Aviation Week & Space Technology

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April 8, 1963

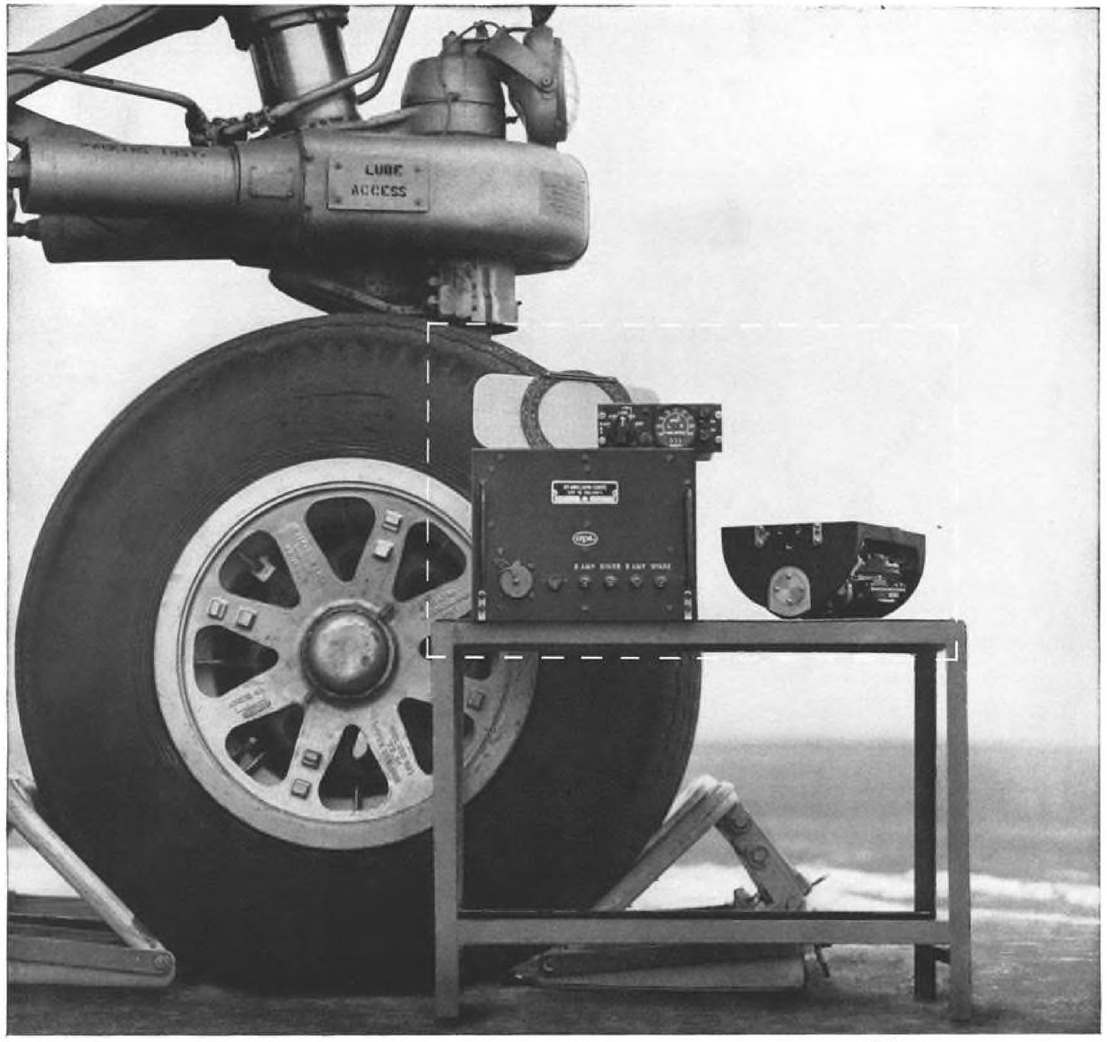
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Here is the latest GPL navigation "first."

