the material and component development phase of a separate Air Force High-temperature (HOTELEC) Program under subcontract from North American Aviation. G.E.'s completely equipped research and manufacturing facilities are ideally suited to develop and produce advanced systems like HOTELEC and the B-70. And, G-E leadership in secondary power equipment extends through 40 years and more than 50 different aircraft.

*Sundstrand Aviation is manager of the B-70 secondary power system for North American Aviation, Inc.

Aircraft pictured represent only a few of those for which G.E. has developed secondary power-generating systems.

Electric's new concept in aircraft systems is awarded B-70 contract

Design Concept

Design innovations in the new G-E generating systems will provide outstanding results in these areas:

• **Reliability**—Key to the increased reliability of the G-E system, is the revolutionary Inductor-Lundell generator. Field windings and rectifiers will be located in the stator instead of the rotor as in conventional machines. Lower component temperatures result from shortening heat-transfer paths between windings and coolant.

In addition, all available control components—relays, transistors, magnetic amplifiers, controlled rectifiers, capacitors, and resistors—were fully evaluated as to performance and reliability. Then exhaustive research—speeded by computers—was conducted on individual circuits of each system to determine the combination of components which would provide maximum reliability and minimum weight for each particular application.

Electrical configuration—It is planned that the B-70 system will consist of four 60-kva generators in parallel for main and emergency power. Through careful system designing, there will be a precise integration of generators with necessary control, regulating, and protective components.

• **Light weight**—Unnecessary weight will be eliminated by (1) combining Inductor and Lundell generator principles, (2) utilizing the generator frame as flux path, (3) use of more efficient magnetic material in the frame, and (4) integrating bearing and cooling and lubricating systems with the Air Vehicle Sundstrand Drive.

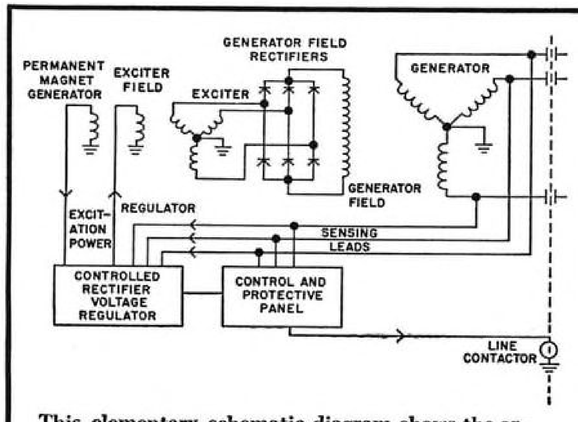
Weight also will be saved in another way. In analyzing the complete B-70 system, North American electrical engineers felt that the long feeder runs from generator to load offered an excellent opportunity to evaluate a variety of generator voltages, feeder sizes, and transformer designs to determine the optimum combination. Coordination with General Electric indicated the practicability of such a design breakthrough. As a result, it was decided that power will be generated and transmitted at 240/416 volts and stepped down to 115/200 volts at the load by novel transformers designed specifically for this application. A net weight saving to the aircraft of hundreds of pounds was thus accomplished together with improvement in electrical transmission and cooling efficiencies.

Future Application

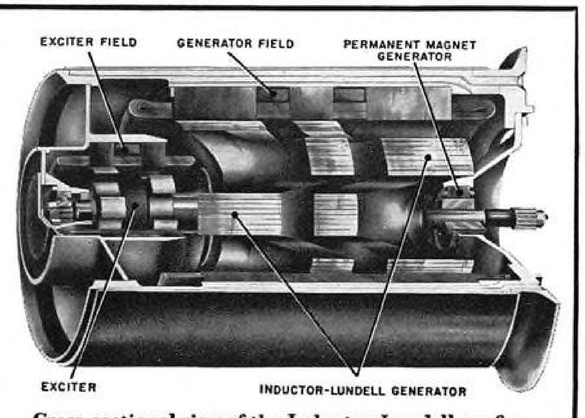
General Electric research on this system holds bright promise for future applications. Further development will make similar systems available in many future ratings and sizes for other types of aircraft. For more details, contact your General Electric Aviation and Defense Equipment Sales Office or write Section 796-1, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

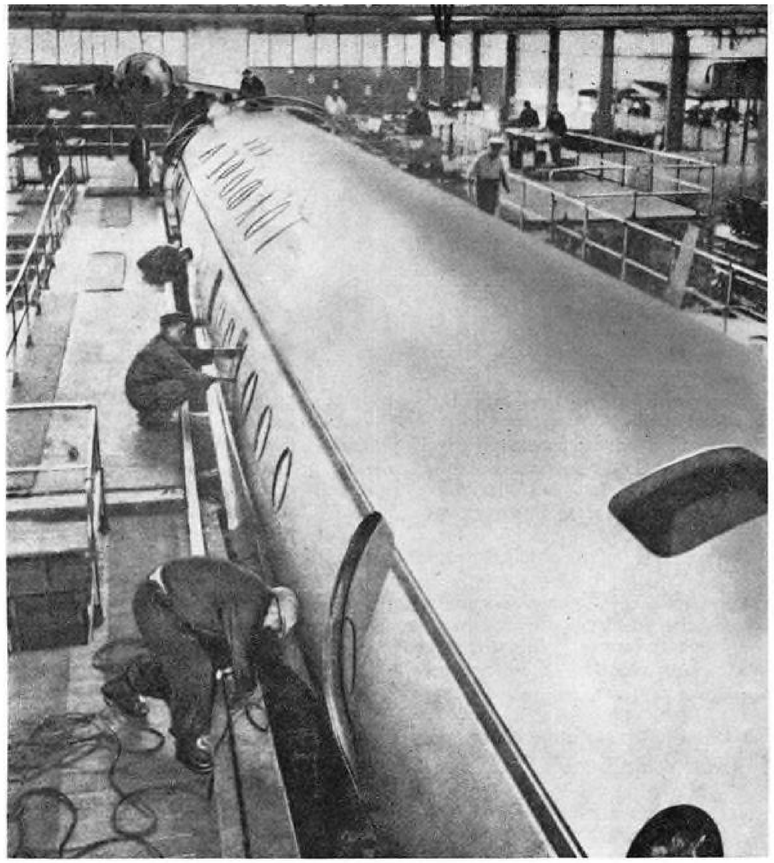
GENERAL ELECTRIC



This elementary schematic diagram shows the arrangement of generator and control components.



Cross-sectional view of the Inductor-Lundell configuration of the secondary power system generator.



Aeroflot Tu-104 Maintenance Dock Activated

Special maintenance and overhaul dock for Aeroflot's twin-jet Tu-104 transports, first shown in model form early this year (AW Mar. 20, p. 45), now is in use at Moscow terminal. Similar docks are being built for Aeroflot's turboprop An-10 and Tu-114 transports.

spring and summer with its New York-New England resort services.

Capital Airlines may have to start serving Idlewild this winter although this is not definite. The carrier has counter space at Idlewild but had been planning no service there until its new equipment and route plans were further along. It is set up to handle diversions into Newark and Idlewild and expects there may be more to take care of.

Eastern Air Lines does not expect to be greatly affected by the situation. Thirteen peak hour movements of the airline have been reduced by the agreement. Eastern expects to plan its non-scheduled diversions further in advance, deciding to divert early enough so that passengers may be advised before take-off.

Under terms of the scheduling agreement, airlines may operate as many schedules as they like between 12:15 a.m. and 6:30 a.m. at LaGuardia. Between 8 a.m. and 11:59 a.m., total for all airlines will not exceed 26 operations; between 12 noon and 5.59 p.m., 23 operations; between 6 p.m. and 8:59 p.m., 28 operations; between 9 p.m. and 11:59 p.m., 35 operations. No more than four departures should be scheduled during any 10 min. increment of an hour.

All details of the arrangement of temporary passenger facilities while the ramp work is in progress have not been decided, according to Arthur Fallon, deputy director of aviation for the Port Authority. Meetings with the airlines take place continuously to work out these details. One possibility might be to use the Marine Terminal section of the airport temporarily, Fallon acknowledged, although this is not firm.

Possibility of lengthening Runway 4-22 by going out into the Rikers channel had been discussed during the rehabilitation planning, but Fallon said there is "absolutely nothing in the mill to make the runway anything other than it is now." Lengthening this runway and providing instrumentation for the 22 end would involve filling in part of a ship channel and relocating the channel for ship passage. Cost of such a project has been variously estimated with $8-10 million a recurring figure. Fallon said he believes it impossible to estimate the cost within 25% until all the present unknowns had been thoroughly studied.

LaGuardia Airport, which was built on filled land and suffers constant sinkage, has been partially rebuilt about every five years by the Port Authority to compensate for the sinkage. This process will continue even after the present rehabilitation program. But the field has a part in the long-range planning for New York metropolitan area air transport picture.

LaGuardia is restricted both by lease agreements and by recent airport rule amendments to a short and medium-haul role. No airline can operate non-stop beyond about 800 mi. from the airport.

With its relatively short runways and with the range restriction, LaGuardia obviously will not be called upon to handle the big jets. But, with the tremendous investment by the airlines in the rehabilitation program (which the Port Authority finances but the airlines ultimately pay for in increased rentals and landing fees), it seems likely that the carriers will want to use some first-line short-haul equipment at LaGuardia, and this could include small turbojets.

Fallon said the types of equipment that will operate at the field in future cannot be pinpointed at this time. If short-haul economics dictate small jets rather than turboprops, for example, then small jets could be expected at LaGuardia.

The airline committee which adjusted the LaGuardia schedules has been in existence for eight years. For at least that long the airport has been taxed beyond capacity at the peak periods of the day when everybody wants to offer most services. A similar committee for Chicago Midway Airport has been serving the same function for three years because of peak congestion at that field.

British Set Up School To Train Civil Pilots

London—Government-sponsored College of Air Training will open next May at Hamble, Hampshire, England. Intended to fill the gap left by the reduced flow of military pilots to civil aviation, the college will offer a two-year course leading to a commercial pilot license and instrument rating standard.

When the college is in full swing, some 230-240 trainees will be under instruction at one time. They will be sponsored by BEA, BOAC and the independent airlines.

Cost of training—estimated to be $11,000 per trainee—will be shared by the government and the sponsoring airline, but graduates will have to repay $2,800 from their subsequent earnings. Men from Commonwealth countries will be free to attend if their sponsoring bodies meet full costs.



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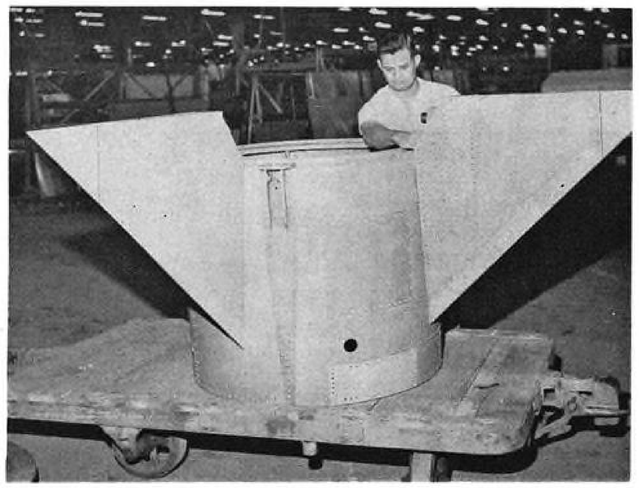
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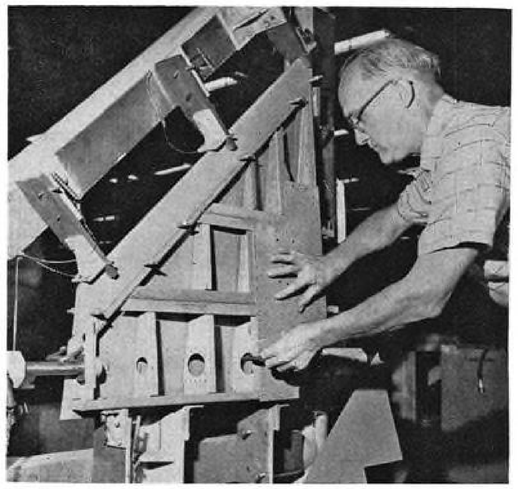
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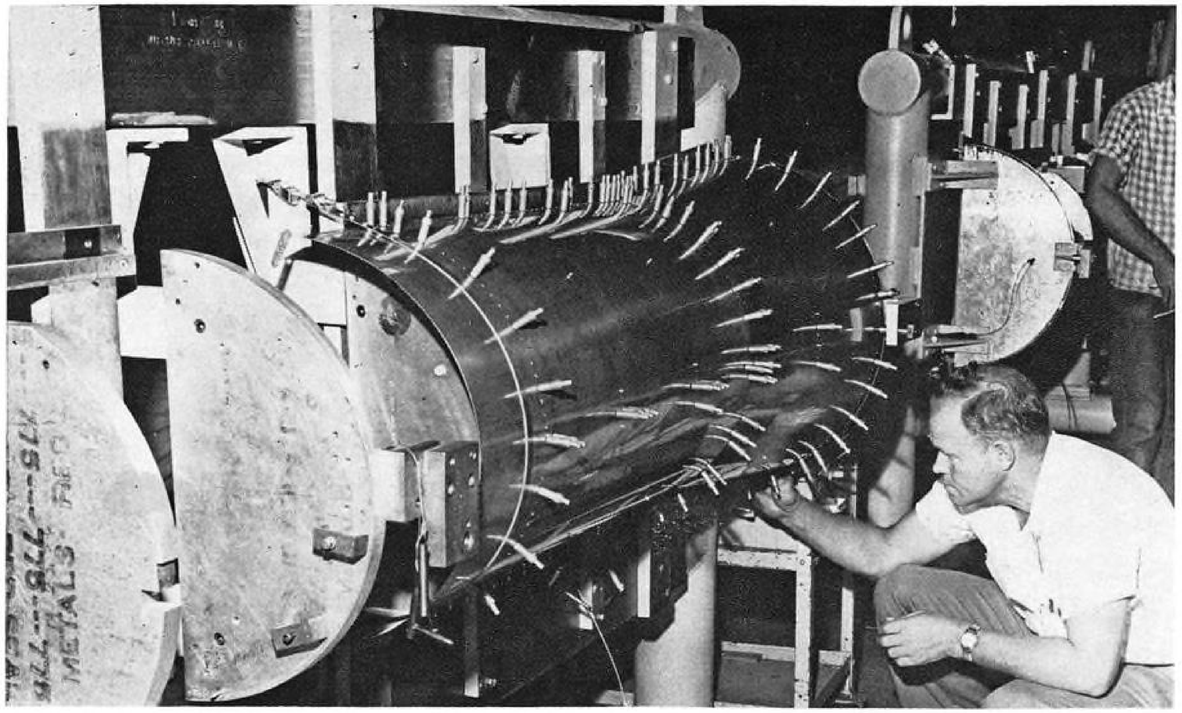


Structural ring of Scout tail section (left) will be slipped over nozzle of Aerojet-General first stage and bolted. Movable fin tips are connected by rods to control vanes in exhaust stream. Tail fin's interior is at right. Unit has steel leading edge and steel skin covering light steel interior substructure for maximum rigidity. Main loads are carried through center spar.

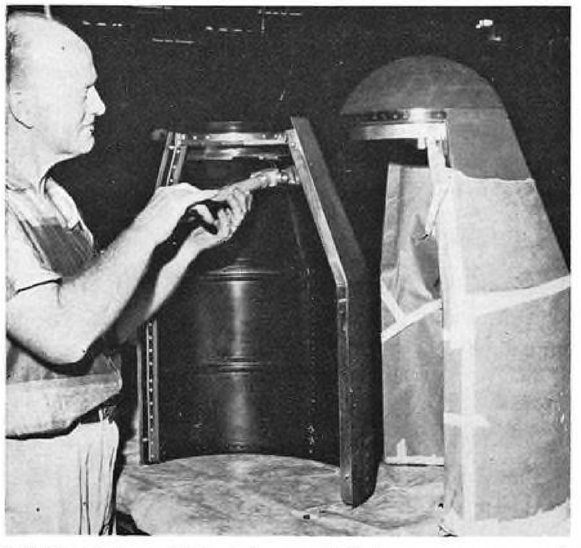
First Production Scout Research Vehicle Fabricated

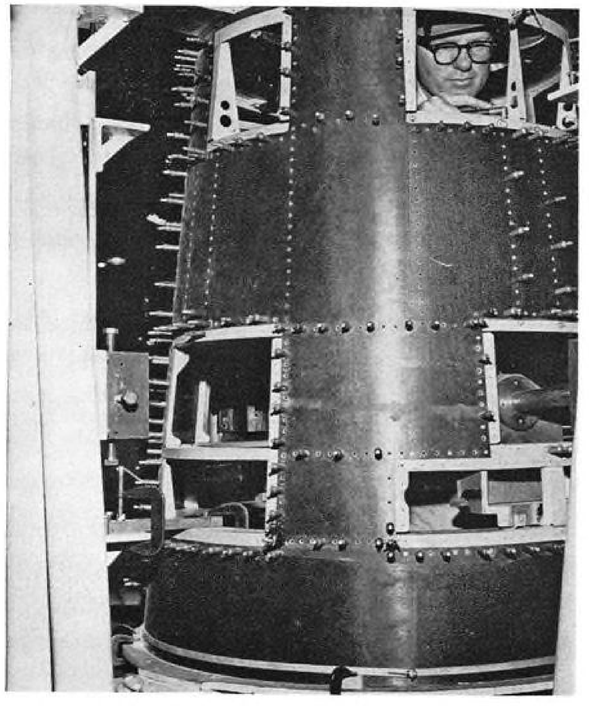


Payload collar which mounts on Scout fourth stage has a thin film of gold in emulsion, applied with hand spray and baked, to keep payload temperatures within limits. Chrome oxide exterior finish radiates heat developed while Scout travels through dense atmosphere.



Components for the first production Scout research rocket (AW Sept. 7, p. 64) are shown being fabricated at Chance Vought Aircraft's Dallas, Tex., plant prior to shipment to National Aeronautics and Space Administration's station at Wallops Island, Va., where they are being assembled by an NASA-Chance Vought team. Stainless steel two-piece lower nose section is in jig above. Section's flared skirt houses three spin rockets.





Ballistic actuator, which ejects nose shells to expose upper payload, is installed at left. Actuator ejection also releases pins holding lower (flared skirt) shells, permitting them to fall away, exposing lower payload area. Transition area, which streamlines stage joints, is made of glass fiber reinforced plastic (right). Transition areas are made in upper and lower quadrants (upper is shown). One is attached to front of rear stage; other is attached to rear of preceding stage. Two quadrants are joined by a threaded aluminum alloy diaphragm which has petal-type periphery. Ignition of stage imparts blast that bends petals downward, freeing prior stage. All stages are separated in this manner. Access panels facilitate bolting and inspection of internal equipment.

HOW FMC SERVES NATIONAL DEFENSE

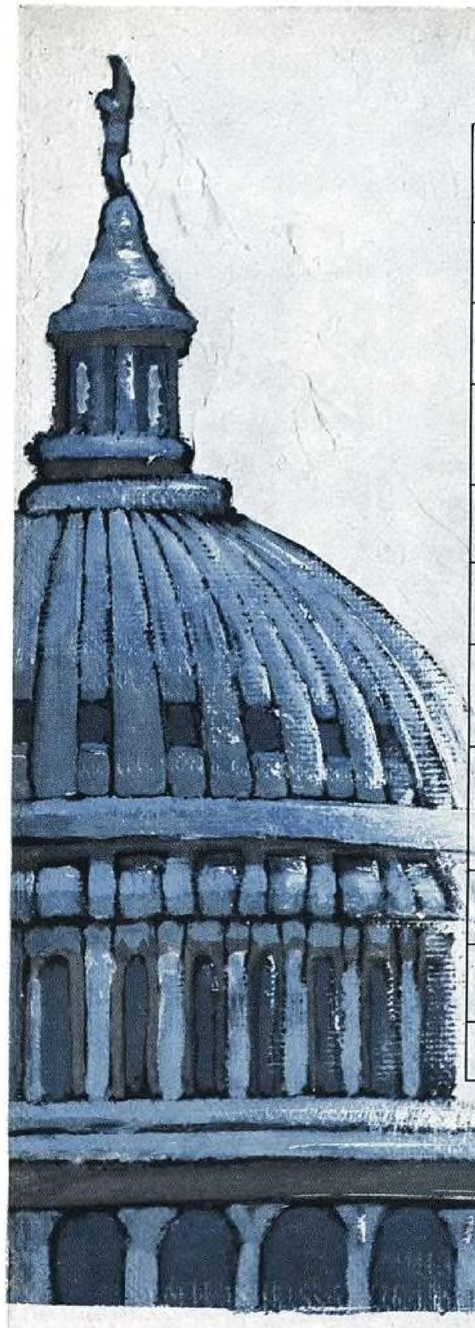
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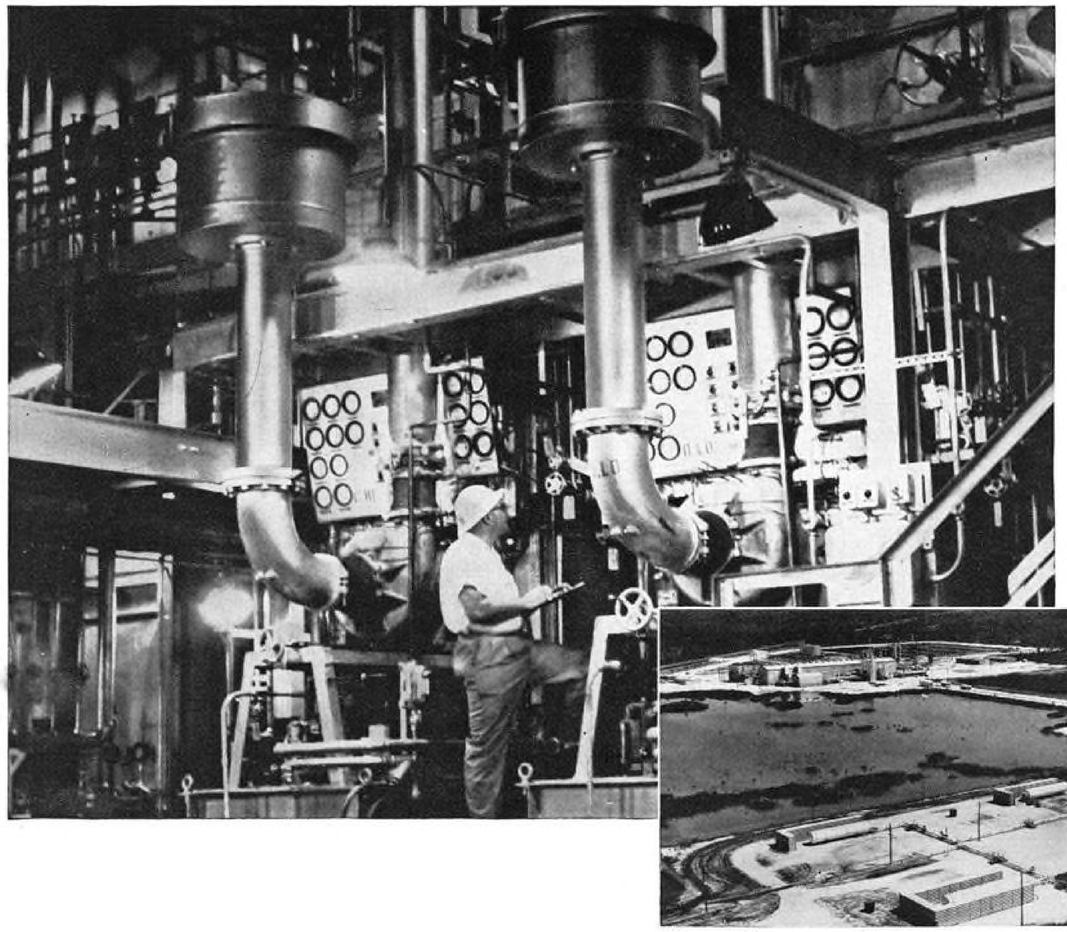
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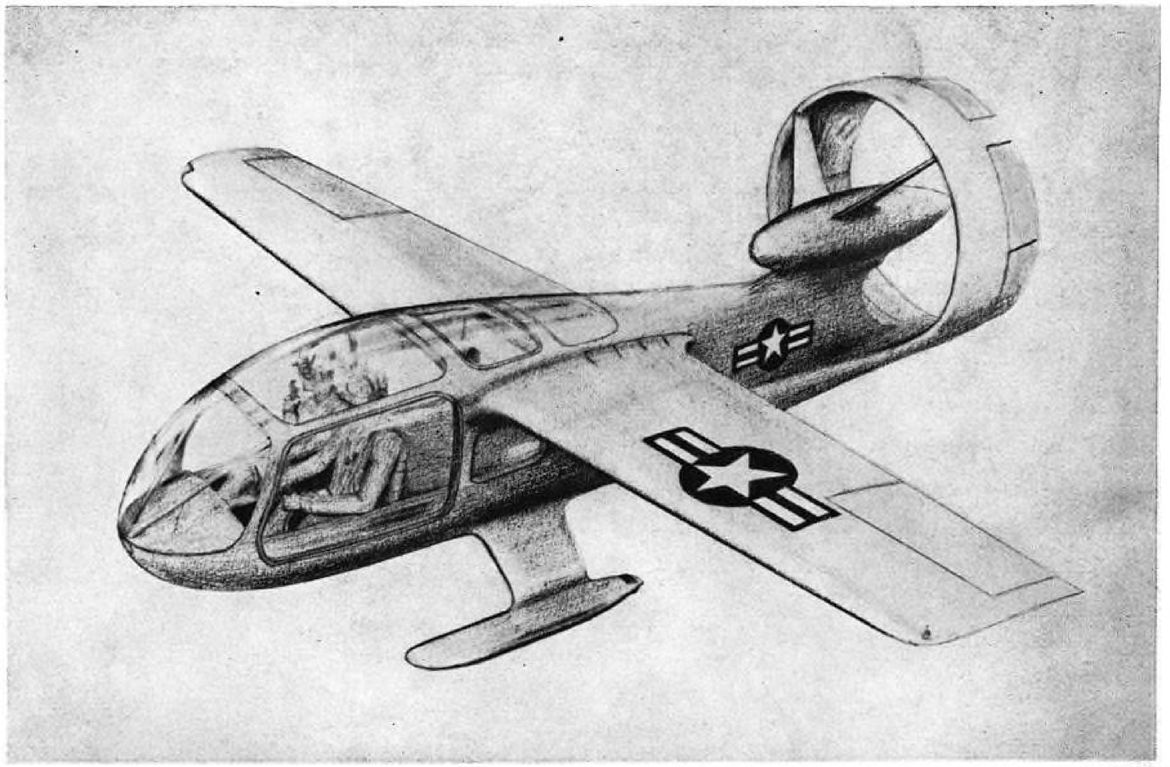