...Smallest, lightest Doppler Radar System ever produced, it's the U.S. Navy's choice for new ASW and attack aircraft

Out of GPL's 16 years' experience in building air navigation systems comes the AN/APN-153(V) Doppler radar system. Weighing only 48 pounds and requiring only one cubic foot of space, it's the lightest, most compact radar yet developed . . . and the latest in GPL's record of navigation "firsts".*

Designated by the U. S. Navy as AN/APN-153(V) for use in new ASW, attack and weather aircraft, it's capable of full operation within 45 seconds; provides automatic acquisition in less than 20 seconds; operates anywhere in any weather, 0 to 70,000 ft.; retains high accuracy throughout virtually all aircraft attitudes. It's easy to install . . . operate . . . maintain. Components can be interchanged without recalibration. AN/APN-153(V) (Model GPK-1000) represents a refinement of design techniques proved in more than 3000 radar systems built thus far by GPL. It is applicable to light commercial as well as military aircraft.

*OTHER GPL NAVIGATION "FIRSTS" ☐ Developed first direct reading ground speed and drift angle sensor ☐ Produced first completely automatic global navigator ☐ Produced first automatic polar-mode computer ☐ Produced first operational Doppler navigation equipment ☐ Developed first Doppler tie-in to an inertial system ☐ Produced first track navigation computer

For information, contact GPL Division, Dept. DPA, General Precision, Inc., Pleasantville, New York.

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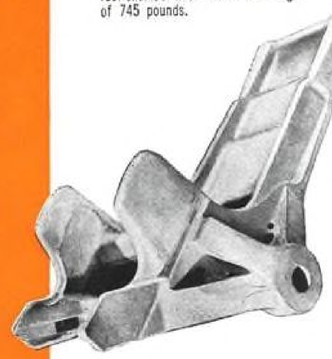
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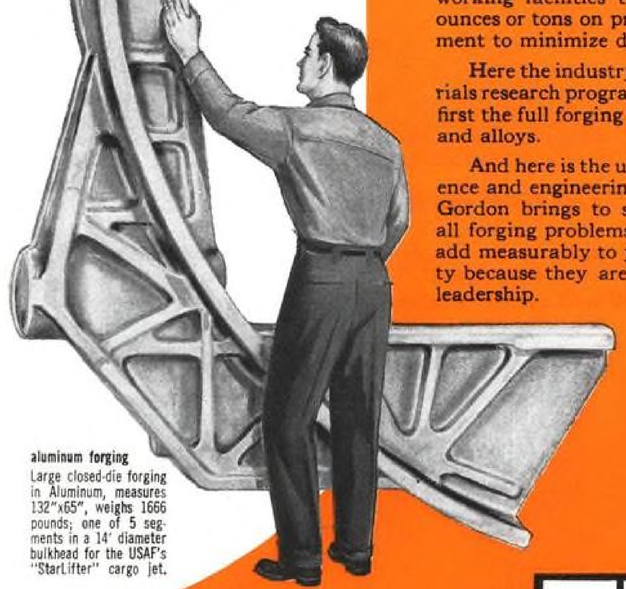
titanium extrusion
Largest Titanium extrusion to date this 51" diameter reactor-in-flight fuel chamber has a machined weight of 745 pounds.



uranium extrusion
Extrusion-forged of depleted uranium, this flanged part is 6½" O.D. by 28" long with a weight of 260 pounds.



alloy steel forging
Complex press forging of alloy steel. This aircraft fuselage part measures 63"x28" with a forged weight of 2216 pounds.



aluminum forging
Large closed-die forging in Aluminum, measures 132"x65", weighs 1666 pounds; one of 5 segments in a 14' diameter bulkhead for the USAF's "StarLifter" cargo jet.



columbium forging
Heaviest, most intricate Columbium forging yet produced, this aerospace nuclear component measures 36"x14" and weighs 1300 pounds.

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WG-8

AEROSPACE CALENDAR

Apr. 16—Institute of Navigation's Western Region Meeting, Charter House Hotel, Anaheim, Calif.

Apr. 16-17—Ohio Valley Instrument-Automation-Electronic Exhibition & Symposium, Cincinnati Gardens and Carrousel Inn, Cincinnati, Ohio.

Apr. 16-18—National Meeting, Aerospace Industries Assn.'s Export Committee, Gramercy Inn, Washington, D.C.