How Liquid Hydrogen came out of the lab

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ARMY STOL research aircraft, designated the Marvel and designed by group at Mississippi State University will be constructed almost entirely of glass fiber. Area suction-type boundary layer control will be used on the wings and portions of the fuselage. Powerplant will be 250 hp. Allison T-63 mounted on the tail in the cigar-like nacelle. Configuration above showing no inlet on the front of the nacelle has the engine ducted directly to the suction boundary layer control system to provide it with air. Alternate nacelle will have forward end open for pitot-type engine air inlet. Pantobase gear will allow landings on water and almost all types of fields. Takeoff from water is not possible with this design.

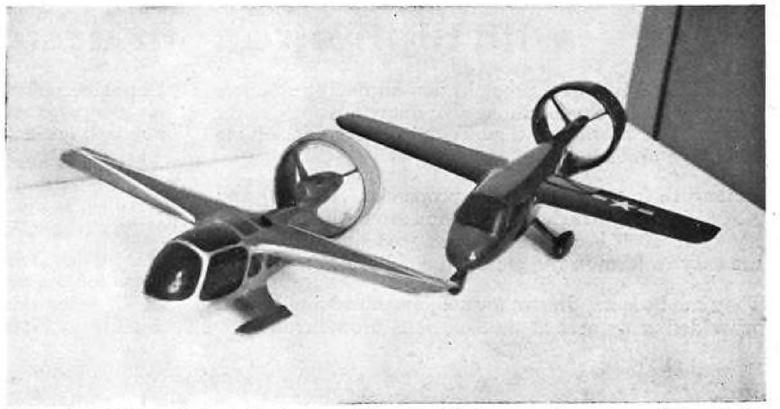
Army Attempts Major STOL Advance

By J. S. Butz, Jr.

Washington—U. S. Army recently initiated a program to build an STOL liaison aircraft with a top speed 10 times higher than its landing speed. The aircraft has been designed to land at 35 mph. yet fly at 350 mph. straight and level at the expenditure of only 250 hp.

Most efficient subsonic aircraft available today have a top speed about 3.5 times greater than their landing speed. This speed range figure was around 1.50 for the original Wright airplane which had a top speed approximately 50% greater than its stall speed.

A total of four aircraft are scheduled to be built and flown within the next two years in this ambitious Army program. Final model in this group which is intended to achieve the revolutionary range of flying speeds will be one of the



FOUR AIRCRAFT will be built in Army-Mississippi State research program. Marvel, the last of the series, is in model form at left above. Model of first aircraft, due to fly next July, is at right. It will have the Marvel wing, boundary layer control system and ducted propeller. Other two aircraft in the program will be gliders.

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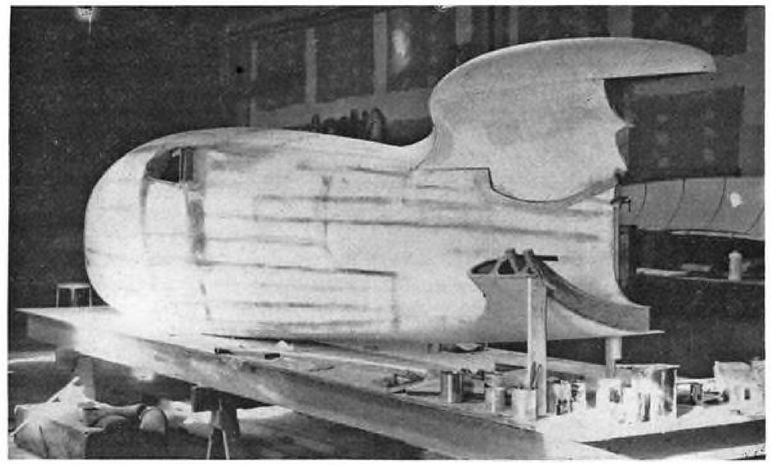
AM 350 is available commercially in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.**

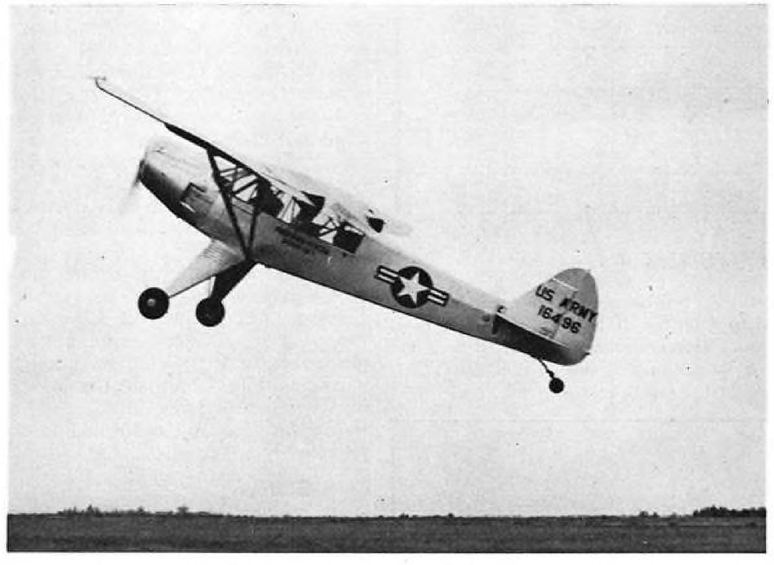
063

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT



MOCK-UP of the Marvel is shown under construction above. It will be used to construct a glass fiber mold for the fuselage. Piper L-21 modified with area suction type boundary layer control is shown below during maximum performance takeoff. Idle power maximum lift coefficient was increased from 2.16 to 3.98 with this system.



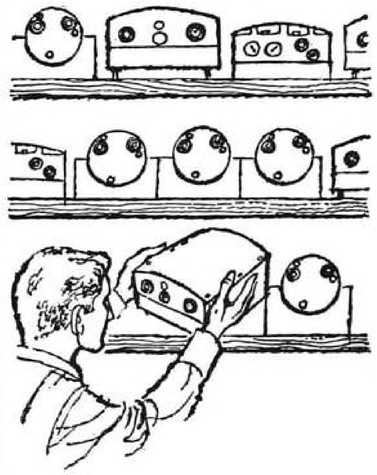
few aircraft yet built incorporating relatively new concepts and techniques in aerodynamics, structures and propulsion in one plane. These new techniques include:

• **Suction-type boundary layer** control over the entire wing and some of the fuselage. More than one million tiny holes will be drilled in the aircraft to draw away the low energy portion of the boundary layer next to the skin and provide a usable lift coefficient for landing nearly three times higher than that customary today. (Design maximum lift coefficient is 6.28.)

• **Molded glass fiber construction.** Extremely smooth outer surface of the glass fiber which is free of wrinkles is essential to the maximum performance of a boundary layer control aircraft. Conventional flaps will be replaced on the glass fiber wings by the more efficient procedure of evenly bending the entire wing chord to change its camber for landing.

• **Ducted propeller at the rear** of the aircraft to improve static thrust and to keep the slipstream from disturbing the flow over the fuselage and wing roots. Unlike earlier rear-mounted propellers, this propeller will not be driven by a long shaft connecting it to a powerplant located forward near the wings. It will be possible to balance the aircraft and eliminate the shaft weight by mounting a light new turboprop, the Allison T63, at the tail coupled directly to the propeller. The engine, under development for the Army, will produce 250 hp. at a weight of only 125 lb.

The aircraft have been designed by



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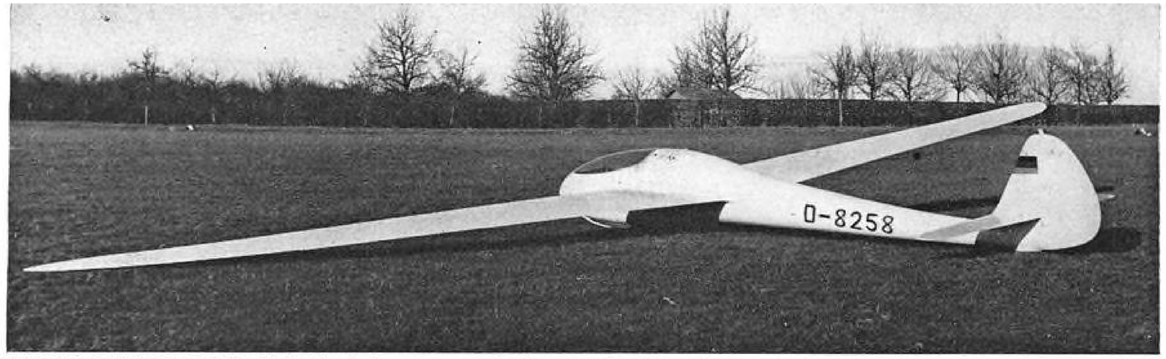
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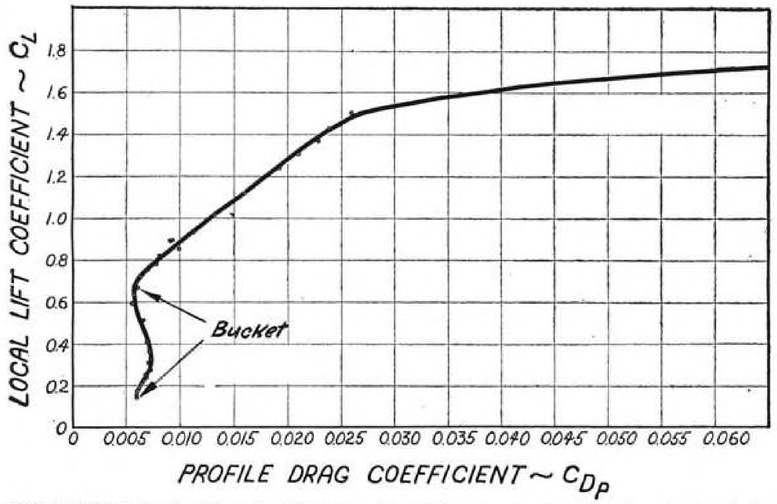
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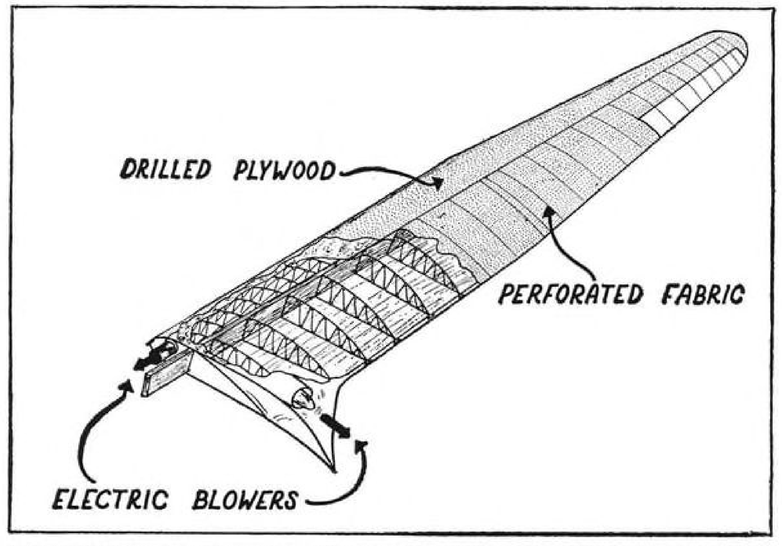
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MARVEL CONSTRUCTION will be based in part upon the German glass fiber sailplane, the Phoenix, above. Phoenix has a drag coefficient of 0.0088, the lowest known to have been measured on an aircraft. Phoenix has a low aspect ratio for a sailplane and achieves its performance through lowering the skin friction drag with no sacrifice in lift.



DRAG CURVE for the Phoenix airfoil shows that it has two laminar flow low drag buckets. Most laminar flow airfoils, such as the one first used on the P-51, have one bucket near zero lift coefficient. A series of two bucket airfoils have been mathematically derived by Dr. Richard Eppler. They will be extensively tested for possible use on the Marvel and other Army aircraft during the present Mississippi State research program.



ARRANGEMENT of glider wing with distributed area suction boundary layer control system installed is shown above. Complete wing would have about one million holes in it.

the Aerophysics Department of Mississippi State University under the direction of the department head, Dr. August Raspet. This university group also will manage the program and has agreed to deliver the series of four aircraft to the Army under a $250,000 contract.

The first aircraft, now under construction by university personnel, is scheduled to fly by next July 1. It will have a metal fuselage, and its configuration is slightly different from that of the final aircraft. Purpose of this model is to test the glass fiber camber-changing wing and glass fiber duct for the propeller which also incorporates four flaps to control the aircraft in pitch and yaw. The wing will have boundary layer control exactly like that to be used later on the all-glass fiber aircraft.

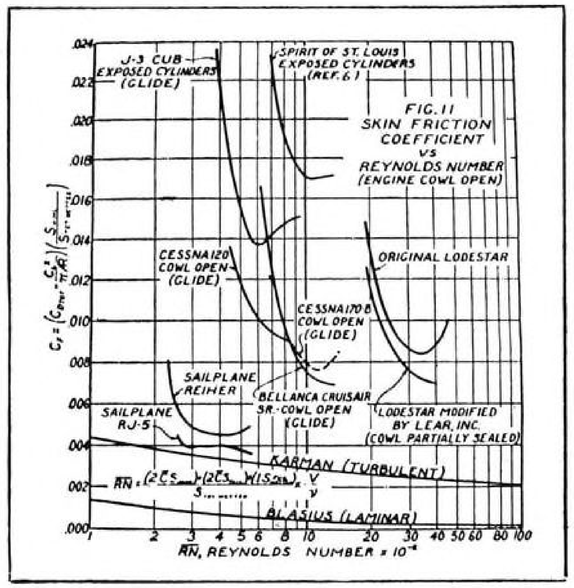
Performance of this first aircraft, however, is expected to be outstanding with a design landing speed of 35 mph., a top-speed of 200 mph. and a speed range of better than 5.5. Its powerplant will be a 90 hp. Continental reciprocating engine submerged in the fuselage under the wing and connected to the propeller by a long shaft.

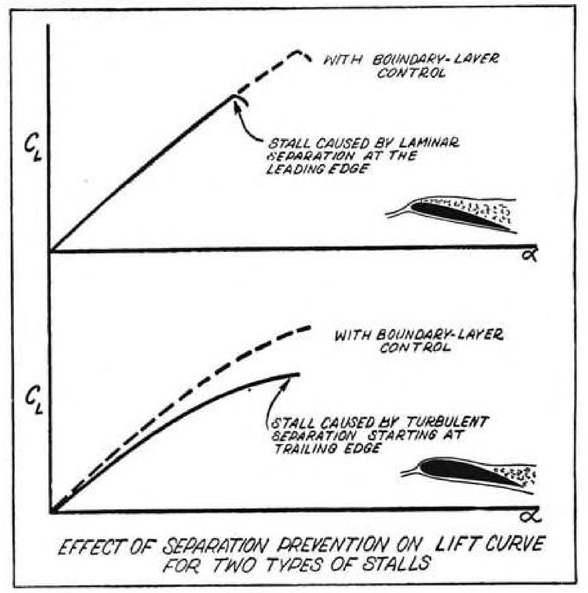
Two Gliders

Second two aircraft in the program will be gliders which, except for their airfoil section, will be the same as the final aircraft minus its engine. They will be built under a subcontract which is now being negotiated. This contract calls for the gliders to be finished one year from the day the contract is signed so that delivery should be before Jan. 1, 1961. Ballast will be used to simulate the engine in these aircraft and small power units will be carried to operate the boundary layer control system.

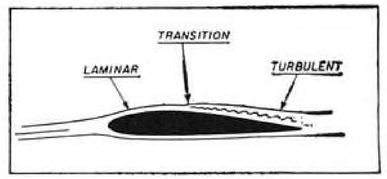
First flight of the program's final aircraft, now known as the Marvel, appears to depend upon the delivery date of the engine. This airframe also will be subcontracted and probably will be ready with the two gliders. If the engine is available it should be ready to fly before the middle of 1961.

Army hopes that two main benefits





BOUNDARY LAYER CONTROL on Marvel is designed to prevent turbulent trailing edge separation (above). This system finally causes a wing to stall abruptly due to leading edge separation at high angles of attack. Curve (above left) shows the skin friction coefficients for a number of aircraft. Karman turbulent line holds for aircraft with turbulent flow over after sections and no flow separation. Army hopes to achieve this with Marvel. Blasius laminar line applies to aircraft with laminar flow over entire surface. This has been achieved at Mississippi State with a low drag boundary layer control system differing from Marvel's high lift arrangement. Transition point on airfoil is at right.



will accrue from this low cost program. First, that the Marvel in its presently-planned form will pass its flight tests so well that it can be turned over to a manufacturer for early production. Second, that the two gliders designed to provide accurate flight test data prior to the first flight of the powered version of the Marvel will also prove valuable in basic studies of improved boundary layer control arrangements.

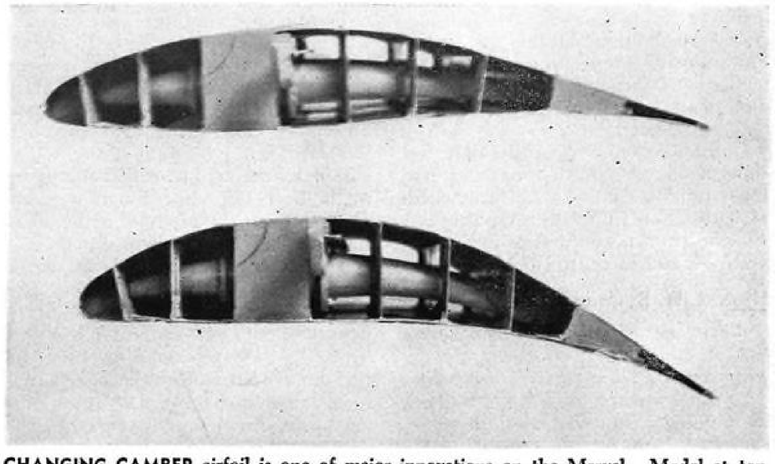
It now appears possible that top speeds of over 500 mph. might be realized with the Marvel airframe and engine if the distribution of the million or so holes in the wing is changed. Its speed range would then be around 14.

Arrangement of the holes for this new top speed is still a research problem under study at Mississippi State as a continuation of the boundary layer studies that already have covered more than 10 years. The two gliders will aid in the fulfillment of basic research contracts for the Army and Navy which total $180,000 for the next year.

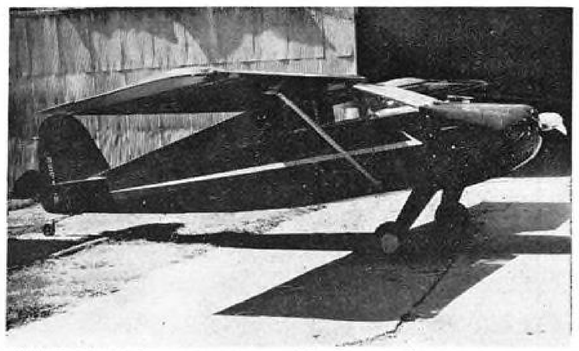
While the Marvel aircraft would appear to be a pure research aircraft to most observers, its designers regard it as a combination of a number of largely proven concepts for the first time. They believe that the background of experience available on each feature of the Marvel design is large enough to ensure the success of the aircraft.

Prior experience with the five major innovations on the Marvel includes:

- **Boundary layer control.** Work in this field was begun in 1904 by Ludwig Prandtl, and it has been under almost constant study in many nations since that time. Although knowledge of the boundary layer is still far from complete, much progress has been made in its control. System to be used on the Marvel was pioneered at Mississippi State and has been proven on three flight test aircraft since 1952.
- **Glass fiber construction.** Considerable experience with this material in aircraft use has been gained in the U. S. and Europe since World War II. Basis for the Marvel's structural design



CHANGING CAMBER airfoil is one of major innovations on the Marvel. Model at top shows airfoil in low drag configuration and bottom photograph shows the high lift shape which replaces the flap. Smooth, highly cambered airfoil is much more efficient than the normal wing with an extended flap that causes an abrupt change in contour and usually a separation of flow.