Apr. 16-18—Optical Masers Symposium, Waldorf-Astoria, New York, N.Y. Sponsors: Polytechnic Institute of Brooklyn, IEEE, American Optical Society, Armed Services.

Apr. 16-19—1963 USAF Aerospace Fluids and Lubricants Conference (unclassified), San Antonio, Tex. Managed by Southwest Research Institute.

Apr. 17-19—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Statler Hilton Hotel, Los Angeles, Calif.

Apr. 17-19—International Nonlinear Magnetics (INTERMAG) Conference, IEEE, Shoreham Hotel, Washington.

Apr. 17-19—Southwestern Conference and Electronic Show, Institute of Electrical and Electronics Engineers, Dallas Memorial Auditorium, Dallas, Tex.

Apr. 17-19—Technical Meeting: Nuclear Materials for Space Applications, American Nuclear Society, Netherland Hilton Hotel, Cincinnati, Ohio.

Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D. C.

(Continued on page 7)

AVIATION WEEK & Space Technology

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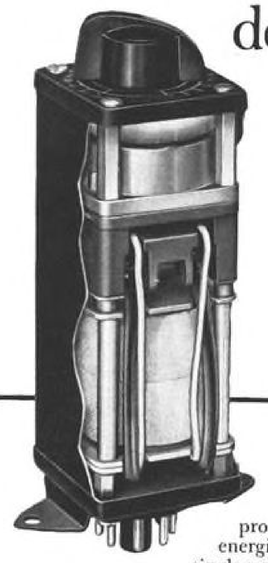
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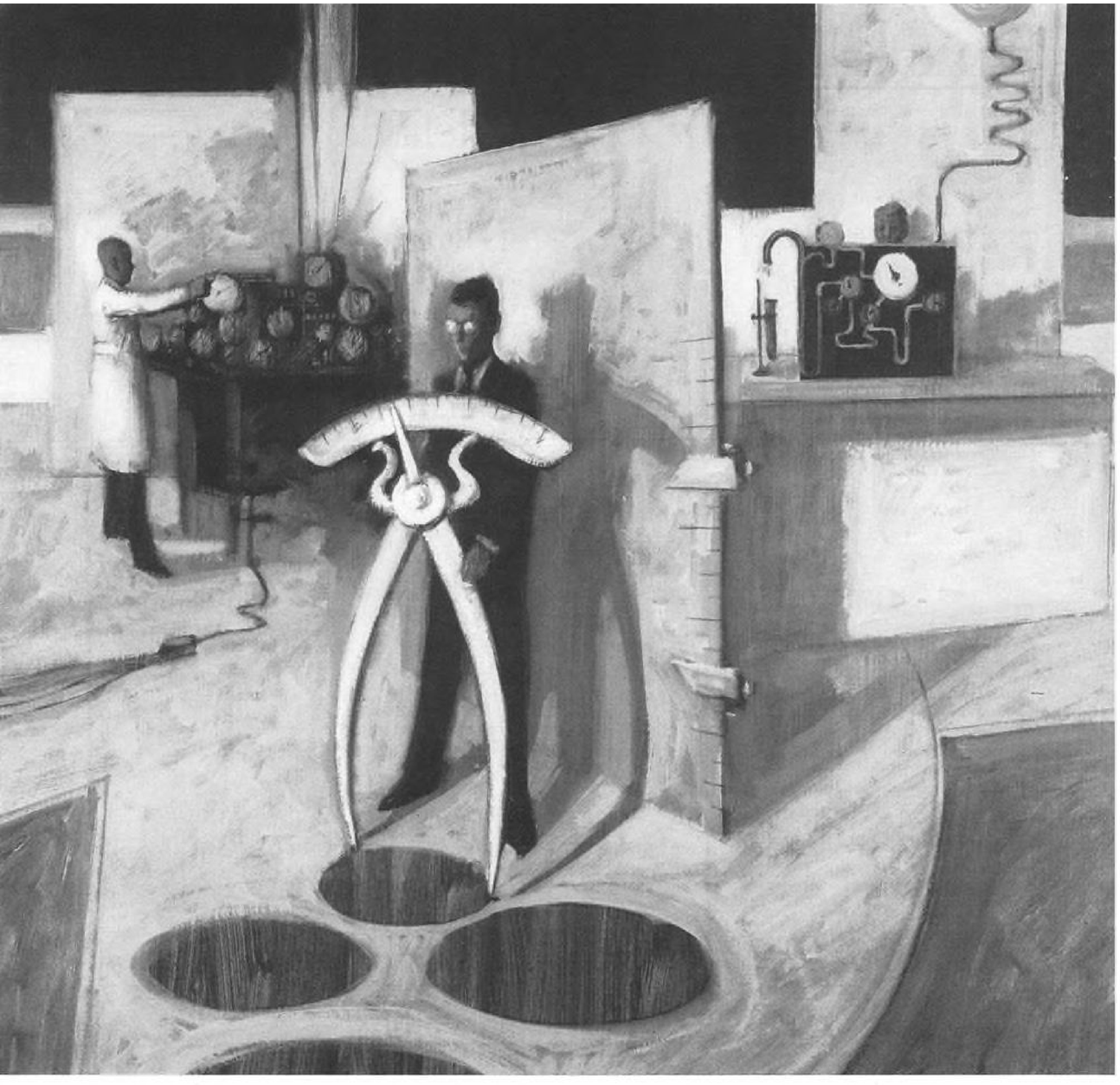
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Their work led to super-sensitive measuring equipment that if used at Hoover Dam could detect an ordinary light bulb being turned off in Los Angeles. They have helped develop measurement accuracies at the *shop level* that have surpassed those until recently found only in the National Bureau of Standards.