UNIVERSITY information was used by Steve Whitman, former racing pilot, to design the "Tailwind" (left). This aircraft will fly 140 mph. on the expenditure of only 40 hp. Static thrust of the Anderson Greenwood pusher (right) was increased 110% through the use of a properly twisted propeller and a well designed shroud.

primarily stems from U.S. work with helicopter blades, recent German sailplanes of this construction and experimental AT-6 glass fiber wing built for USAF by Eastern Aircraft Co. This AT-6 wing had less drag, was lighter and stronger than the original wing.

• **Camber-changing wing.** This wing, which eliminates the abrupt break in wing contour caused by trailing edge flaps, has been flown on sailplanes in Germany for the past few years. The sailplane HKS-3, which won the world competition in 1958, is fitted with this type wing. The camber-changing mechanism is operated a number of times during each flight with one airfoil shape used for high lift during tight climbing in thermals and the other for minimum sink speeds during high-speed glides.

• **Ducted propeller.** Experimental work at Mississippi State has shown that it is possible to increase the thrust of a pusher propeller on the back of a fuselage by about 60%. In the case of the Marvel, this means it will have a thrust-to-weight ratio of 0.8. This was achieved by an unevenly twisted propeller which matched the uneven inflow velocity through the shroud. Objections to carrying the shroud were also offset by using it as a stabilizing and control surface.

• **Control system.** This is the only portion of the design that has not had flight tests to date. The aircraft scheduled to fly on July will extensively test the effectiveness of the flaps in the propeller shroud as control devices.

High Lift Boundary Layer

There have been two primary objectives to all boundary layer control work with aircraft. The first is to reduce drag and increase cruise speed or range by building a wing that would have unseparated laminar flow over its entire area at high speeds. The second is to increase lift and lower landing speed by delaying the turbulent separation which occurs at the trailing edge of a wing at high angles of attack.

Both of these objectives have been realized in actual flight with varying degrees of success by a number of experimenters in the U. S. and abroad. Probably the best tangible proof of the substantial progress that has been made with boundary layer control can be obtained at Starkville, Miss. There, scores of military officers, industry engineers and visiting scientists have been treated to a demonstration ride in two powered aircraft and one sailplane equipped with suction boundary layer control. Most convincing aspect of the demonstrations is that all takeoffs and landings are made across a paved runway rather than down it.

The Piper L-21 and Cessna L-19 fitted with boundary layer control leave the ground before they cross the 150 ft. wide runway and climb out steadily at an angle of about 45 deg. They circle the field at around 35 mph. true airspeed, touch down on the side of the runway and come to a complete stop with room to spare before they have crossed it.

Performance improvement on the L-21 gained through the area suction boundary layer control includes an increase in maximum lift coefficient at idle power from 2.16 to 3.98. Air horsepower required to get this new lift coefficient was only 2.08, which eliminates the argument that the power might be better utilized if it were applied through the propeller rather than the boundary layer control system.

The maximum idle power lift coefficient for the L-19 was raised from 2.23 to 4.60 at a cost of only 5.4 air horsepower. Lift coefficient on the Schweizer TG-3A sailplane used for the original studies of the system was increased from 1.38 to 2.28 using only 0.8 hp. in its suction system.

Physically, the suction boundary layer control systems on these aircraft consist of a million or so holes drilled in the upper wing surface with small pumps located in the wing roots or attached to the main powerplant. The entire inner volume of the wing is used as a plenum chamber in the pumping of the low energy boundary layer air through the holes. Internal structure of the wing does not cause total head losses except in the vicinity of the inlets to the air pumps where flow velocity becomes quite large. Careful inlet placement in relation to the local wing structure was found to keep losses low.

During some tests, the wing was divided into two compartments, one on the forward portion of the chord and one on the aft. This allowed two different pumping pressures to be used but did not change the general concept.

Hole Diameters

Hole diameters which have been tried range from 0.018 in. to 0.030 in. They are placed close together in rows which run spanwise along the wing. Usually, there are 20 holes per inch in each row in a fabric-covered wing and 10 per inch in a wood or metal skinned wing. Chordwise spacings of rows has varied from 0.1 in. to 2.0 in. This arrangement provides in effect many spanwise slots cut in the wing.

Structural tests at Mississippi State have indicated that the strength of fabric, wood or metal covered wings has not been materially affected by any of the hole configurations. The fatigue strength of wings modified in this manner is still open to question, although the flight test aircraft have been flying extensively for periods ranging up to six years.

Problem of properly arranging and drilling the holes in a reasonable length of time also has been solved. Small automatic drilling machines are in operation which run along a narrow toothed rack. They can make 15 perforations per second in doped fabric, five to eight per second in wood and 0.030 in aluminum sheet. Most drilling is done by securing the rack to a wing that already has been covered. It has been found at Mississippi State that about 80 man

MOTOROLA MILITARY CAPABILITIES REPORT:

SEASONED IN THE SERVICE

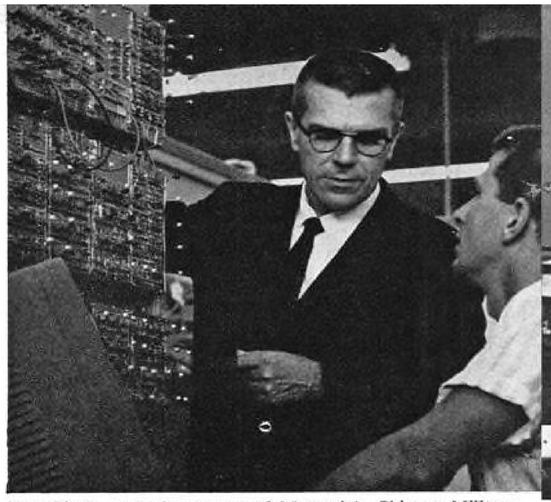


William Wheeler, vice president in charge of Motorola's Military Electronics Division discusses participation role in the B-70 project being developed for the Strategic Air Command at North American.

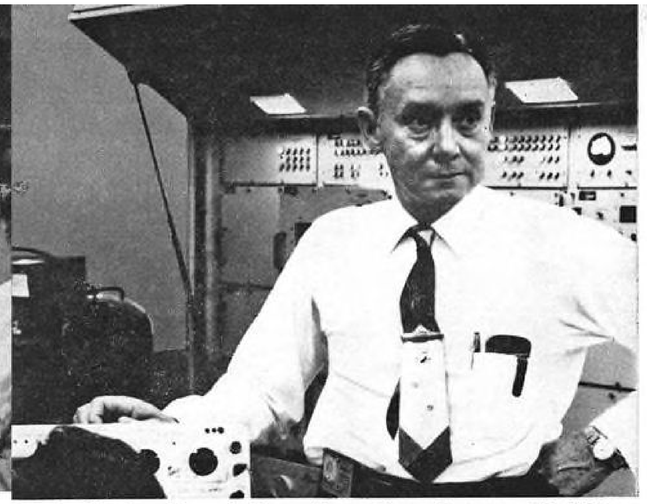
"North American's pre-award analysis and evaluation, before awarding the contract for the Mission and Traffic Control System of the B-70 Valkyrie to Motorola, was one of the most thorough and extensive ever made."— North American Aviation, Inc.

On the next two pages: Motorola's Seasoned Military Service Record.

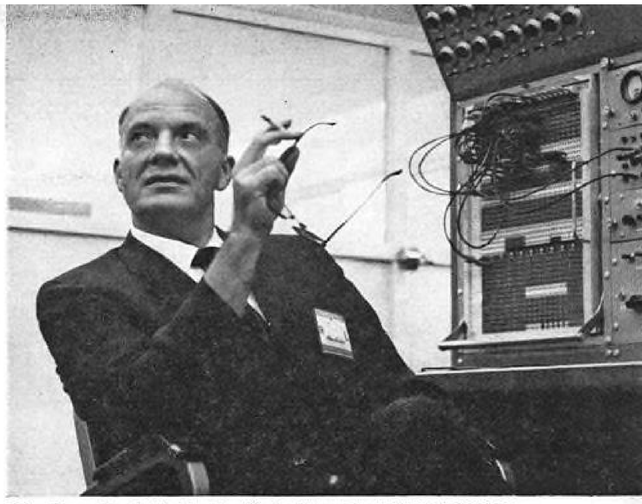
Since before World War II, Motorola has demonstrated its exceptional ability in military electronics on assignments that include communications equipment... radar... missile guidance... data processing and display... antisubmarine warfare... demonstrating with each success the value of a technical task force that is...



Roy Olson, general manager of Motorola's Chicago Military Electronics Center, which emphasizes work in surface and subsurface electronic equipments and systems.



Joe Chambers, Motorola vice president and general manager of the Western Military Electronics Center, directs Phoenix laboratories concerned primarily with work on sophisticated airborne and spaceborne electronics.



John Byrne heads highly classified advanced study and developmental work on a wide variety of military contracts at Motorola's Systems Research Laboratory, Riverside, California.

Seasoned in the service

Few weapon systems now under development are expected to play as important a role in U.S. defense in the coming decade as the B-70 Valkyrie. This fantastic new weapon will cruise at more than 2000 m.p.h. at altitudes over 70,000 feet.

Motorola's long record of military electronic achievements led to its appointment as major systems manager to develop and build the B-70's vital Mission and Traffic Control System.

This major system encompasses the communications, navigation, identification (IFF), and landing aids. It will keep B-70 crews in constant contact with each other and with U.S. headquarters from anywhere on the globe. It will provide the Valkyrie with its capability to be electronically directed to a designated target anywhere in the world and be immediately recalled on command.



Hundreds of thousands of Motorola walkie-talkies were produced for World War II combat use.

High-level responsibilities such as this are not new to Motorola. It was in June of 1940 that the prototypes of the history-making Motorola walkie-talkie were delivered to the U.S. Army Signal Corps. During World War II, Motorola not only supplied vast quantities of equipment that kept advancing U.S. ground troops in constant communications, but was also chosen by the Signal Corps to direct and manage the supply of the entire U.S. Army's need for electronic crystals. These critical frequency-determining components were vital to radio communications.

In the late forties and early fifties it was weapon fuses, radar bombsights and tactical microwave communications. Today, in company-owned research and production centers across the country, thousands of Motorola engineers and scientists are at work on a broad range of military projects. Included are missile guidance, high-resolution radar, sonobuoys, the next generation of equipment for radio-telephone communications between ground troops, and advancement of the frontier of knowledge in solid-state electronics.

Motorola's exclusive concentration in electronics, its cost-conscious approach to producibility, and its preoccupation with reliability are evident in every military product from the smallest solid-state device to the most complex weapon systems. Small wonder that with the military, Motorola rates one of the highest confidence quotients among suppliers of electronics equipment. For in the development and production of military electronics, it has been proved time after time, *there is no substitute for seasoned experience.*

For a comprehensive brochure on Motorola's Military Electronics capabilities, write Technical Data Service, Motorola, Inc., Military Electronics Division, 8201 East McDowell Road, Scottsdale, Arizona.

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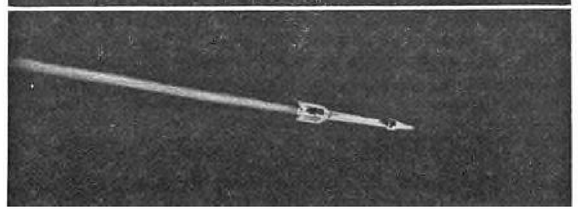


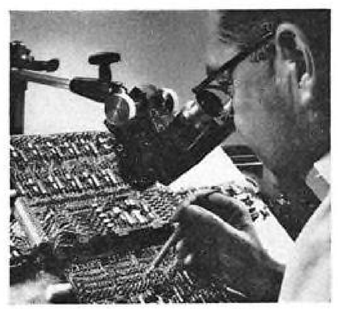
Development of passive seeker by Motorola, Riverside, is under contract to the Signal Corps for use with U.S. Army drones capable of performing night, day, and all-weather surveillance.



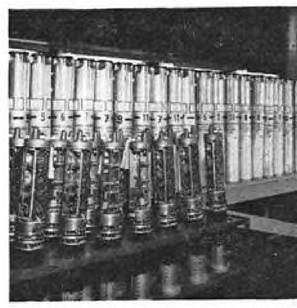
Motorola's surging capabilities in the solid state electronics art is achieving new dimensions in complexity, performance and reliability for new electronic concepts.







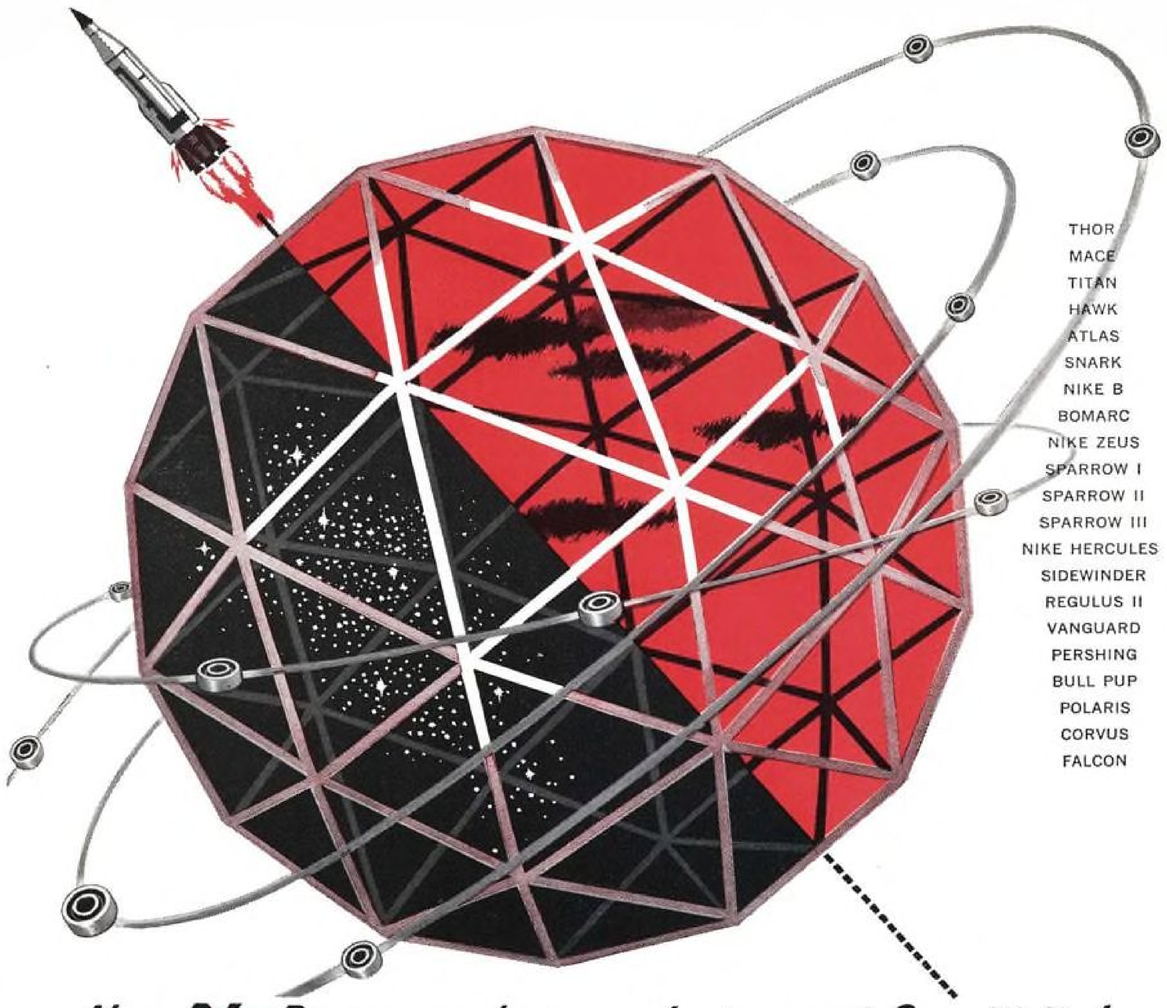
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hours of semi-skilled labor is needed to perforate the wing.

Effectiveness of this system in increasing lift depends largely upon the percentage of the chord to which the suction is applied. Tests have shown that the lift at a given angle of attack and the maximum useful angle of attack are increased as the rows of holes are extended forward from the trailing edge. On the most efficient wing configurations, all but the forward 3% of the chord is covered. Turbulent separation at the trailing edge never occurs on these wings, and the stall is caused by the laminar flow separating around the leading edge. Prevention of this type of stall by use of suction and rounding the leading edge is being studied to improve maximum lift coefficient even further.

Experimental Proof

Experimental proof that distributed suction could be used to prevent the separation of the turbulent boundary layer was first shown at Mississippi State in 1952. This had been accomplished on several occasions by other types of boundary layer control systems during the 1930s and 1940s. Most of the systems used single suction slots located ahead of the turbulent separation point on the trailing edge of the wing. Two aircraft using this system were constructed at Gottingen under the direction of Stuper during the 1930s. They had outstanding performance for their day, but the power needed by this system was much greater than that required by the distributed suction method.

Later at Arado, in Germany, a combination suction blowing system was developed using a single slot located at the flap hinge. Air was sucked in over the inboard flap and blown through a nozzle into the boundary layer on the outboard flap. A turbopump located in the wing at the juncture of the two flaps operated the inboard flap system with its low pressure side and fed the outboard nozzles with its high pressure side.

Flight tests and theoretical studies in the U.S. after World War II showed that this system could improve the takeoff performance of a number of aircraft, but that in some situations it would be more advantageous to put the power required to run the system into the main engines for improved thrust.

The National Advisory Committee for Aeronautics and the Navy Bureau of Aeronautics were active for several years after World War II in the development of boundary layer control systems for lift improvement. Much of this work could be described as completely successful. Some NACA flight test results with an F-86 modified with both suction and blowing boundary layer control systems includes the following improvements:

- **Leading edge suction** on an F-86 increased the angle for stall by 10 deg. and eliminated unpleasant stall characteristics which included wide yawing motions. Life coefficient was increased from 1.1 to 1.8 with reductions in stalling speed up to 23%. The addition of leading edge slats improved stalling speed by only 15%.
- **Area suction flaps** on this aircraft decreased stalling speed about 7%, while the blowing flap improved it around 10%.

General consensus among NACA and Air Force engineers familar with the demonstrated capacity of boundary layer control systems, both of the high lift type and the low drag variety to be discussed later, is that they have been reduced to engineering problems and could be applied with advantage to a number of types of aircraft. Apparently, lack of funds is the primary reason why the system has not been integrated into a design in the past the way that it is now being done on the Marvel.

Supersonic aircraft came along about the time boundary layer control first showed substantial promise. Shortly afterward, large ballistic missiles began to receive attention from the government. These vehicles and the urgent problems of high speed flight absorbed practically all available funds. Boundary layer control and other promising developments attacking the classical problems of subsonic flight were swept into a backwater and out of the main stream of aeronautical development. Army is now apparently determined to use this bypassed subsonic work to try to effect a large increase in the speed, utility and economy of its aircraft.

Some Oppose Plan

As would be expected, there are qualified people who disagree about the benefits of boundary layer control. Some manufacturers of large jet transports doubt the effectiveness of high lift boundary layer control systems for these aircraft, contending that it does not improve performance to a degree that would warrant the cost and the additional complexity. Some fighter plane manufacturers have reached the same conclusion after their studies of such systems.

Although the flight test aircraft at Mississippi State appear to provide a strong argument in favor of area suction boundary layer control for liaison aircraft, a number of doubts have been raised regarding its operational usefulness, including the possibility of the



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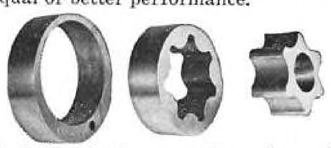


Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

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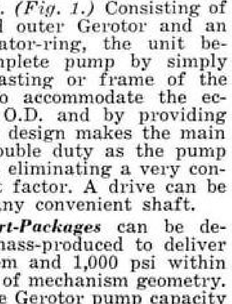


FIG. 2

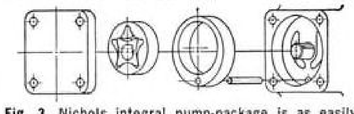


Fig. 3. Nichols integral pump-package is as easily installed as an anti-friction bearing.

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clogging of its million or so wing holes. Experience at Mississippi State shows that flights in heavy rains do not have any effect on the effectiveness of the system. No flights have been made in freezing rain but this is felt to be marginal for an aircraft such as the L-19 even without perforations. If heavy dust is allowed to accumulate on the wings and is rained upon before it is wiped-off, a mud is formed that clogs the holes. A vacuum cleaner and a brush can remove the mud and clear the holes with little effort. Metal wings have shown less tendency to clog with such mud than fabric wings.

Another major doubt expressed is that the Mississippi State aircraft require a much smoother leading edge and upper wing surface than present commercial construction permits without highly elevated costs. The proper smoothness has been achieved on the recent experimental aircraft by covering the leading edges with glass fiber. The skin of the Marvel is expected to remain smooth in almost all flight conditions. This wrinkle-free characteristic of complete glass fiber construction has been demonstrated in flight in the U. S. and Europe.

Concern has been raised for the safety of a boundary layer control aircraft during certain portions of a maximum performance landing if a sudden loss of lift occurred due to failure of the boundary layer control system. The Marvel design probably will include gas generators as an auxiliary power source to run the pumps for several minutes in an emergency. Normally, the pumps would be powered by the main engine. If the main powerplant fails during critical portions of a high performance takeoff, it would be disastrous to any type STOL aircraft.

High lift boundary layer control systems using suction have two main advantages over the blowing type which make them more attractive for use on an aircraft such as the Marvel. First, suction tends to stabilize the boundary layer and keep it laminar while blowing does not. For this reason, suction has been used to reduce skin friction drag, while blowing has not been successful in this area. Second, suction systems require much less power than blowing systems, and it is possible to consider using them during cruise.

Normally, there is a transition from laminar to turbulent flow on the top of the wing somewhere near the point of maximum thickness. The transition is caused by the boundary layer thickening as the flow expands on the rear of the wing. The high positive pressure build up during this expansion finally causes reverse flow along the surface, and the boundary layer separates from the wing.

The high lift system on the Marvel will, with the expenditure of less than 10 hp., keep the turbulent boundary layer completely attached to the wing at all speeds. This will eliminate the wing pressure drag. Suction also will be applied around junctures and other areas of adverse pressure gradients so that there will be little turbulent separation on the fuselage, landing gear and tail areas. Once the pressure drag has been virtually eliminated in this manner, further drag reduction can only come through lowering the skin friction by keeping the laminar boundary layer from becoming turbulent over the after portion of the aircraft.

Complete laminar flow over a wing was achieved at Mississippi State in 1952. Total drag of this glider wing was reduced to 50% of its normal value through the use of area suction.

The boundary layer control system required for low drag has important differences from the high lift system however. Many complex compartments must be used inside the wing to obtain the right suction pressure on each row of slots or the hole distribution must be changed to achieve a laminar boundary layer on the complete wing. Suction must also be applied to lower surface.

The low drag system is much more sensitive to surface imperfections, vibrations, skin wrinkling and other flight disturbances than the high lift system. One small insect attached to the wing will trip the boundary layer and create a turbulent zone behind it that covers a significant percentage of the chord. Glass fiber construction is expected to help this situation, but cleanliness of the aircraft will be a must if laminar flow and very low drag is to be achieved.

Generally, the high lift arrangement uses larger, widely spaced holes, while the low drag system requires small holes fitted close together. These hole patterns apply if the entire wing is used as a plenum chamber for the pumps, providing only one suction pressure.

Internal compartmentation to provide different suction pressures has been ruled out as a means of combining the high lift and low drag systems to give Marvel a speed range of 14. The approach being taken is to develop a wing perforation pattern that will combine the best qualities of both systems. Considerable progress already has been made.

Problem is to reduce the boundary layer thickness around the leading edge at high angles of attack so that when the flow reaches the aft portions of the wing, the high porosity of the high lift system will not be required to keep the laminar boundary layer attached.

Centrifugal forces tend to become high around the leading edge, and boundary layer thickens much more than it would traveling over a flat plate of the same surface area. A number of suction arrangements are being tried on the leading edge so that the boundary layer can be kept very thin back to the 30 or 40% chord at high angles of attack. When this is accomplished, the two systems can be married.

Experience with the low drag boundary layer control is probably more extensive than that with the high lift type. Three schemes have been used successfully to apply suction and achieve complete laminar flow over a wing chord—a porous skin material in England and at the NACA; slots in Zurich, and at Northrop and a perforated skin at Mississippi State and in England.

The first experimental work with suction was performed at Ackeret's Institute in Zurich in the 1920s. Dr. Pfenniger, who played a prominent part in this work, has been at Northrop for a number of years. His work there has included the direction of flight tests of an F-94 fitted with a boundary-layer-controlled glove over a section of its wing. Complete laminar flow over chord of the glove was maintained during all of these flights. On the basis of this work, the Air Force planned over three years ago to modify a B-57 so that its entire wing would have the Northrop boundary layer control system using slots. The project was canceled after sufficient funds were not made available. The large drag reductions that appeared possible on the basis of the flight test results prompted Air Force Lt. Gen. Donald Putt, former Air Force deputy chief of staff for development, to tell Congress in 1956 that successful application of boundary layer control could reduce the weight of the Boeing B-52 from 400,000 to 225,000 lb.

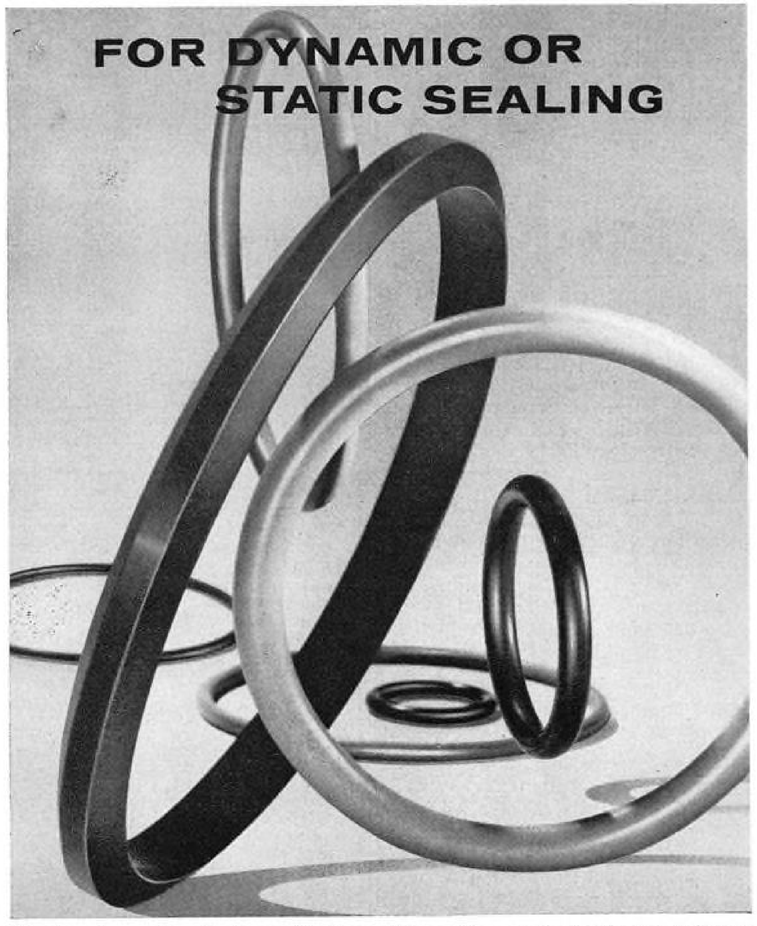
Dr. Lachmann, at Handley Page in England, also achieved complete laminar flow over a wing chord in flight, using a Vampire fitted with a glove in much the same manner as Pfenniger's system.

Lachmann has not been successful in selling his achievements.

British Army Loses Bid for Air Force

London—British army's campaign to operate its own air force ended last week when the Air Ministry announced formation of a new group to control all tactical transport operations including army support.

The new specialist transport group headed by an air vice marshal will form part of the Royal Air Force Transport Command and assumes the title of the famous No. 38 group which was responsible for airborne operations during World War II.

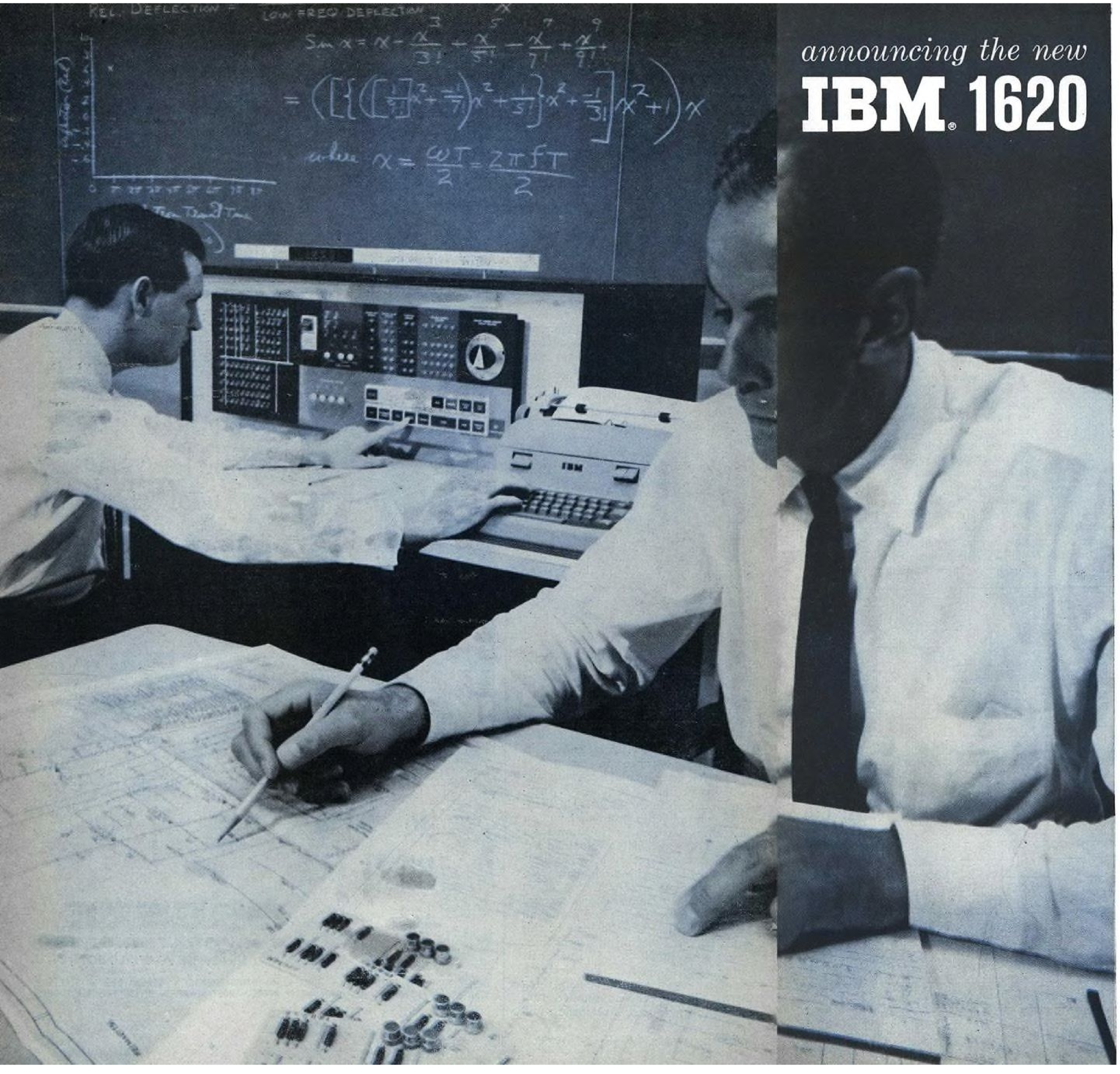


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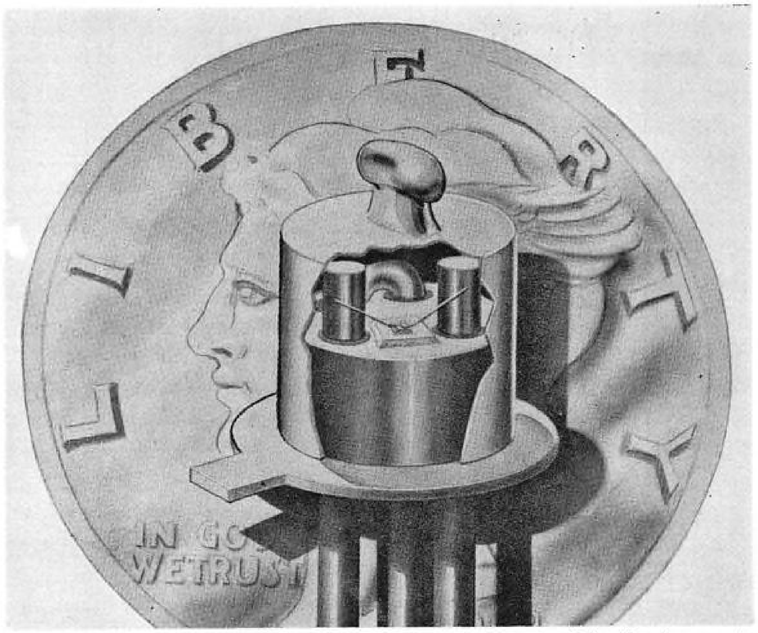


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Automation Cuts Zeus Transistor Cost



MESA TRANSISTOR, Type 2N559, with switching speed of less than 20 milli-microseconds, will be used by the millions in Nike Zeus anti-ICBM missile system. To reduce cost, improve reliability and provide quantities needed, Western Electric is developing mechanized fabrication techniques and machines under Army sponsorship.

By Philip J. Klass

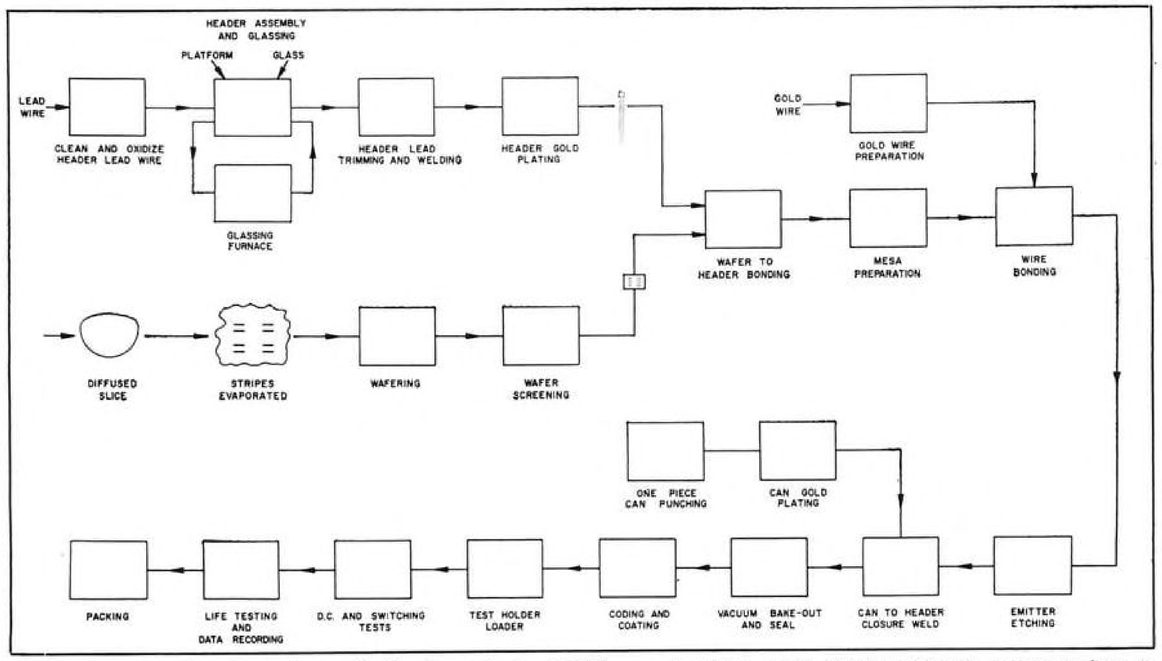
Laureldale, Pa.—Important behind-the-scenes effort for the Nike Zeus program is under way at Western Electric to develop techniques and facilities for fully automated or semiautomatic production of the tens of millions of ultra-reliable transistors, resistors and capacitors which will be needed if the anti-ICBM missile goes into production (AW Nov. 2, p. 30).

One objective of the mechanization program is to slash the cost of manufacturing components by as much as 70%. Components represent more than half the cost of the Zeus system.

Even more important, however, the program is intended to produce components with vastly improved reliability, an imperative requirement for a system which may use nearly 10 million components in a single installation.

One of the most difficult mechanization tasks is under way here at the semiconductor manufacturing facility operated for the Army by Western Electric—prime contractor for the Zeus.

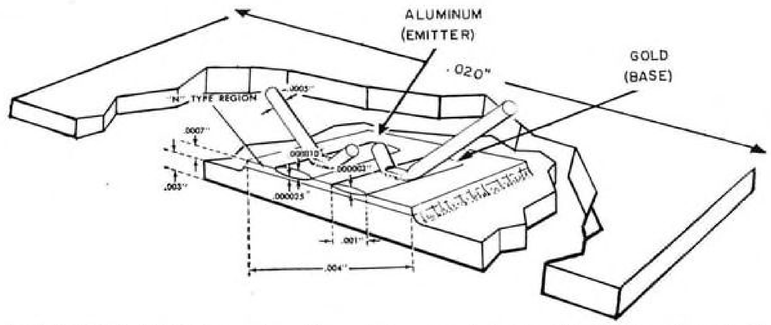
Some concept of the difficulty of the task can be gained from the fact that the ultra-high-speed Type 2N559 diffused base mesa transistor, which will make up 90% of the switching transistors used in the Zeus system, must be fabricated on a tiny germanium crystal whose working area is the size of the diameter of a human hair. Dimensions of the base and emitter elements deposited on the crystal must be controlled to within a few millionths of an inch. The Type 2N559 has a switching time of less than 20 milli-microseconds (20-billionths of a second). Such speed is needed to provide the fast computational speeds required of the ground-based digital computers for tracking, target discrimination and guidance. An appreciation of how fast this 2N559 switching time is can be gained from the fact that light, traveling at a speed of 186,000 mi. per second, would cover a distance of only 20 ft. in the time it takes this transistor to switch.



FLOW DIAGRAM of mechanized assembly line for producing 2N559 mesa transistors, which Western Electric expects to have in operation by mid-1961, is shown. Operations enclosed in rectangles will be mechanized; others will be handled on a batch process basis.

Development Costs

Approximately $4½ million of Army funds have been spent or appropriated to date to cover the development of mechanized transistor production facilities and the cost of fabricating one of each type of machine required. To build sufficient number of machines to supply millions of transistors required for Zeus production is estimated to cost another $10½ million. (The $137 million in supplemental funds requested by the Defense Department for Zeus preproduction effort, and authorized by Congress, includes monies for construction of several mechanized transistor production facilities.)



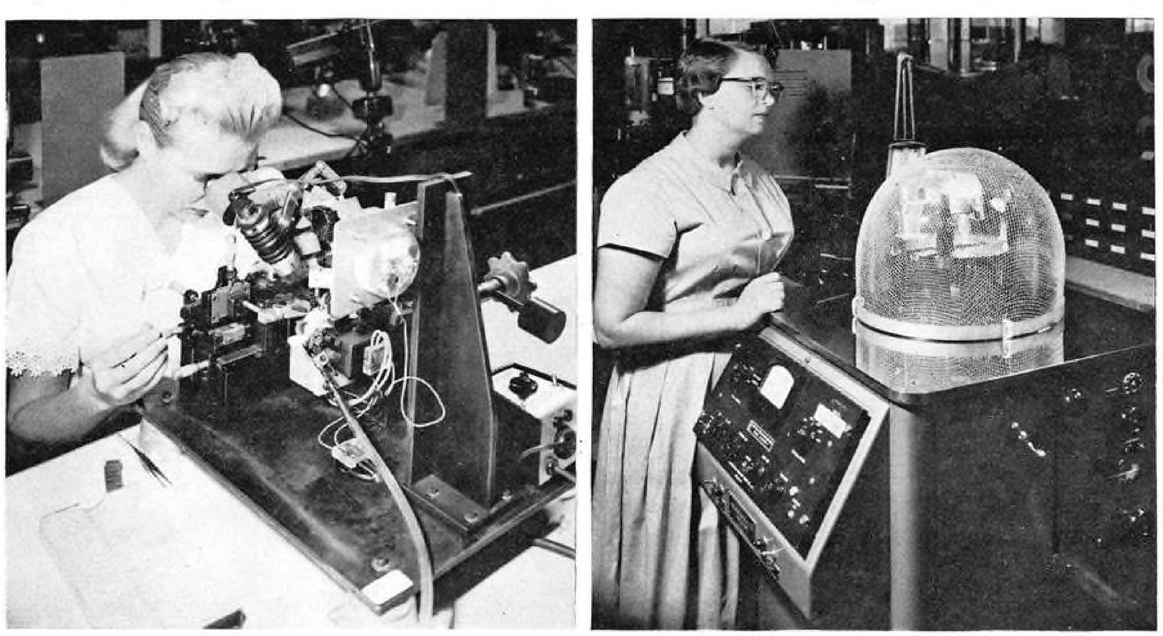
DIMENSIONS of 2N559 mesa transistor point up manufacturing difficulties involved. Emitter and base must be formed, and wires attached, in an area the diameter of a human hair.

Western Electric does not propose to operate all 2N559 transistor manufacturing facilities. Rather, it is planned to set up identical facilities at several other semiconductor manufacturers' plants. Western Electric officials and engineers recently completed a survey of all major transistor manufacturers to evaluate their technical competence and facilities in order to recommend the best alternate source producers for the 2N559.

There has been some industry criticism of the Army's decision to give the mechanization task to Western Electric, rather than throw it open to other transistor manufacturers. While it is true that several other companies are making mesa transistors, and a number of companies have mechanized production of more conventional transistors, the mesa transistor was developed by Bell Telephone Laboratories and Western Electric was the first to produce it in quantity.

Some industry sources have questioned whether other non-mesa type transistors with fast switching times, already in production, couldn't be used. Dr. J. A. Morton, BTL vice president, replies to this by pointing out that the mesa transistor can operate with lower junction temperatures than its competitors, and extensive tests have shown that transistor failure rate goes down directly with lower junction temperatures. In addition, Morton believes that the mesa transistor has far more growth potential than its more conventional competitors.

Another advantage of the 2N559, according to Morton, is the fact that it



MECHANIZATION is planned for operation which bonds 0.0005 in. diameter gold wire to tiny emitter and base electrodes. At present this operation requires a highly skilled operator using a microscope and several micrometer controls as shown at left. Mechanization is not planned for operation at right which vacuum-deposits tiny metallic stripes onto germanium crystal. Reason is that batch-process technique can be used to produce 2,100 transistor wafer depositions in a single operation.

can be used in a greater variety of circuit applications. This permits the 2N559 to be used for 90% of the switching transistors and permits the reliability effort to be concentrated on fewer types of devices.

Present reliability objective for the 2N559 is a failure rate of no more than 0.01% per thousand hours. Morton is confident this figure can be achieved, perhaps even bettered.

Western Electric believes that all producers of 2N559 transistors must employ identical techniques and facilities to assure product uniformity and interchangeability.

The heart of a mesa transistor is a germanium crystal, measuring 0.020 in. square and approximately 0.00035 in. thick. This is only slightly larger than the period at the end of this sentence.

The mesa, or active working portion, occupies only about 4% of the crystal area, measuring approximately 0.004 in. square. The mesa rises about 0.0007 in. above the P-type germanium region and consists largely of an antimony doped N-type region about 45 millionths of an inch deep.

Deposited atop the mesa are two tiny metal stripes, one gold, the other aluminum, which each measure about 0.001 in. wide by 0.006 in. long. The gold stripe, which functions as the transistor's base electrode, is diffused into the N-type mesa to a depth of about three-millionths of an inch. The aluminum stripe, which serves as the emitter, is diffused into the mesa for a depth of about 10-millionths of an inch.

The most critical dimension, which largely determines the transistor switching speed, is the separation between the underside of the aluminum (emitter) stripe and the N-P junction. This distance, nominally about 25 millionths of an inch, must be established by precise control of the diffusion process. Other critical dimensions include the width of the two metallic stripes and the spacing between them.

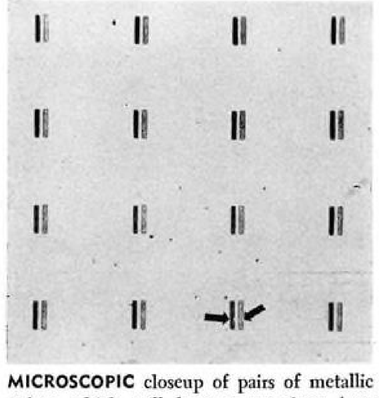
Fine gold wire, measuring 0.0005 in. in diameter ($\frac{1}{10}$th the diameter of a human hair), is used to make connections between the two metallic stripes and the transistor "header" upon which the crystal is mounted. Bell Laboratories has developed a thermal compression technique for bonding the fine wires to the stripes without damaging them. A small heated wedge-shaped tool presses one end of the gold wire against the stripe, causing a cold flow of metal which bonds the wire to the stripe.

The bond can withstand 20,000g, Western Electric says.

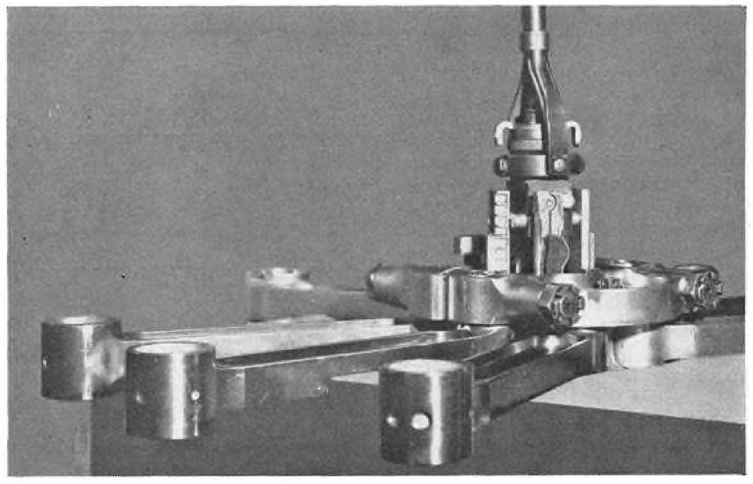
Mechanized Fabrication

After early studies of the problems involved in mechanized fabrication, Western Electric decided to mechanize individual or small groups of operations on a piecemeal basis rather than attempt a single continuous in-line automatic assembly line.

In this way it could first concentrate on those operations where transistor quality is extremely dependent upon the skill of individual operators and



MICROSCOPIC closeup of pairs of metallic stripes which will become transistor base and emitter electrodes. Stripes are produced by means of thin nickel mask and vacuum deposition on thin slice of doped germanium crystal. Arrow shows faulty pair.



Taking The Stress Out Of A Master Rod

A properly fitted link pin sets up enough internal stress in the master rod bores to bulge the crank shaft bearing area very slightly. These bulges are so small they are almost impossible to detect. But they sometimes set up enough stress to crack the master rod bore during the engine's operating cycle. Master rods are expensive to replace.

This simple Airwork "extra" sharply reduces the danger of bore cracking. After the link pins are in place, Airwork uses an electric hone to eliminate the tiny internal bulges created by pin pressure. Then we make sure the bearing area is perfectly circular after the pins are in place.

It takes only a few extra minutes to hone a pre-assembled master rod to perfect roundness . . . but it adds a lot to the satisfaction you get from a smooth running, long lived Airwork overhauled engine. Airwork saves you time and trouble by doing more work at overhaul, *when it can be done at low cost* and no inconvenience to you. Give your engine an Airwork overhaul—and be sure of maximum operating satisfaction.

Airwork CORPORATION
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COMPONENT KNOW-HOW
THE KEY TO SYSTEMS CAPABILITY



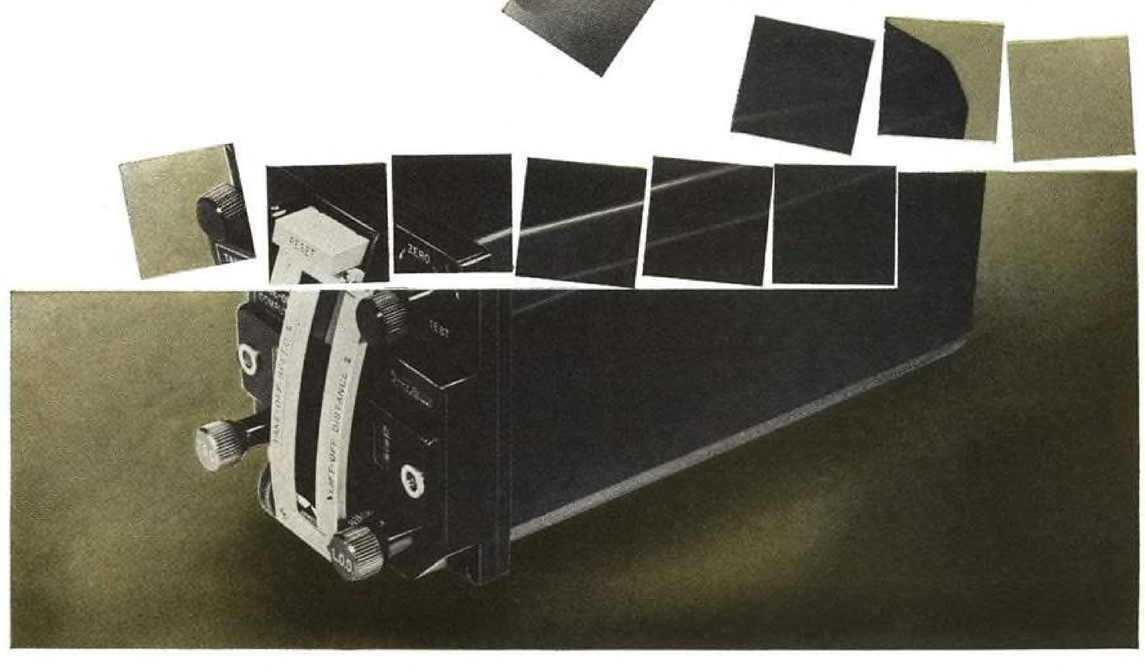
In systems development there is no substitute for experience in component and subsystem design. For more than five years, Daystrom Pacific has been providing gyroscopes, transducers and other basic building blocks for major airborne and missile systems. The development of equally reliable airborne instrument systems has further enhanced Daystrom Pacific's over-all capability.

Backed by its parent organization, Daystrom, Inc., the company has expanded its airborne instrument and subsystem work to include systems development programs that require the competency of an outstanding technical team... the thinking and abilities of an advanced planning group.

If you are responsible for the development of a major systems program, you will be interested in Daystrom Pacific's experience and systems capability. Write for our new engineering brochure—File No. AW-876-1.

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

Cold-Finishing of Alloy Steels: The Cold-Drawing of Bars

Cold-finishing of alloy bars may be divided into two general categories: (1) cold-drawing, where the bars are pulled through a die with no surface removal; and (2) turning and grinding, which removes the surface. We shall consider the cold-drawing procedure in this discussion.

Cold-drawing is the process of pulling a pickled and limed bar through a die, which results in a bright, smooth finish of the section, combined with close tolerances. The alloy bars are prepared for cold-drawing by pickling in a hot solution of dilute sulphuric acid for removal of scale. This is followed by a water rinse, and immersion in a hot lime-water bath to neutralize the effects of the acid, and to aid in carrying special liquid lubricants into the die.

Alloy bars may be cold-drawn under four conditions: *as-rolled, normalized* (low-carbon grades only), *annealed* (lamellar or spheroidized), or *quenched and tempered*. These conditions are determined by the grade of alloy steel, the resultant hardness, and the mechanical properties desired for a given end use.

In cold-drawing, the alloy bar is machine-pointed, to reduce the size at one end so it will pass easily into the die opening. Otherwise, the bar is pushed or extruded into the die by an auxiliary device. A die-holder, which can be made to contain from one to four dies, is mounted in an appropriate head assembled across a "draw bench," so that from one to four bars can be drawn at the same time. The draw bench has a bed which accommodates a 4-wheel buggy with jaws that grip the pointed ends of the bars as they emerge from the dies. The buggy has a hook on one end which engages an endless chain, thus pulling the bars through the dies for their entire length.

After cold-drawing, each bar feeds automatically into a straightening machine, and is sheared or "cracker-cut" to length on appropriate machines. Saws are used when the cross-sections of the bars are too large to be cracked or sheared, or when clean square ends are required.

Smaller sizes in the form of coils are drawn on "bull-blocks," or "wire-blocks," depending on sizes, followed by straightening and cutting on special machines.

Specifications with respect to chemical composition, grain size, hardenability, and the like, of cold-drawn alloy steels have been given long study by Bethlehem metallurgists. If you would like suggestions on cold-drawn products, or any other problem concerning alloy steels, our metallurgists will be glad to give you all possible help, without cost or obligation on your part.

In addition to manufacturing the entire range of AISI alloy steels, Bethlehem produces special analysis steels and the full range of carbon grades.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

Export Distributor:
Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

where there is a high labor content. This approach was more flexible, permitting individual machines to be introduced as soon as they were developed without waiting for completion of a fully automatic line, according to W. D. Boynton, assistant superintendent of engineering here at Laureldale.

A study of the 400 different operations that go into the manufacture of a mesa transistor showed, for example, that there were several operations which were already being performed on a large-batch basis where mechanization was difficult to justify. For example, 700 pairs of gold and aluminum stripes can be deposited on a single slice of doped germanium crystal, measuring about ¾ in. in diameter, in a single operation.

(A nickel mask with tiny slots is used to produce stripes with required dimensions in much the same way as a stencil is used in painting.)

Three crystals already were being deposited in one vacuum chamber in a single operation, providing 2,100 potential mesa crystals. Thus a handful of operators and vacuum chambers could easily meet large-scale production needs without mechanization. Furthermore, the yield is relatively independent of operator skill. After the stripes are deposited, the large crystal is cut into 700 0.020 x 0.020 in. squares.

Western Electric found that mechanization could pay off for most of the operations. For example, the bonding of gold wires to metallic stripes presently is performed by a highly skilled operator, viewing the work through a microscope, and using a number of micrometer controls to position the work and the tool. An experienced operator can turn out about 35 to 40 units per hour.

With a new mechanized wire bonding machine under development, the production rate should be increased by a factor of 10-1, to over 300 per hour. Equally important, the number of rejects should be reduced and the yield will be less dependent upon individual operator skill.

A new fully automatic machine will evacuate, bake, back-fill the transistor case with inert gas and then seal it off with a cold-weld pinch operation at a rate of 800 to 1,300 per hour, compared with a manually controlled machine which now turns out only 50 units per hour.

By mid-1961, when Laureldale expects to have one of each type of machine in operation, approximately 95% of the manufacturing operations involved in producing 2N559 transistors will be mechanized. This will include automatic testing equipment, both at intermediate stages of fabrication and for final 100% inspection. Each transistor will be tested for 12 key parameters.

Accelerated life tests will be conducted on 1,065 units out of every batch of 10,000 transistors. Units will be operated at higher powers and elevated temperatures to step up the failure rate. If the sample fails to meet accelerated life tests standards, the entire batch will be rejected.

Dr. Morton says that for the first time, sufficient test data is available to make it possible to establish a direct correlation between transistor life and junction temperature, making it possible to accurately extrapolate from accelerated life test data to predict reliability under normal operating conditions.

With a mechanized manufacturing facility, Western Electric expects that it will be able to double its present yield of good transistors. (Yield is measured from the time a large slice of germanium crystal with deposited stripes is cut into tiny wafers until the finished unit emerges from final test.) Company also believes that mechanization will drop the cost of 2N559 mesa transistors from approximately $13 each to $3 per unit.

miller WELDERS



AND BOTH MILLERS... *Through and Through*

BIG TWIN combination ac-dc welders work from single phase service — deliver new convenience and economy. Two a-c amperage ranges of 20-125 and 60-290 plus two d-c ranges of 18-100 and 65-290 amps master nearly every welding requirement from light gauge metal to structural pieces. Movable shunt type transformer affords infinite current adjustments. Other features include: Horizontal design for easy stacking; weather-resistant construction and Class B insulation; Miller-built semi-metallic rectifier for best d-c welding; high open circuit voltages and new weld stabilizer. This is THE all-time, all-around welder!

LITTLE TWIN ac-dc combination welder has two a-c amperage ranges of 20-115 and 60-180 plus one d-c range of 40-150. Operating from single phase service, this Miller model incorporates many design and construction features usually found only in large industrial types. These include really rugged construction, forced air cooling, new Miller semi-metallic rectifier, movable shunt type current control, new weld stabilizer and open circuit voltage in abundance. Power factor correction is available on both models. Complete specifications on either model will be sent promptly upon request.

miller ELECTRIC MANUFACTURING COMPANY, INC. • APPLETON, WISCONSIN

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Your present ability and potential in a space-age specialty are important to Chance Vought. And you know from experience that advancement comes quickest when ability can be used immediately, *demonstrated* to the fullest.

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One Vought division may well stand out *today* as a place for your most rapid advancement. Why not write for further information?

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DALLAS, TEXAS

PRODUCTION BRIEFING

Ryan Aeronautical Co. will produce additional Q-2C turbojet-powered missile targets for USAF under a $10 million follow-on contract. Order will carry production into mid-1961.

Linde Co., division of Union Carbide Corp., is producing liquid hydrogen in quantity at its Tonawanda, N. Y., plant. Unit can produce more than 25,000 liters a month with less than two parts per million impurities.

Standard Railway Equipment Manufacturing Co.'s Special Products Division will install jet blast deflector fences for United Air Lines at all airports at which the airline now operates jet transports, or will begin jet service by mid-1960. A 200-ft. section of 7-ft. fence is already installed at United's passenger terminal at New York International Airport.

International Telephone & Telegraph Corp.'s Federal Division will produce tests sets to check out Army's Lacrosse missile guidance equipment under a $600,000 follow-on contract from Martin Co., Lacrosse prime contractor. Division's contracts for test equipment phase of Lacrosse total $1.3 million. Lacrosse guidance contracts held by Federal total $8.4 million.

Hamilton Standard Division of United Aircraft Corp. will design and produce the air conditioning system for the Northrop T-38 turbojet trainer. System will be an air cycle type designed to be used interchangeably in the Northrop N-156F fighter.

Consolidated Electrodynamics Corp.'s Datalab Division will build magnetic tape recorder-reproducers for use in Army-ARPA Project Courier under a $200,000 contract from Western Development Laboratories, Government and Industrial Division, Philco Corp.

Westinghouse Electric Corp.'s J34-WE-48 turbojet has been approved for production by BuAer and is scheduled to become operational in North American T2J-1 trainer next month. Engine has undergone more than 1,500 hr. of test, including flight evaluation and 150-hr. military qualification test. Engine has single-stage turbine; earlier models had two-stage turbines.

East and West Coast regional marketing offices are being established by Chance Vought, Inc., Dallas, Tex., to expand activities in areas of subcontracting, subsystems, components and special services for Aeronautics, Astronautics and Electronics divisions of the



VOUGHT'S OPAL ADDS ACCURACY TO MOBILITY

Even the most complex missile can be made to keep up with a mobile task force. In fact, portable plants producing liquid oxygen now travel with the big missiles they fuel. The problem is, mobility means more than this.

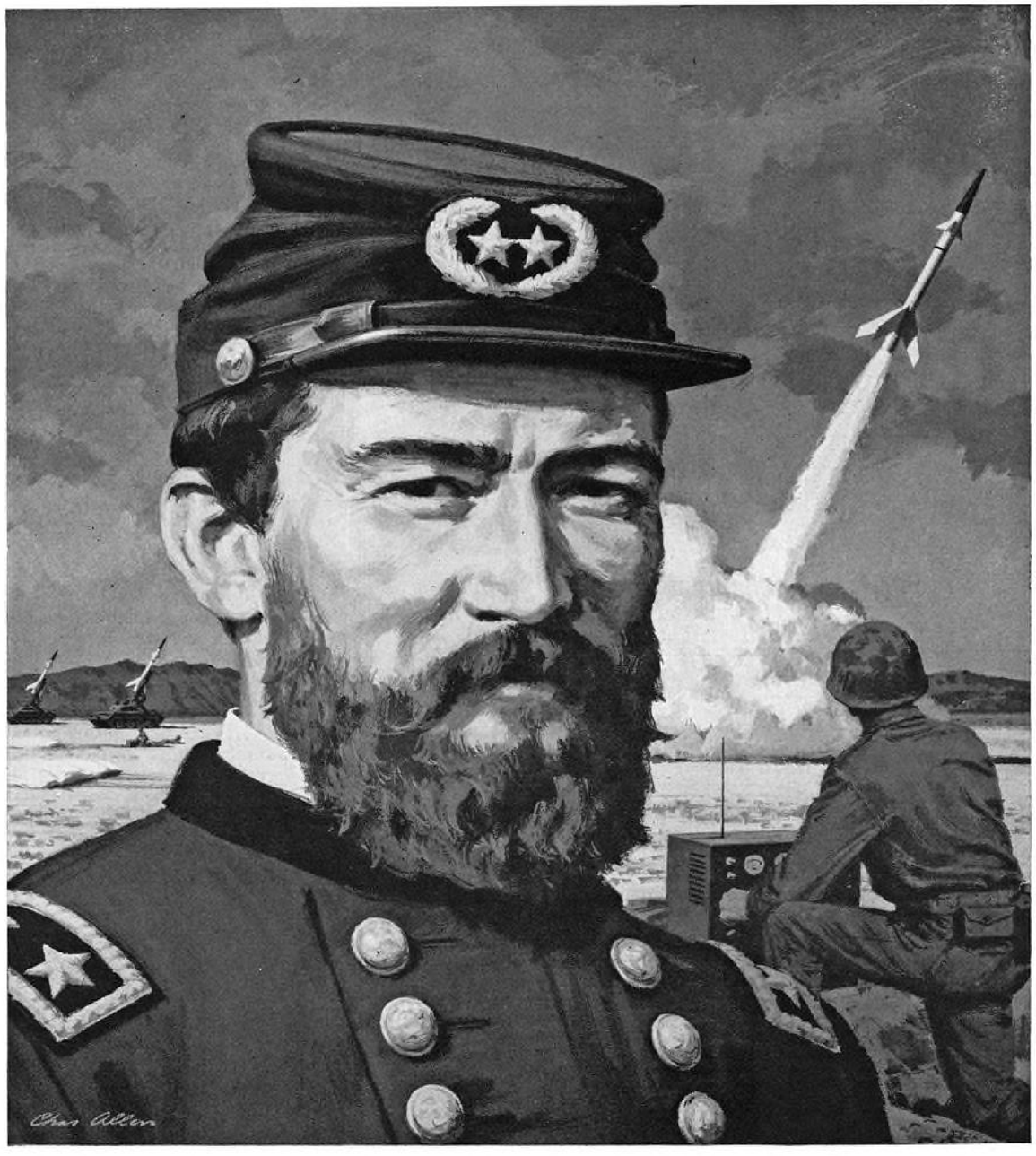
Accuracy must be transportable, too. To the soldier on the launching team this means knowing *his own* location as well as the enemy's. This requires a means for instant orientation in the field.

This soldier would appreciate OPAL, a 35-pound electronic and optical package developed by Vought Electronics, a division of Chance Vought Aircraft, Incorporated. OPAL (Optical Platform Alignment Linkage) uses high precision optics and a sensitive detector to align remote inertial navigation systems in azimuth or to align entire missile systems. OPAL is fast. It is precise to within seconds of arc accuracy. It is sufficiently rugged to be air-dropped.

OPAL is typical of a lengthening list of Vought Electronics products — products which have battlefield applications. The alignment device, for example, is one of many items of ground support equipment in which the Vought division is qualified. Antennas and related electronics form another broad area with Army applications, and automatic power controls — including hydraulic actuators — form a third.

In addition to its development activities, Vought Electronics manufactures military systems and components. Other major interests are being advanced in the company's Aeronautics, Astronautics, Range Systems and Research Divisions.

CHANCE VOUGHT
DALLAS, TEXAS



"If we can move...we can whip 'em"

Cavalryman Phil Sheridan kept his maps in a pocket of his muddy coat. He read them like other men read their mail. "If we can move . . . something like this," he would suggest, with his finger tracing a bold path, "I think we can whip 'em." Sheridan, Lee, Stuart and the Civil War's other masters of mobility gave the world some classics of maneuver. Today their influence on U. S. Army tactical concepts is doubly significant. The Army's perimeter has become global. Threats must be met at any point on the compass. Movement in the Sheridan spirit is the answer: units that can move 4,000 miles in a day, and weapons specifically designed to move with them.

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Only the New
Cherrylock
Aircraft Rivets
Give you ALL
these advantages . . .

★ *Positive Mechanically Locked Stem*
★ *Flush Fracture (No Stem Trimming)*
★ *Strong Clinch*
★ *Wide Grip Range*
★ *Positive Hole Fill*

The Cherrylock* "2000" Series Locked Stem Rivet offers every feature desired in an aircraft blind rivet . . . proven high sheet clamp-up with no stem trimming (fractures flush on installation), uniform head seating, complete hole-fill, wide grip range, and positive mechanically locked stem.

Fast, economical, easy installation (with no stem trimming) is available with Cherrylock rivets, using existing Cherry installation guns. You get better fastening at lower installed cost.

One rivet can be used for several material thicknesses, reducing stock requirements and lowering costs. Positive hole-fill, even in oversized holes, simplifies preparation problems to further reduce installation costs. Available in:

A-286 Stainless Steel—Monel—Aluminum

For technical data on the new Cherrylock "2000" Series rivets, write Townsend Company, Cherry Rivet Division, Box 2157-N, Santa Ana, California.

**Patent Pending*

CHERRY RIVET DIVISION
SANTA ANA, CALIFORNIA
Townsend Company
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Cape Contracts

Cape Canaveral, Fla.—Recent Cape Canaveral contract awards have included:

- $4,321,658 to the Henry C. Beck Co., of Palm Beach, Fla., for construction of launch facilities for the 1.5-million-lb. thrust Saturn space booster awarded by the Army Corps of Engineers, Jacksonville, Fla.
- Unspecified amount to Gainesville (Fla.) Scrap Iron and Metal Co. for complete dismantling of the missile launcher and tower for the now-canceled Air Force-North American Navaho 5,000-mi. range cruise missile awarded by the chief of redistribution and marketing, Air Force Missile Test Center.

company. Manager of the regional marketing operation is William L. Hoffman; Edward Davis will manage the West Coast office in El Segundo, Calif., and Carlton A. Van Emon will head the East Coast office at Garden City, Long Island, N. Y.

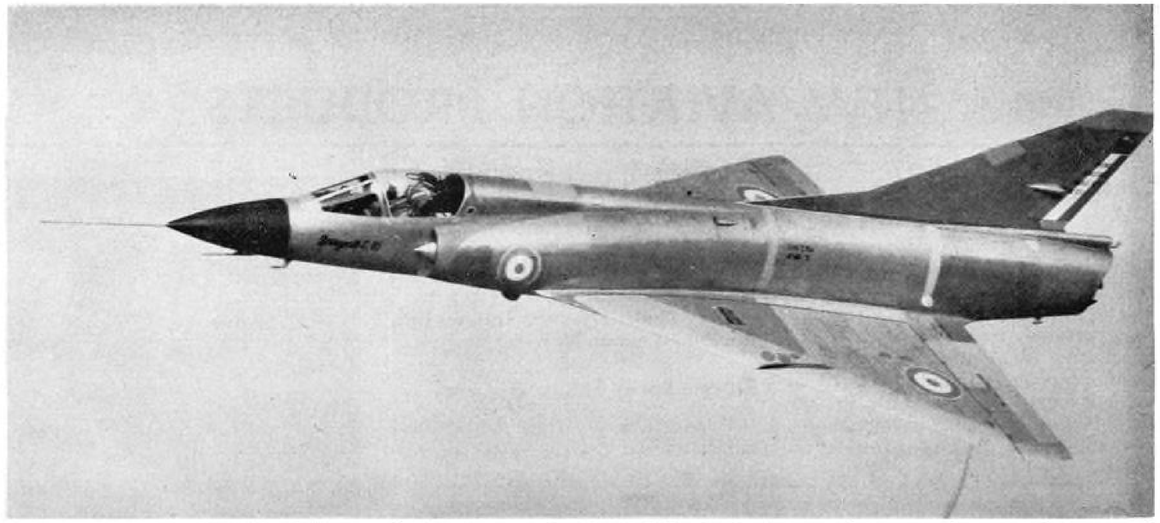
Federal Aviation Agency certificated the Boeing 707-220 after a 65½-hr. flight-test program. Approval is under the original type certificate issued for the 707-120.

Kearfott Co., subsidiary of General Precision Equipment Corp., will design, develop and manufacture hydraulic control systems for the Pershing missile under a contract from Army Ballistic Missile Agency. Each system controls the rate of motion and the angular position of two synchronized rotary output shafts which drive the jet fins and aerodynamic control fins of the missile.

Semicon of California, Inc., Watsonville, Calif., reports it is equipped to fabricate parts from pure tungsten. Porous tungsten of controlled particle size and porosity can be manufactured by the company for filters and ion sources.

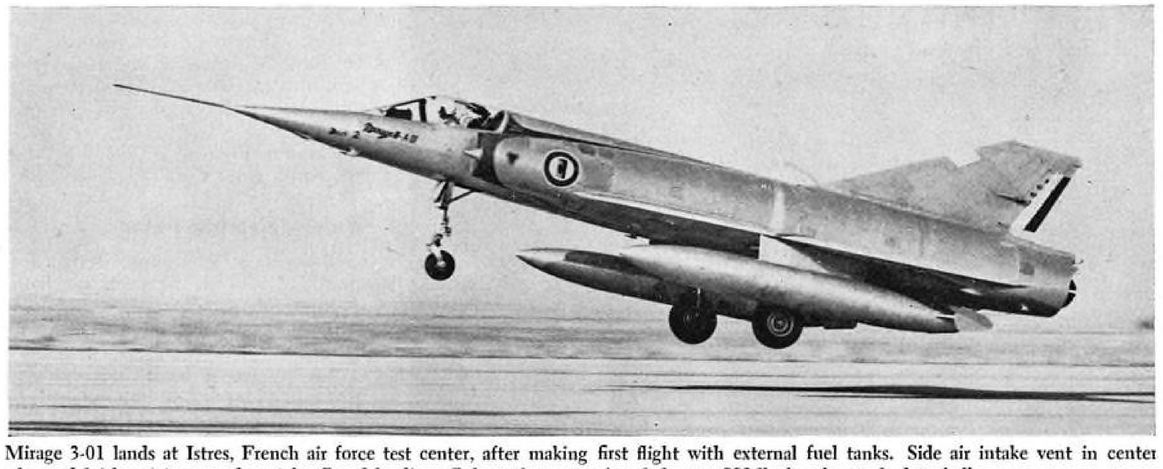
Optomechanisms, Inc., Mineola, N. Y., has developed a satellite photometric monitoring system for Air Force Cambridge Research Center which records instantaneously the reflected light and angular rate of an object in space. System has recorded eighth magnitude stars in twilight and first magnitude stars in mid-daylight, company reports. System weighs 60 lb.

Librascope, Inc., will produce guidance computers for Centaur space probe under a $1.8 million contract from Minneapolis-Honeywell, which is developing Centaur's inertial guidance system for Convair Astronautics Division of General Dynamics Corp., prime contractor on the NASA project.



First photo shows Dassault Mirage 3-05 preproduction interceptor-bomber in flight. Production rate of nine aircraft per month is expected to be reached by mid-1961 (AW Aug. 17, p. 102). First production model is scheduled to be rolled out in September, 1960.

First Photo of Preproduction Mirage in Flight



Mirage 3-01 lands at Istres, French air force test center, after making first flight with external fuel tanks. Side air intake vent in center of roundel (above) is opened on takeoff and landing. Below, the same aircraft has an 882-lb. bomb attached to belly.



NEW AVIATION PRODUCTS

Shock, Reliability Tester

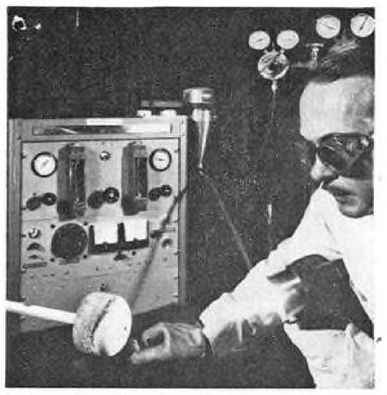
Mechanical shock test machine can be readily converted to a low frequency, high amplitude vibration tester by installing a suitable flywheel cam.

The 3 in. displacement of the shock table permits "in service" loadings of shock and vibration to be placed on components undergoing full operational or duty cycles. The arm and table may be placed in chambers for simultaneous environmental testing. Specifications include: Shock table load, 4,000 lb. (wt. specimen x g), table size 15 x 15 in., shock motions displacement 3 in., time interval minimum .006 sec., time interval maximum .100 sec. acceleration 1 to 150g, over-all size 8 x 4 x 3 ft.

J. T. Muller Dynamic Testing, Inc., Box 296, Hanover, N. J.

Plasma Spray Gun

Hand held plasma spray gun permits fabrication with refractory metals, carbides, borides, silicides and nitrides.



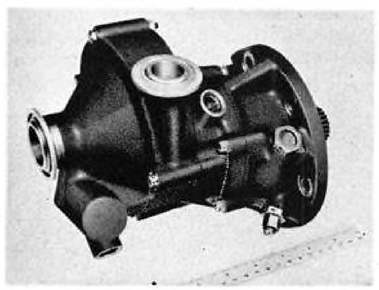
The gun weighs less than 4 lb. and is 3½ in. long. The unit will operate on such gases as argon and nitrogen at power levels to 40 kw. The manufacturer says materials such as titanium carbide, tungsten, chromium or titanium can be deposited on most ceramic base materials or metals without metallurgical, crystallographic or chemical charges.

Giannini Plasmadyne, 3839 S. Main St., Santa Ana, Calif.

Water Injection Pump

Water injection pump, designed to operate 1,500 hr. between overhauls, is applicable to cryogenics, non-lubricating and corrosive liquids and exotic liquid propellants.

Sundyne pumps have a rated capacity of 85 gpm. and can be modified for greater capacity. The pumps use either a gearbox power source or can be coupled directly to a high speed drive. Metering capability, regardless of variations in inlet and discharge pressures, eliminate pressure regulators and control valves.



Sundstrand Aviation, Rockford, Ill.

Liquid Oxygen Valve

Liquid oxygen relief valve is designed to protect thermal insulated ground support equipment. In addition to liquid oxygen, the valve is applicable to liquid nitrogen and other cryogenic fluids.

Valves have "pop action" seating and reseating. Pressure setting in a range from 75 to 450 psi. may be specified.



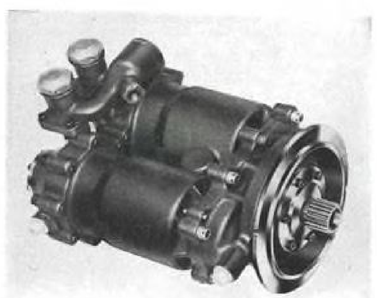
Sizes available are ¼ in. to 1½ in. NPT male inlet connection. Pipe-away adapters are available for most models.

Bastian-Blessing Co., 4201 West Peterson Ave., Chicago 46, Ill.

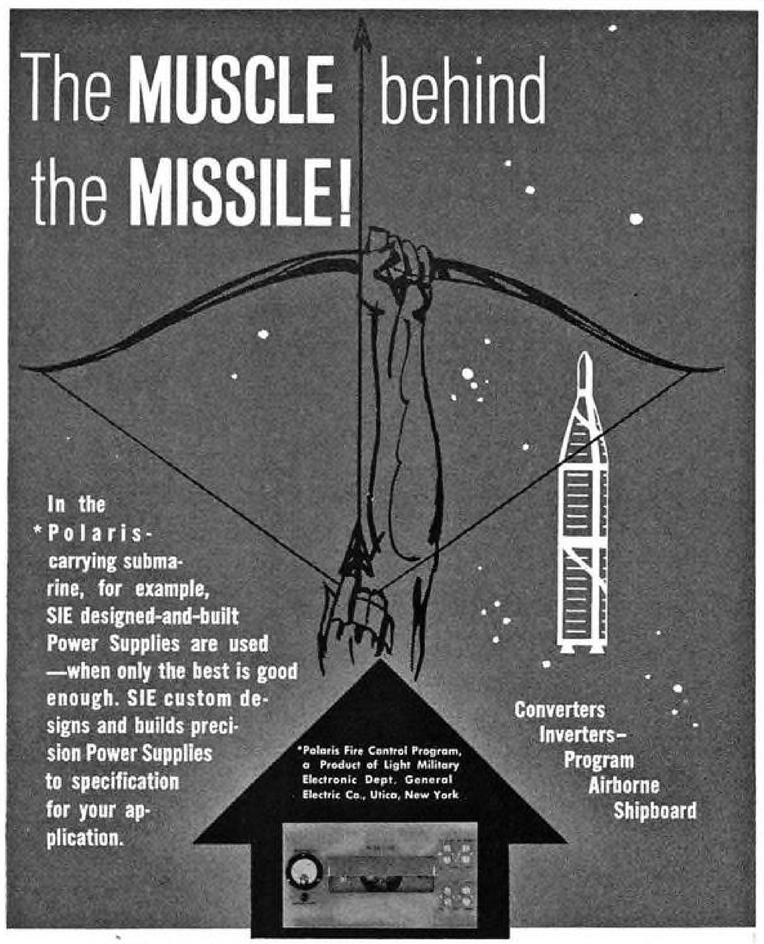
Aircraft Hydraulic Pump

Hydraulic pump is designed to maintain system pressures of 4,000 psi. full flow at fluid temperatures of 550F.

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Pesco Products Division, Borg-Warner Corp., 24700 N. Miles Rd., Bedford, Ohio.

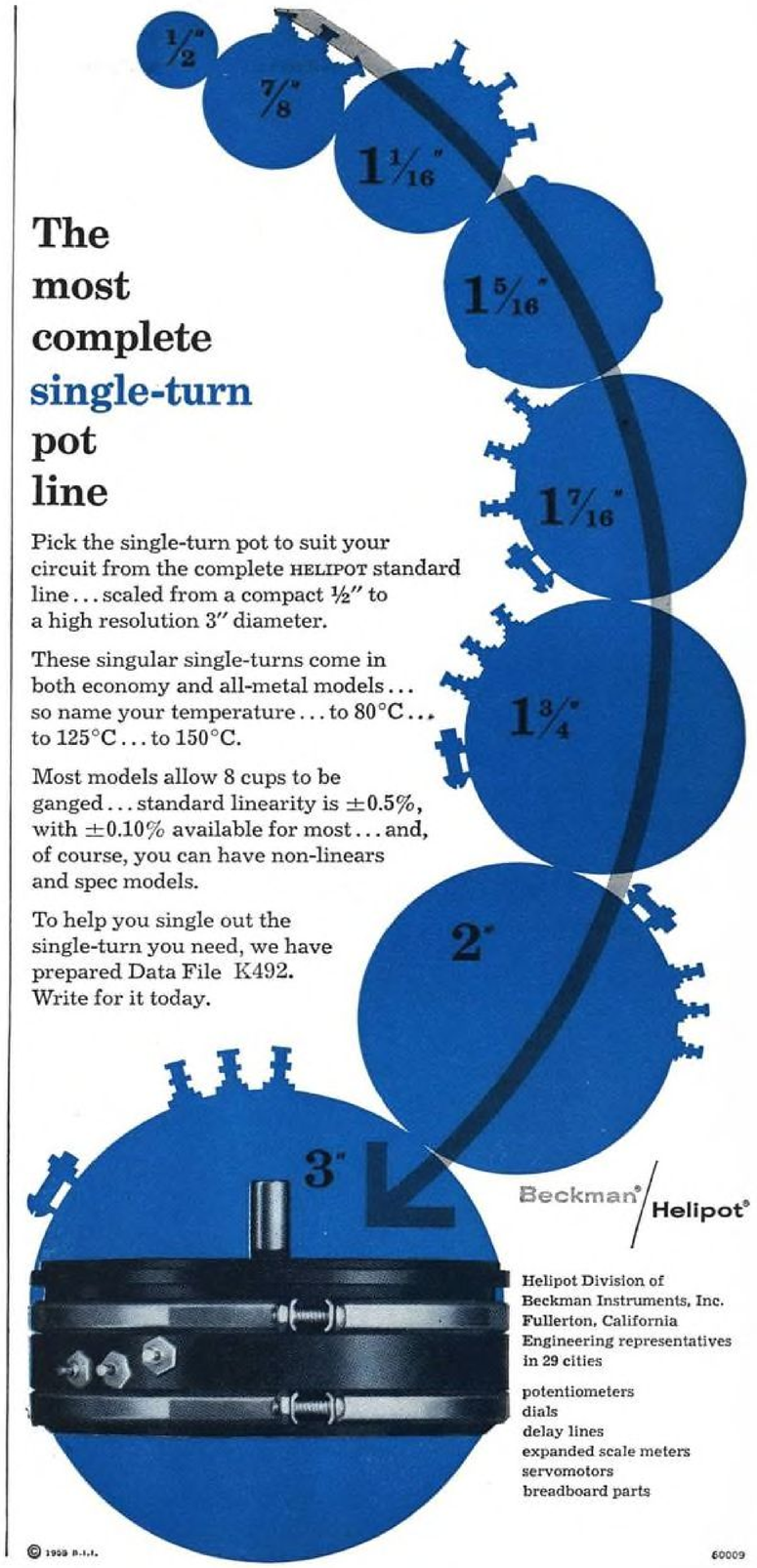


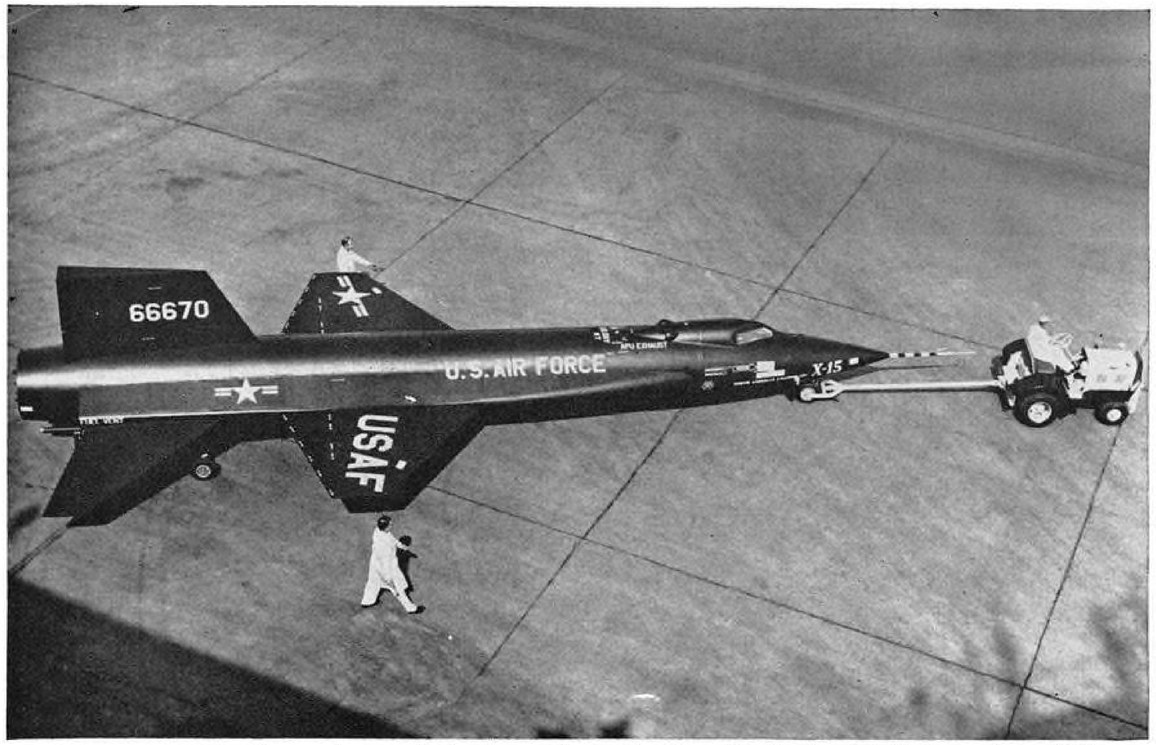
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NORTH AMERICAN'S X-15 hypersonic research aircraft uses wire developed especially for America's first manned space flight.

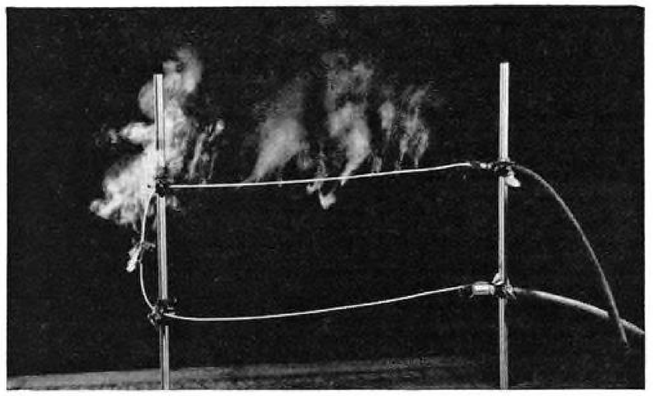
Here's how space-age wire problems are being solved at America's foremost wire research laboratory

Specific contracts awarded to Autolite for basic wire research attest to the major importance of high-performance wire to America's space pioneering.

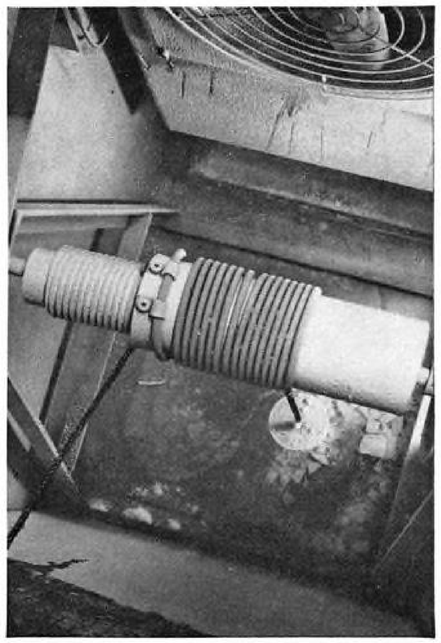
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CORONA problems are compounded as air density decreases at higher altitudes. Corona can seriously disturb other electrical circuits, power losses are increased, and in extreme cases, insulation may fail completely. Testing the wire in a vacuum simulating high altitudes reveals the effectiveness of the insulation material.



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LOW TEMPERATURES cause many insulations to become hard and brittle. At the same time, the wire may also be subject to severe vibration. This cold-flexing test indicates the ability of wire and cables to withstand these aspects of a space environment.



ROBERT BARKER, Manager of Autolite's Port Huron Engineering Laboratories, and H. W. Borgman, Section Engineer, discuss wire designs at Port Huron with E. G. Vincent, Senior Design Engineer, and N. H. Dukes, Purchasing Supervisor, of North American Aviation, Inc. With a background of a number of research projects carried out successfully for military aircraft and missile manufacturers, the Port Huron Laboratory is America's foremost authority on wire for these pioneering fields. The knowledge and facilities of this Laboratory are available to all Autolite customers.

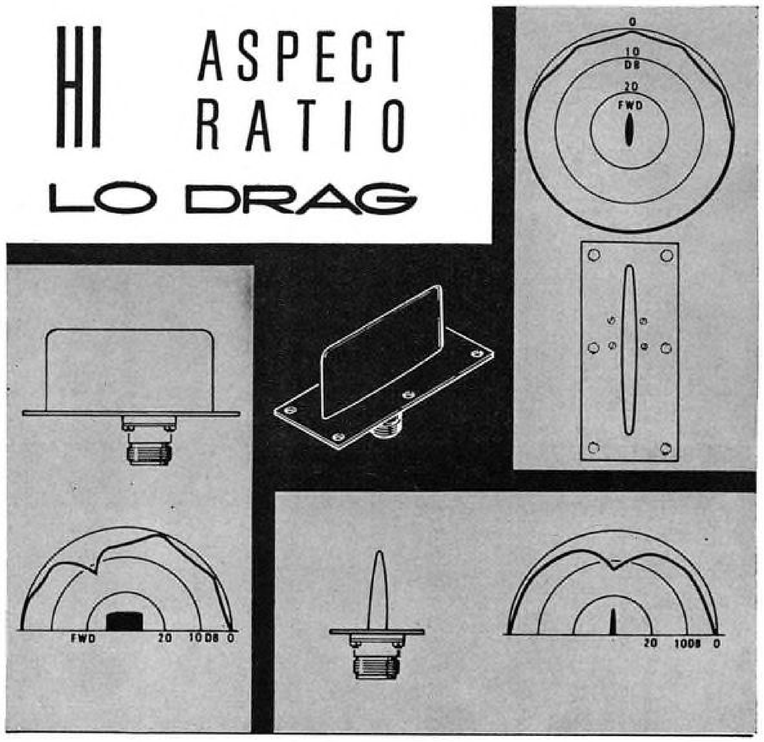
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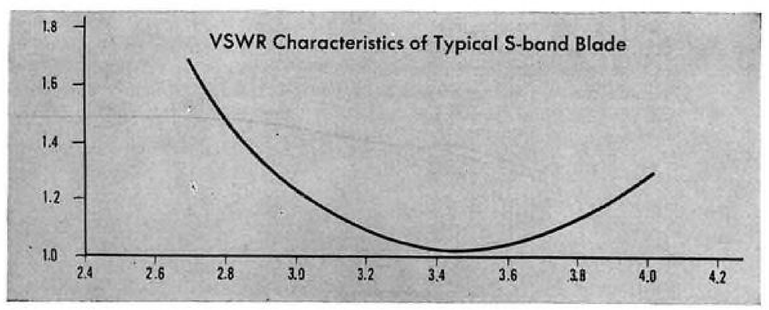
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WHAT'S NEW

Reports Available:

The following reports were sponsored by the Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C.:

Methods of Flight Vehicle Noise Prediction—by P. A. Franken and E. M. Kerwin, Jr., Bolt Beranek and Newman, Inc. for Wright Air Development Center, U.S. Air Force, Nov., 1958. $3.00; 191 pp. (PB 151827).

Vibrations In Helicopters: Training Considerations—by R. J. Randle, Jr., Aero Medical Laboratory, Wright Air Development Center, U.S. Air Force. March, 1959. $.50; 10 pp. (PB 151-824).

An Electrolytic Saw—by M. Metzger, University of Illinois for Office of Naval Research. March, 1958. $.50; 8 pp. (PB 151574).

Graphite Technology—by S. W. Bradstreet, Armour Research Foundation for Wright Air Development Center, U.S. Air Force. Jan., 1959. $2.00; 73 pp. (PB 151682).

Effects of Several Impregnants on the Oxidation Resistance of Graphite—by P. T. Whelan, Watertown Arsenal, U.S. Army Ordnance Corps. No date. $.75; 23 pp. (PB 151575).

True Position Dimensioning—by D. Bibeau and D. Sweet, Bendix-Scintilla Division, Bendix Aviation Corp., Sidney, N. Y. An explanation of the system, it's theories and practical application. 1-10 copies $3.00 each; 10 or more $2.50. 28 pp.

Motorola Zener Diode Handbook—Motorola, Inc., 5005 E. McDowell Rd., Phoenix, Ariz. Contact Semiconductor Products Division for additional information. Manual covers basic theory, design characteristics and applications for zener diodes. $1.00; 130 pp.

Proceedings of the Midwestern Conference on Fluid & Solid Mechanics—Engineering Institutes, Division of Extension, The University of Texas, 18th and Red River Sts., Austin, Tex. Report of the meetings held at the University of Texas in Austin on Sept. 9-11, 1959. $12.50 per volume.

Combustion-Driven Oscillations Bibliography—by Abbott Putnam and Carl Speich, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio. Over 550 references to literature on pulsations and noise associated with combustion, 1940-1959. Copies may be obtained free of charge by contacting Battelle's publications office.

BUSINESS FLYING



SECOND prototype M.222 Flamingo, is composed of wood-metal-plastic construction. Builder envisions a future all-metal version.

Second Flamingo Ready for Initial Flight

By Edith Walford

Vienna, Austria—Completion of the second prototype M.222 Flamingo, built by Simmering-Graz-Pauker A.G., was stepped up following the crash of the first prototype in August.

The second prototype of the aircraft, designed for the European business and sport flying market, is identical to the first model except that it has a more luxurious interior.

It is currently waiting its first flight at SGP's Simmering works near Vienna, pending an Air Ministry decision on whether a government or company pilot should flight-test the aircraft.

The prototype crashed after a series of flight maneuvers and killed both pilot and mechanic.

SGP's design team under chief engineer Erich Meindl started work on this four-seat aircraft in October, 1957. Its development from drawing board to flight test stage has taken a little more than a year.

First flight was made on May 15 and

LOW silhouette is emphasized in this side view of the Flamingo. Austrian plane is in the $31,000 price class.



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FLAMINGO undergoes taxi trials near Simmering-Graz-Pauker plant at Vienna, Austria.

it was demonstrated for the first time at this year's Paris air show (AW July 27, p. 68).

While waiting for results of the official investigation of the crash, the company started a private investigation of its own. SGP later said it was satisfied the accident was not due to any structural weakness of the aircraft. This was subsequently supported by several foreign experts and the official accident investigation analysis just released further confirms the company's private findings.

Chief pilot of Austrian Airlines, Eduard Stefl, was flying the plane when it crashed around noon on Sunday, Aug. 2. Stefl had spent much of his free time in flight-testing the M.222. Eduard Brückner of the Air Ministry, Vienna, government chief test pilot in charge of the aircraft test program, was away at the time. This was the 65th flight for the plane.

Normal Maneuvers

Witnesses say that Stefl, accompanied by SGP's chief mechanic Eduard Schwingenschloegel, took off in ideal weather. He flew at an altitude of about 6,500 ft. for about 50 min. during which he put the aircraft through a normal series of flight maneuvers and then came in to land with only the starboard engine operating. Losing height rapidly, the plane made two very tight left-hand circles over the landing strip at what looked like an abnormally low speed. At this moment, observers say, full power was developed on the starboard engine. The aircraft rolled and crashed from a height of about 200 ft.

The Flamingo is powered by a pair of O-320-A Lycoming engines rated at 150 hp. at 2,700 rpm. Ceiling is about 21,000 ft.; cruise ceiling on one engine 7,872 ft. Range is 745 mi. at a cruise altitude of 6,560 ft.

Engineers gave special design attention to short takeoff and landing performance—985 and 557 ft. respectively. HOCO variable-pitch propellers are made by Hoffmann & Co., Bavaria, the only German firm in the field. Later models of the M.222 are to be equipped with U.S.-built Hartzell propellers.

The cabin has two front and two rear upholstered, adjustable seats. Baggage compartment aft can accommodate a fifth passenger. The one-piece plastic canopy allows both pilot and passengers a good, all-around view and can be pushed back for easy entry or exit or to allow unwieldy cargo to be loaded conveniently. Heating installation is also provided.

Forward Section

Forward section of the steel-tube fuselage frame is aluminum-alloy plated and the rear section has a plastic shell.

The laminar-profile, plywood-covered wing is constructed in one piece and bolted to the fuselage by its main spar.

Landing gear and nosewheel retract hydraulically.

Tail controls are statically and aerodynamically balanced and elevator and rudder can be trimmed during flight. The ailerons are fitted with an adjustable trim tab.

Total fuel capacity, carried in wingtip tanks, is 68.6 gal. Fuel tanks are fitted with visual content indicators.

Karl Zach, technical director of SGP, favors the present composite wood-metal-plastic construction of the M.222 which, in his opinion, gives the aircraft considerable aerodynamic advantages. But he envisages an all-metal version in the near future to meet potential demand overseas.

Although a price for the Flamingo has not yet been fixed, the company originally said it would be close to $31,620. The goat-skin covered seats, with which present models are being fitted, plus one or two other interior refinements, will probably increase the price slightly. Radio, avionic equipment and compass are optional extras.

With the Flamingo, SGP entered into the field of aircraft design and construction for the first time and was severely criticized for doing so by some other Austrian industrialists and small-scale aviation experts. SGP, who up to now has concentrated on the manufacture of locomotives and all kinds of diesel-powered vehicles, has built up a sound reputation in this field.

M.222 Flamingo Specifications

Dimensions	
Span	36 ft.
Length	28½ ft.
Height	10½ ft.
Wing area	184 sq. ft.
Weights	
Gross weight	2,310 lb.
Payload	1,540 lb.
Maximum cruising weight	3,850 lb.
Powerplant	
Two O-320-A Lycoming engines	
Takeoff power	150 hp. each
Nominal power	150 hp. each
Rated speed	2,700 rpm.
Performance	
Maximum speed at sea level	186 mph.
Cruising speed with 75% power at sea level	168 mph.
Rate of climb at sea level with maximum load	23 ft./sec.
Rate of climb at sea level with maximum load on one engine	6½ ft./sec.
Cruising ceiling	21,000 ft.
Cruising ceiling on one engine	7,872 ft.
Range at an altitude of 6,560 ft.	745 mi.
Endurance	4.3 hr.
Additional details	
Takeoff distance at an elevation of 35½ ft.	1,798 ft.
Free roll	985 ft.
Landing distance with brakes applied	557 ft.
Landing speed	69.5 mph.
Fuel consumption at cruising speed	15.8 gph.
Fuel capacity	68.6 gal.

Beech 1960 Backlog Reaches $24 Million

Wichita, Kan.—Seven models of its executive aircraft line are in production by Beech Aircraft Corp. here for 1960. The company, which expects to sell more than $45 million worth of executive planes next year—approximately $5 million more than in 1959—is starting its 1960 sales year with a commercial aircraft backlog of more than $24 million. The new line includes:

- **Twin-Bonanza,** which this year features an airstair door, providing direct entry into the right side of the fuselage behind the wing and individual track-mounted seats and increased head room, will list for $95,500 for the standard H50 340-hp. supercharged version, and $83,000 for the standard D50C 295-hp. high compression model.
- **Four-place Debonair,** of which approximately 300 will be produced in its first year, will list for $19,995.
- **Travel Air light twin,** which will have an additional 19 in. of cabin interior length giving an additional 17 cu. ft. of area, will be marketed at no increase in the basic price of $51,500. A new, larger tail and larger flaps are external design features of the new Model B95.
- **Super G18 twin Beech,** priced at $126,000, has a completely revised cockpit and new windshield design providing increased visibility. Gross weight is increased to 9,700 lb.

Also in the new line are the six-place twin engine Beech Queen Air (AW Oct. 26, p. 132) and the restyled four-place M35 Bonanza, which featured square wingtips.

The 1960 line will be displayed at Atlantic Aviation Corp.'s facility at Teterboro, N. J. on Dec. 12-13.

PRIVATE LINES

Expansion of light plane facilities has been completed at Cambridge, Md., airport, with installation of a 3,000-ft. hard surfaced runway, with lighting available on request, 80-100 octane fuel, storage and maintenance operations. Choptank Aviation Co., has been named operator of the facility.

Piper delivered its 50,000th airplane, an Apache light twin, which went to Firwood Manufacturing Co., Dearborn, Mich., which will continue to operate its original Super Cruiser on utility duty. Piper is currently producing 13 business and utility aircraft daily.

Controlling interest in Callair, Inc., agricultural aircraft manufacturer, has been purchased by John Mangum, Jr., Bay City, Tex., a company dealer since February 1957.

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- Polaris
- Minuteman
- Nike Hercules
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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Vitro Engineering Co. Division, Vitro Corp. of America, New York, architectural and engineering construction inspection services, (PR PD-8-S-1083), $27,483.

General Precision Laboratory, Inc., Pleasantville, N. Y., components of AN/APN-102 doppler radar sets, spare parts, maintenance tools and test equipment and related data; end use; modification of RB-47H aircraft, (PR's OC-9-16K1-RB-47-12773, EC-9-4950 and MD-O-5841-15080), $300,000.

McGraw-Edison Co. Instrument Division, Thomas A. Edison Industries, West Orange, N. J., 39,584 ea., transmitters, temperature, type MS24482-1, Aerno 61-2435; 6,174 ea., bulbs, electrical resistance, type G-1, Aerno 61-0219, for use on C-119, C-121, C-124 and C-131 aircraft, IFB 33-600-60-7 PR MA-9-05D1167), $215,249.

The Lewis Engineering Co., Naugatuck, Conn., 4,493 ea., indicators, temperature, thermocouple, engine exhaust, type MJ-4, Aerno 61-8843, for use on F-100D and F, F-105A, F-84 and T-33A aircraft, IFB 33-600-60-7 (PR MA-9-05D-1167), $142,652.

Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J., 20 ea., R-1820-84A engine for HUS-1 aircraft, 16 ea., R-1820-84B engine for HUS-1G aircraft, (MIRP's R59-1979-115-NOas and R60-3910-7-NOas), $1,135,056.

Kollsman Instrument Corp., Elmhurst, N. Y., type C-2A computers, data, spare parts, tools and test equipment for B-52G and B-66 aircraft, (PR's EA-9-05C-4624 and MA-9-05C-791), $536,977.

Federal Systems Division, International Business Machines Corp., Oswego, N. Y., engineering and management services used in the B-52 series aircraft, (PR EG-9-11A-4774), $734,523.

Aeronautical Division, Minneapolis-Honeywell Regulator Corp., Minneapolis, Minn., 300 ea., cagable vertical gyros, P/N JG 7044N-2, Aerno 64,0511 and 200 ea., horizontal yaw-roll gyros, P/N JG 7044M-3, Aerno 60-0517, replenishment spares for F-100D and F aircraft, (PR WR-9-1280-4572), $344,000.

Crucible Steel Co. of America, Midland, Pa., columbian sheet rolling program, (PR BM-9-MMP-9142), $250,000.

U. S. Gauge Division, American Machine and Metals, Inc., Sellersville, Pa., 226 ea., transmitters, pressure, synchro style, type MH-5, Aerno 61,2479 and data, for aircraft usage on C-130B, F-105D and E, F-106A and T-38A, (PR EA-9-6610-4785), $43,896.

Dayton Aircraft Products, Inc., Fort Lauderdale, Fla., 1,900 ea., Army-locking, P/N 48-B-4348 and 3,800 ea., Link-locking, P/N 47-A-4675, applicable to U-2A bomb rack, (PR WR-O-FSC10-3955), $33,098.

Sperry Phoenix Co. Division, Sperry-Rand Corp., Phoenix, Ariz., components for the MA-2 automatic flight control system used in the B-52 aircraft, (PR's EG-9-05F-4670 and MA-9-05F-527), $793,750.

Gilfillan Brothers, Inc., Los Angeles, Calif., nine ea., modification kits, MK-381/GPQ-T1A, spare parts, for attachment to the AN/GPQ-T1A ECM trainer), (PR EM-9-6910-6411), $150,000.

General Electric Co., West Lynn, Mass., 429 ea., starters, combustion, aircraft engine, type STU-7/A, Aerno 42-8753 and data, (PR MO-9-03J-1212 and amendment No. 1), $1,544,400.

Lockheed Aircraft Corp., Marietta, Ga., C-130 airplanes, development, test, skis, spare parts, support equipment and data, (MIPR R59-1437-1530NOas and amendment No. 1), $2 million.

Leland Airborne Products Division, American Machine & Foundry Co., Vandalia, Ohio, 891 ea., inverters, 250VA, three to one phase, Class B, Aerno 42-2316, spare parts and data for use in F-104F, IFB 33-600-60-1 (PR's EA-0-03C-6055 and amendments 1 and 2 and SA-9-03C-9305), $219,182.

MANAGEMENT

USAF Defends Team Role Bidding Policy

By Craig Lewis

Washington—Air Force defends its philosophy of requiring weapon system team members to bid competitively to retain their team roles on grounds that the best subsystems and components available must be chosen for a new weapon system.

Industry feels that Air Force should make its new competitive philosophy clear so that bidding team members will know what they face if their team wins a competition. The issue was discussed at an astronautics marketing symposium during the annual meeting of the American Rocket Society.

USAF recently has been requiring subsystem contractors on a successful team to retain their team roles through competitive bidding. Buford M. Brown, vice president of the Westinghouse Electric Co.'s Baltimore Division, said it is important to clarify ground rules at the start so that companies joining in a team bid will know whether they must bid competitively to retain their roles after the prime contractor has been chosen.

Defending the Air Force approach, Maj. Gen. William T. Thurman, assistant for production planning in the office of the deputy chief of staff for materiel, said that USAF has to be sure that a system has the strongest elements available. He outlined these circumstances which lead to new subsystem competitions after a prime contractor is chosen:

- **Services may have been** developing components which fit into a new system chosen for development. These components cannot be ignored, and the service, therefore, must specify the component source for the prime contract.
- **While an over-all system** might be superior, an element of the losing system may be superior to the corresponding element in the winning proposal. Air Force analyzes this element in the context of the winning system and, if it looks good, it must be used simply because it is the better way to do the job.
- **Sometimes an element** of a winning proposal does not have enough data to support it or is not thought through clearly. A competition forces the subsystem team member to do the job properly or lose his place to a better proposal.

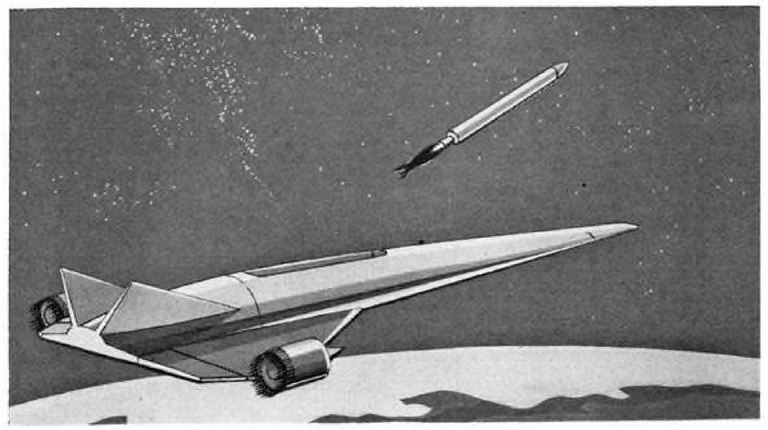
Thurman said a symposium conducted a few weeks ago indicated that many prime contractors do not realize that an increasing proportion of their work is being done outside their own companies and that there is a corresponding need to improve purchasing policies and techniques. He said this improved money management on the part of primes is vital, because they are handling more and more money as systems grow larger and fewer.

Urging increased vigilance in purchasing matters, Thurman noted that congressional pressure is increasing for the services to pay closer attention to subcontracting and to "knowing where the money goes."

Thurman also conceded that industry research costs are rising substantially in relation to procurement costs, and he said the Air Force will be more liberal in recognizing research costs in contracts. He observed that new cost principles recently issued recognize more contractor-sponsored research costs, but he said USAF has to be careful to keep companies from incurring large research bills at government expense.

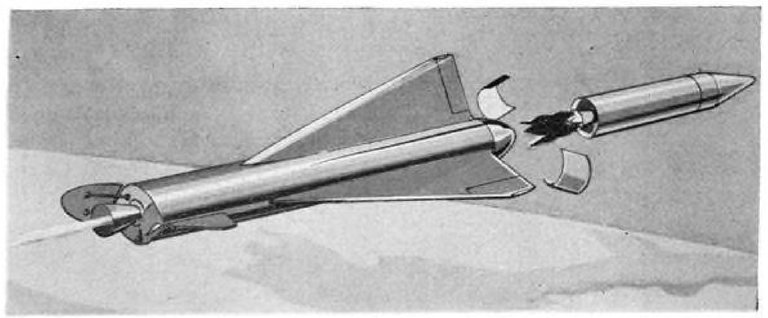
Lack of government aid was cited as a factor impeding companies in their long-range planning by Dr. A. C. Gilbert, director of space long-range planning for Bendix Aviation Corp.'s Systems Division. He said the National Aeronautics and Space Administration should take a long, hard look at its development timetable in light of budget realities and produce a firm schedule that industry can use in adapting its talents to NASA needs.

Brown said some of the services provide "pretty good guidance" for company planning, but he warned against using this guidance exclusively because it can inhibit free thinking and inde-



Recoverable Rocket Booster Concepts Proposed

Lockheed Missiles and Space Division has proposed a recoverable rocket booster system in which an airbreathing winged booster (above) would launch a second-stage vehicle at high altitude. Another proposal, below, envisions a winged first-stage booster which, after launching second stage at altitude, is programed to close clamshell doors over rocket exhaust nozzle and re-enter atmosphere nozzle-end first. As vehicle glides to ground, it would be air-snatched by a recovery aircraft, or guided by radio to a landing.





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Address	Main Plant and Headquarters: Chula Vista, California (near San Diego) Manufacturing Plant: Riverside, California Assembly Plants: Auburn, Washington; Winder, Georgia
Age	Established 20 years
Health	Financial health excellent - Sales this year, $184,000,000 Backlog approaching a quarter-billion; 68% commercial
Present Position	World's largest producer of components for flight
Experience	After years of experience in the engineering and manufacture of ready-to-install power packages, Rohr today is widely diversified in many fields of structural flight components. For instance, the design and production of such major components as fuselage sections, jet pods and struts, empennage assemblies, flap tracks, missile racks, wing leading edges, etc. Perhaps even more important is Rohr's leadership in the development and manufacture of stainless steel honeycomb sandwich panels, and advanced research in the field of practical usage of exotic metals.
Reason for these openings	Rohr is selecting successful professional and administrative personnel to join its highly-regarded team.
Business References	America's major aircraft companies
Availability	We are available for interviews whenever it is mutually convenient. Please forward details of your education and experience to Mr. J. L. Hobel, Industrial Relations Manager, Rohr Aircraft Corporation, **AW-7** Chula Vista, California

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pendent development of new concepts.

Creative thinking by industry also was urged by Kurt Stehling, rocket propulsion scientist in NASA's Office of Program Planning and Evaluation. He said NASA "must be guided by the fruitfulness and ingenuity of industry" in making its plans, and he urged industry to submit proposals as it develops ideas. He also said companies should be patient after submitting their proposals, keep in touch rather than abandoning them and keep submitting new ones.

Commenting on industry's role in the wake of the transfer of the Army's missile-space development team to NASA, Stehling agreed that the move increases NASA's in-house capability but said it eventually will mean more work for industry. He said the technical talent acquired with the Army team will be conceiving new ideas and systems for industry to produce.

Gilbert observed that NASA's in-house capability is being defined in terms of the old National Advisory Committee for Aeronautics, and he said it is proper for NASA to provide the wind tunnels and other facilities that industry cannot support.

Gilbert said NASA should stay in the area of basic research and should avoid carrying systems all the way through the development cycle. He also predicted that NASA will fall into this pattern.

Stehling pointed out that NASA was built upon the traditional NACA concepts and that it is difficult to change organizational attitudes overnight. He said that over the next two years NASA will be conducting an educational effort and working out arrangements with industry that will result in a broader outlook on the part of NASA and a corresponding increase in the industry role.

Commenting on immediate commercial prospects in space work, Stehling said the communications satellite is the only current example of a system that could be completely released to industry for commercial use. In the commercial area, Gilbert said Bendix is considering a navigational satellite system that would include ground equipment costing $1,000 to $2,000 which could be sold for use on ships.

Early design effort was generally discussed as the answer to reliability problems, although Stehling observed that the lack of simple craftsmanship in producing and handling a system often is the cause of failure. H. J. Longfelder, development program manager of Boeing Airplane Co. Aerospace Division, said design work should allow for this lack of craftsmanship. He said Boeing has long recognized this and observed that early design work on the Dyna-Soar vehicle will have to allow for lack of skill in production.

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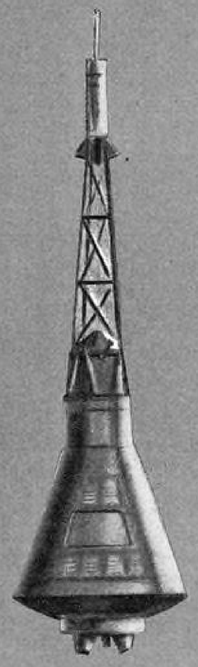
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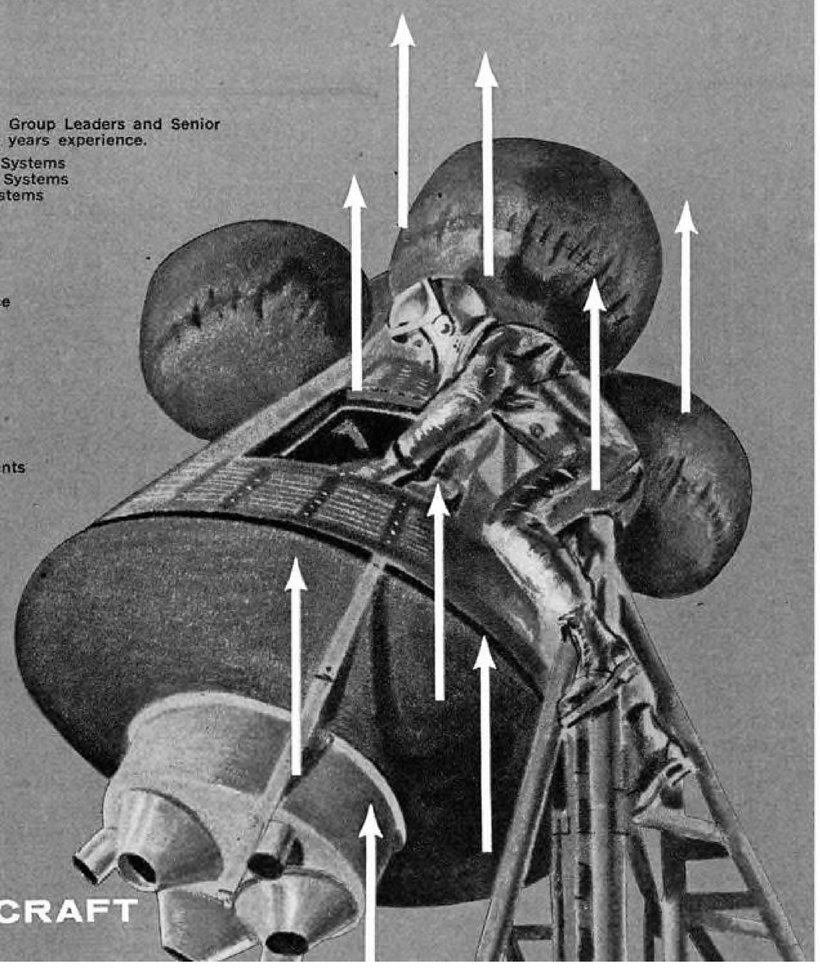
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It was this anticipation that led to initial work on the first U. S. manned Space Capsule a full year before the competition was announced. Designed to carry a human astronaut beyond the atmosphere into orbital space flight, the Capsule is an integral part of N.A.S.A.'s Project Mercury.

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General Precision Equipment Forms Subsidiaries Into Company

New York—Four subsidiary companies of General Precision Equipment Corp.—which together account for approximately 80% of the parent corporation's total business—are to be consolidated into a new operating company to be known as General Precision, Inc. The change will become effective as of Jan. 4.

The four subsidiaries, each of which will become operating divisions of the new company, are: General Precision Laboratory, Inc., Pleasantville, N. Y., Kearfott Co., Little Falls, N. J., Librascope, Inc., of Glendale, Calif., and Link Aviation, Inc., Binghamton, N. Y.

Chairman and chief executive officer of General Precision, Inc., will be J. W. Murray. President will be D. W. Smith. Both will continue to hold the same respective positions in the parent holding corporation. Managements of the new divisions will remain the same as at present.

In addition to the usual advantages of consolidation such as greater efficiency and flexibility, the reorganization will place these companies, which in combination are occupied with about 75% military business, in a better position to compete for larger systems management and production contracts by centralizing management, improving facilities utilization, and increasing financial resources in line with the trend of the avionics industry in this direction.

Sales of the four companies to be consolidated have risen from an annual rate of $92 million in 1955 to an estimated $177 million this year. The total General Precision Equipment Corp. backlog at present is approximately $200 million, of which between $170 and $180 million is attributed to this group.

The new divisions will have available a total of about two million square feet of plant space, slightly less than double their plant area in 1955; 15,000 employes, compared with about 7,000 in 1955, including 4,500 engineers, compared with about 1,300 in 1955.

In announcing the consolidation, General Precision Equipment Corp. officials denied reports that negotiations were under way with the Martin Co. for a merger (AW Nov. 9, p. 29). These officials said that no conversations had taken place with Martin during the previous month. The Martin Co. has corporate holdings of General Precision Equipment Corp. shares of slightly more than 10% of the total outstanding.

Each of the companies that will make up the new group has one or more areas of specialization within the avionic industry:

- **Kearfott** specializes in inertial systems and such components as the precision gyroscopes and accelerometers that are required in these systems.
- **General Precision Laboratory** holds the prime contract for a key portion of the Federal Aviation Agency's airways modernization program—the Data Processing Central for the experimental air traffic control system. It integrates transistorized file-type digital computers with a large capacity drum-storage system, working on line with communications, display and print-out systems. The company also produces doppler air navigation systems, and military data-handling and closed-circuit television systems.
- **Librascope** specializes in an extremely broad range of computer applications, mostly digital, including the computer for the FAA's air traffic control system.
- **Link Aviation** is, according to the parent company, the nation's largest manufacturer of flight simulators.

The most important non-military contract now under way within the group is the development of the Data Processing Central for the FAA's experimental air traffic control system. Equipment for the central will be assembled and installed at the FAA's National Aviation Facilities Experimental Center, Atlantic City, N. J., in the near future as the first step in Phase II of the FAA program for the central. Phase I consisted of an experimental program exploring the use of rented commercial computers for air traffic control purposes.

The FAA plans to have the central in operation for simulating the control of live air traffic by the end of 1960, and actually to be controlling aircraft with the system by the end of 1961.

United, Snecma Settle J75 Contract Claim

Paris—United Aircraft and the French state engine builder, Snecma, currently are settling damage claims which resulted from the French backing out of a contract to build United's J75 turbojet engines in France (AW May 4, p. 30).

Two of the turbojets were to power France's future atomic strike aircraft, the Mirage 4B. The French finally canceled the deal because of budgetary

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difficulties. Beforehand, however, the French Air Ministry had ordered about a dozen J75B prototype engines for initial studies. By canceling them, the French will have to pay some $100,000 to United, officials said.

British Air Industry Reorganization Urged

London—Too many firms chasing too few orders is one of the problems facing Britain's aircraft industry, Duncan Sandys, minister of aviation, said in the House of Commons.

He said the majority of manufacturers recognized that an extensive reorganization of the industry was both essential and urgent, and he proposed to do everything he could to encourage the industry to set about it, but he gave no details.

There were no plans, Sandys said, to expand the total production of aircraft. The government was only considering ways in which it could help the industry increase its civil sales. The whole question of research and development in the industry was also still being examined, Sandys commented.

He promised an early statement on current discussions with the independent and state airlines with respect to policy and operational facilities.

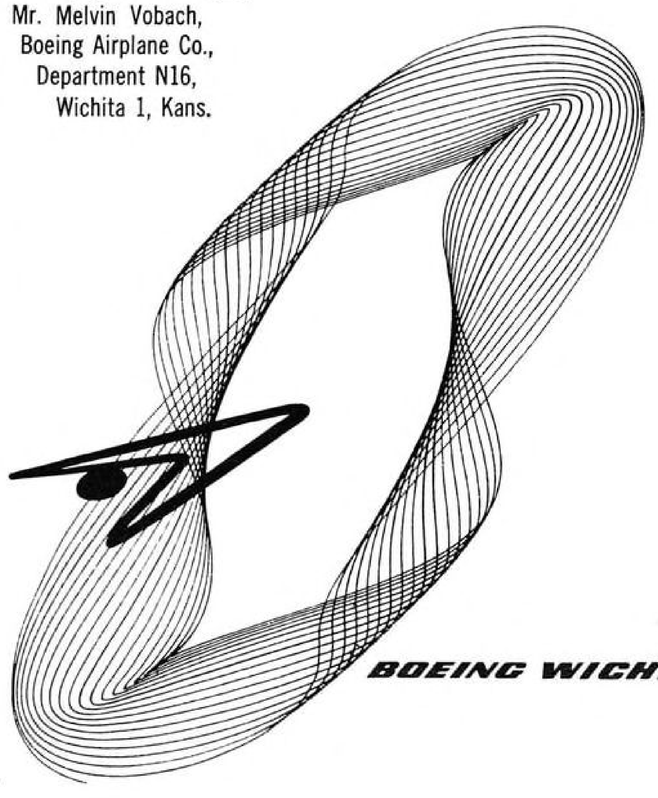
Financial Briefs

Miniature Precision Bearings, Inc., reported a 31 cents per share increase in earnings for the three-month period ended Sept. 30, as compared with the 1958 period. Company earned 59 cents a share for the quarter, as compared with 28 cents a share for the same period last year. Total earnings for the first six months of the fiscal year beginning Apr. 1, 1959, were $1.35 a share, in comparison with 46 cents a share for the first half last year. Sales for the three months were $2,272,000, an increase of 59% over the 1958 period sales figure of $1,429,000. Net income for the quarter ended Sept. 30 was $168,000, after taxes; it was $81,000 for the comparable quarter last year. Net after-tax income for the half year ended Sept. 30 was $385,000, compared with $131,000 for the six months period last year.

Textron Electronics sold 100,000 shares of its common stock at $7.50 a share to American Research and Development Corp., a Boston venture capital firm, and elected Georges F. Doriot, American Research president, to the board. Textron Electronics, a subsidiary of the textile company, will use the proceeds for working capital and acquisitions, like its recent one of Globe Electronics, Inc., Council Bluffs, Idaho.

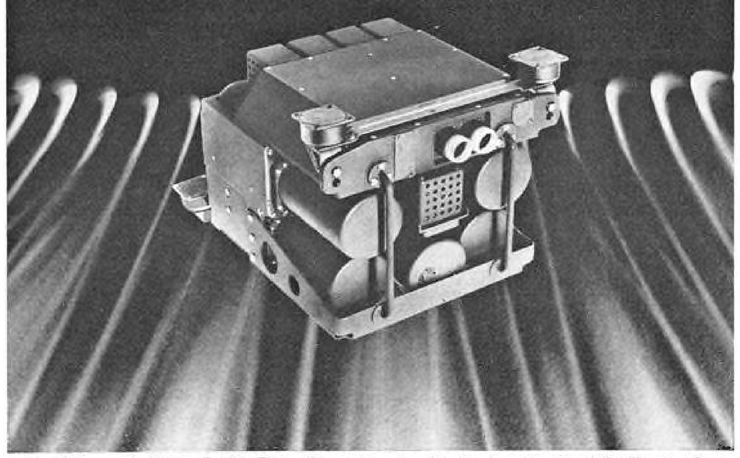
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WHO'S WHERE

(*Continued from page 23*)

Changes

Robert W. Pollock, chief of technical liaison, C.T.L., Inc., Cincinnati, Ohio.

P. A. Hearne, divisional manager, Guided Weapons Division of Elliott Brothers (London) Ltd., a member of the Elliott-Automation Group, London, England. Also: Elliott Brothers Aviation Division has been formed into three new divisions and the following appointments made: **W. H. Alexander**, manager, Aircraft Controls Division; **F. Haskett**, manager, Aircraft Engine Instruments Division; **F. Shields**, manager, Aviation Service and Repair Division.

Dr. Hugh L. Cox, lead engineer-advanced classified projects, The Martin Co., Denver, Colo.

Willis L. Littleford, general manager, Helicopter Division, Republic Aviation Corp., Farmingdale, N. Y.

Autonetics, a division of North American Aviation, Inc., Downey, Calif., has established four separate product divisions and appointed the following operations managers: **C. A. Wolf** for Armament and Flight Controls; **N. F. Parker** for Computers and Data Systems; **S. F. Eyestone** for Inertial Navigation; **E. A. Holmes, III**, for Industrial Products.

Dr. H. C. Schjelderup has joined the senior staff of National Engineering Science Co., Pasadena, Calif.

Herman A. Kahle, manager-static equipment section, Engineering Department, Jack & Heintz, Inc., Cleveland, Ohio.

William H. Newell, assistant to the president, Ford Instrument Co., division of Sperry Rand Corp., Long Island City, N. Y.

Leon S. Wiles, Washington, D. C., representative of the Norden Division of United Aircraft Corp., Stamford, Conn.

Frank K. MacMahon, manager of military programs, and **Don W. Dickinson**, military relations administrator, Vertol Aircraft Corp., Morton, Pa. Also: **A. V. Tuccillo**, manager-licensing.

Dr. Harald Schutz, director of the Westinghouse Astronautics Institute, Westinghouse Electric Corp.'s Air Arm Division, Baltimore, Md.

Robert M. Jackson, assistant to the vice president in charge of sales, the Garrett Corp., Los Angeles, Calif.

Cregg Coughlin, assistant to the president, Fairchild Engine & Airplane Corp., to represent Fairchild in Washington, D. C.

Alfred E. Williams, assistant general sales manager, Link Aviation, Inc., Binghamton, N. Y.

Howard R. Fisher, chief chemist, Parker Seal Co., a division of Parker-Hannifin Corp., Culver City, Calif.

George E. Bartlett, engineering manager Moog Servocontrols, Inc., East Aurora, N. Y.

Dr. K. N. Satyendra, director of research, Electronic Systems and Equipment Department, Nortronics, a division of Northrop Corp., Hawthorne, Calif.

Charles D. Howell, assistant vice president-manufacturing, Westinghouse Air Brake Co., Pittsburgh, Pa.

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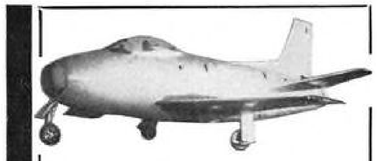
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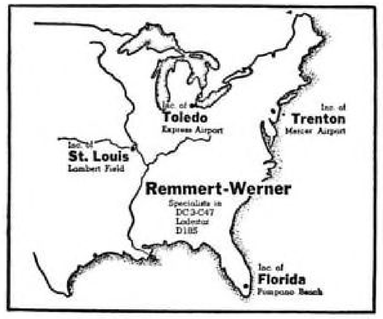
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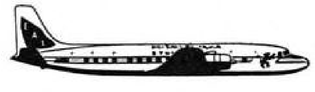
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LETTERS

Range Rhyme

I have read your magazine with keen interest ever since I found out about AVIATION WEEK in 1955. While frequently containing minor discrepancies, your stories and articles give us more advance information on some programs than we are able to get from the range users ourselves. I particularly agree with Mr. Hotz and most of his editorials on our progress in missile work.

Though I have been tempted to write you often about certain items—such as some technically educated joker claiming we are not in a "race" with the USSR or some airline pilot criticizing military pilots (of which I am one), I have never done so. When you published "The Ballad of AFMTC" this week (Nov. 9, p. 148), however, I cannot resist sending in another poem.

The author of "Medaris, von Braun and Me" is unknown to me. I copied it off the wall of a downrange station. Downrange personnel do many things to pass their spare time and I feel some bright radar technician wrote this in a lull—but cannot be sure.

If you want to publish this—please be my guest. Better hurry, though; General John retires in January.

Medaris, von Braun and Me

In the missile game, we've won great fame,
The world knows our Jupiter C
And what we've done with Explorer I,
Medaris, von Braun and Me.

Now Explorer II went off in the blue
On its own self guided spree.
Number III kept in track and now reports back
To Medaris, von Braun and Me.

We'll send up others to join their brothers.
Some will orbit, some fall in the sea.
Yet history will toast the men with the most,
Medaris, von Braun and Me.

Oh watch our smoke as we go for broke
To solve the space mystery.
We have a thirst to be there first,
Medaris, von Braun and Me.

Our skill we pride, we'll travel wide
Into space so wild and free.
To the moon, then Mars, then to distant stars,
Medaris, von Braun and Me.

When finally we've planned a space ship that's manned,
And they call for brave men two or three,
To try first for the moon in that metal balloon,
Call Medaris and von Braun—NOT ME.

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Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Search for Infinite

The letter from Mr. Waldo Claflin (AW Nov. 2, p. 134) represents an important point of view, but I disagree substantially with most of the points he makes.

I am a mechanical engineer who has subscribed to AVIATION WEEK since 1946, but I am not connected to aircraft or missile work in any way. I have no "ax to grind," but I do have a strong interest as a private citizen in the accomplishments of my country.

Mr. Claflin suggests that, since the United States and Russia have not agreed on all the rules, no race exists. Communist Russia has never been famous for agreeing to rules of any kind. We were certainly in a production race during World War II, but it can hardly be said that the opposing parties started the race at the same time. In a sports contest does the race begin with the starting gun? No, it starts long before the event. He who prepares himself well for the race betters his chances of winning. Therefore, even in such a formalized event as a sporting contest the contesting parties will not have begin the "race" at an agreed time.

We are now in a titanic race for the minds of men. The outcome of this giant contest will have much greater implications than just how large a piece of hardware we can throw into the sky. We have always prided ourselves in being first in whatever we do. These space accomplishments capture the imagination of people the world around, and especially the young people who are most receptive to new ideas. What American does not recall with pride the accomplishments of the Wright brothers, Lindbergh, Rickover? Claflin, in discussing Russia's clustered engines, says that anyone could cluster engines. If his reasoning is correct, when then should we honor the above men, whose only achievement was to be first in their respective fields, and whose accomplishments opened the door to vast new world of knowledge? Perhaps "anyone" could cluster engines, but the fact remains that we have not done it with large thrust engines and are just now getting around to trying it. Isn't it a bit ironic that the man given this job predicted rather accurately the space accomplishments to date in a series of articles for Collier's magazine, quite some time before the Russians succeeded in boosting their Sputnik into orbit? In his articles, von Braun based his suggested vehicles on clustered small engines. Where would our space program have progressed had we implemented his ideas at that time? I am sure that Dr. von Braun would be one of the first to say that the entire space program does not revolve about himself; he is too much of a team man for that. However, I believe he is symbolic of the whole program. There are parallels between his life and that of Christopher Columbus. Columbus was a supra-nationalist, driven by a grand dream. He could not achieve this dream in his own country, but finally found a nation that could support him in his adventure into what was then a great or greater an unknown than space is for us today.

With all the interservice rivalry, congressional hearings, reorganization and re-evaluation of the space program, I am reminded of the construction of the Hale telescope on Mount Palomar. One of the greatest problems with this telescope was the production of the giant mirror. The task was given to a highly skilled man, backed by a great industrial company. In the course of their attack on this problem they developed many new and valuable extensions of the art, but after an expenditure of over $600,000 and a great amount of time there was still no usable glass disk which of course was the object of the problem in the first place. The task was given to a small company, which produced a high quality disk in a fairly short time and, as I recall, at less than one-tenth of what had previously been spent. I believe that it is highly possible that our satellites and space probes have contributed more to basic knowledge than have those of the Russians. However, the uncommitted peoples of the world will, in my opinion, view space accomplishments in simpler, more basic terms. Whether we like it or not our space program has become an extension of our national policy. The prestige of our system is at stake. I believe that our system of free enterprise has a literally infinite capacity for achievement, but our capacity must be brought into focus.

Let us be done with leadership that is satisfied with our achievements! Let us use the vision of a von Braun and the drive of a Rickover, and get on with the job.

Deep within man is the search for the infinite. Ancient philosophers spoke of the universe around us. Countless men through the centuries have guessed at what the other side of the moon was like. I congratulate the Russians for their grand achievement, for their clustered engines, for their "unsophisticated" hardware that brought to man his first glimpse of the far side of the moon.

But as an American I wish we had done it first.

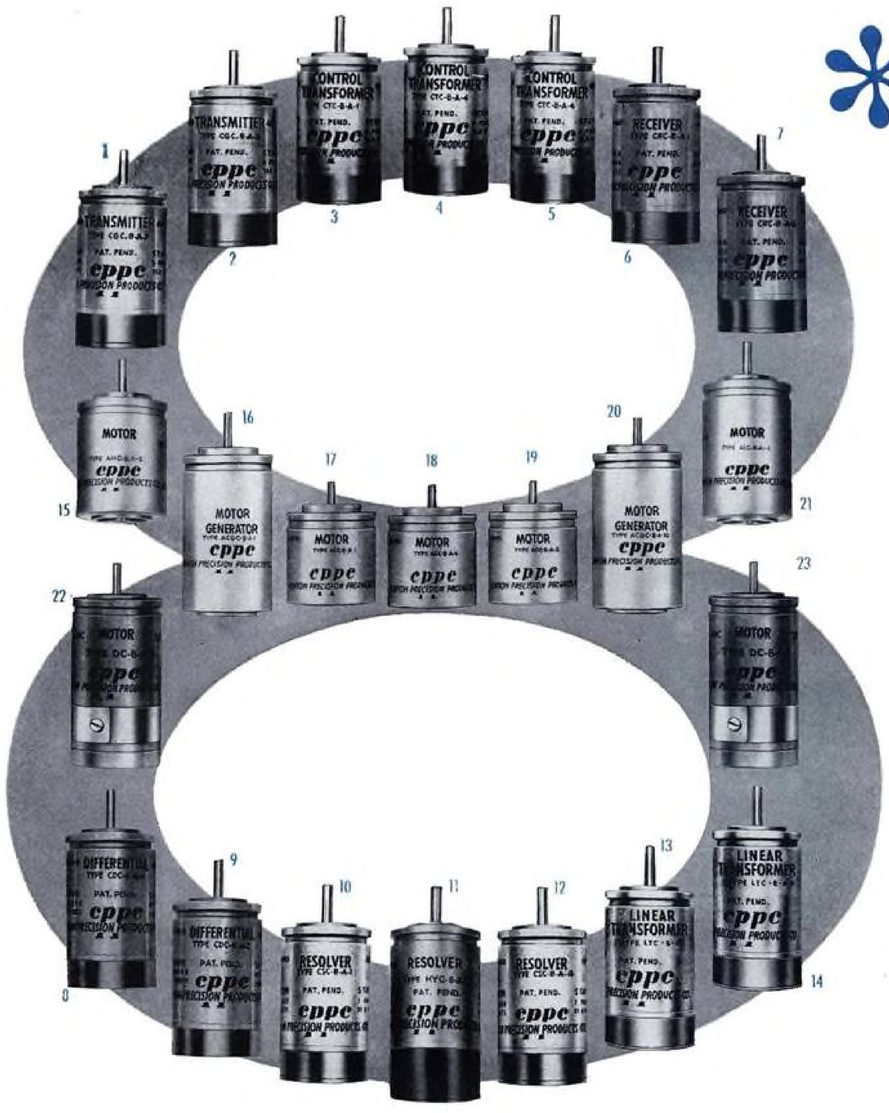
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Viewing Space Race

After reading Mr. Waldo M. Claflin's letter concerning the "space race" (AW Nov. 2, p. 134), I can make only one comment:

Even the ostrich should take his head out of the sand once in a while.

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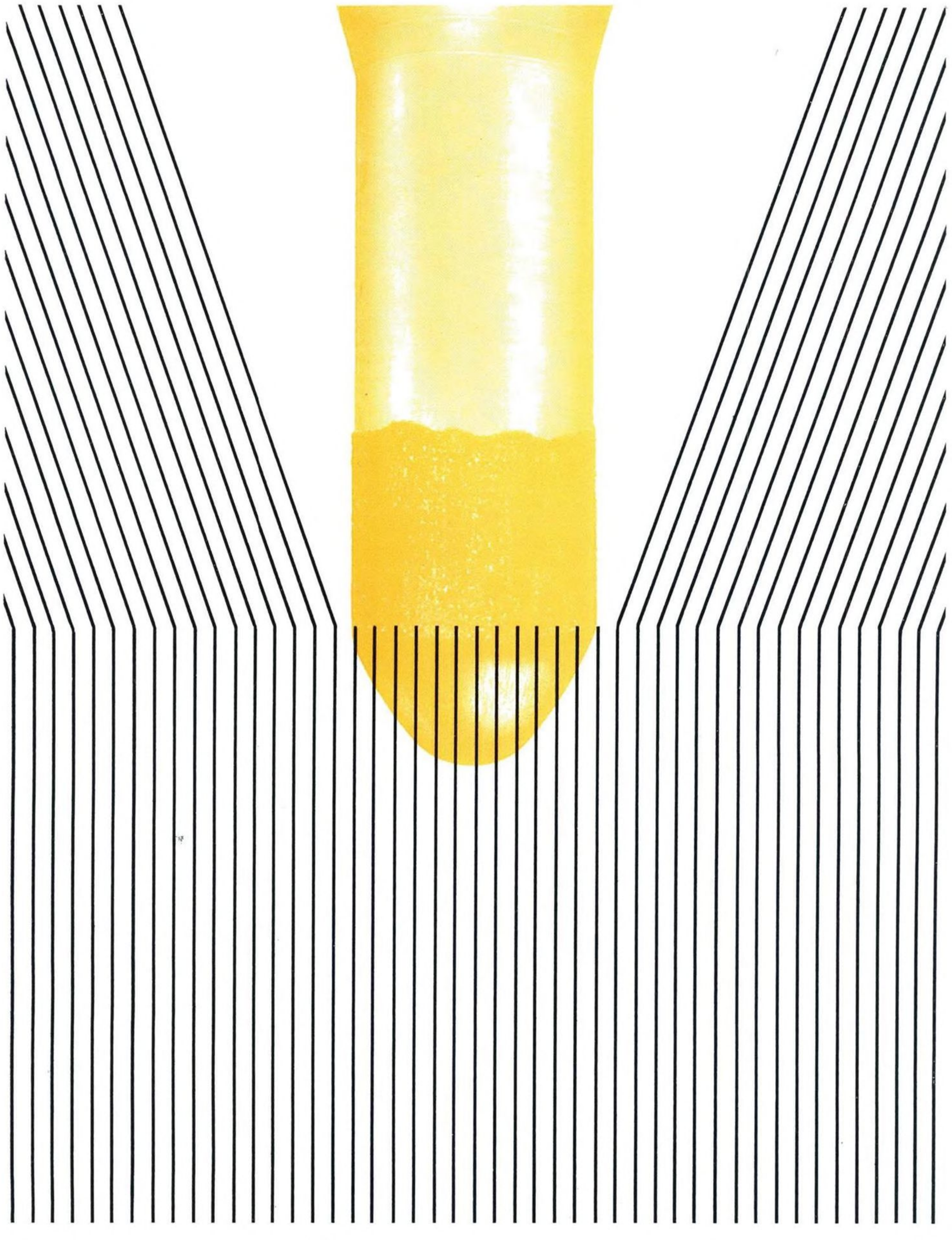
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