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These are the exacting men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

AEROSPACE CALENDAR

(*Continued from page 5*)

Apr. 22-24—Second Manned Space Flight Symposium, AIAA/NASA, Marriott Hotel, Dallas, Tex.

Apr. 22-24—Third Annual San Diego Symposium for Biomedical Engineering, Del Webb's Oceanhouse, San Diego, Calif.

Apr. 22-25—10th Weather Radar Conference, American Meteorological Society, International Inn, Washington, D.C.

Apr. 23-25—Hypersonic Ramjets Conference, AIAA/ASME, Naval Ordnance Laboratory, White Oak, Md. (Secret)

Apr. 23-25—National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla.

Apr. 25-26—Annual Convention, Society of American Value Engineers, Americana Hotel, New York, N.Y.

Apr. 29-30—1963 Spring Meeting, Western States Section/The Combustion Institute, Vacation Village Motel, San Diego, Calif. Sponsor: General Dynamics/Astronautics.

Apr. 29-May 2—34th Annual Scientific Meeting, Aerospace Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

Apr. 29-May 2—22nd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton-Jefferson Hotel, St. Louis, Mo.

Apr. 29-May 2—Spring Meeting, United States National Committee of International Scientific Radio Union (URSI), National Academy of Sciences, National Research Council, Washington, D.C.

Apr. 29-May 3—Annual Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, Atlantic City, N.J. Co-sponsor: Army Research Office.

May 1-3—19th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D.C.

May 1-9—Third National Conference on the Peaceful Uses of Space, Chicago, Ill. Sponsors: NASA; Committee for Economic and Cultural Development of Chicago.

May 2—Manned Space Laboratory Conference, AIAA/Aerospace Medical Assn., Statler-Hilton Hotel, Los Angeles, Calif.

May 2-3—Fourth National Symposium on Human Factors in Electronics, IEEE, Marriott Twin Bridges Motel, Washington, D.C.

May 2-5—International Travel Fair and Flying Display, Biggin Hill Airport, Kent, England.

May 5-8—1963 Annual Conference, American Assn. of Airport Executives, Galt Ocean Mile, Beach Club and Coral Ridge Hotels, Fort Lauderdale, Fla.

May 6-8—Aerospace Reliability and Maintainability Meeting, AIAA/ASME/SAE, Washington, D.C.

May 6-9—Ninth Annual Aerospace Symposium, Instrument Society of America, Jack Tar Hotel, San Francisco, Calif.

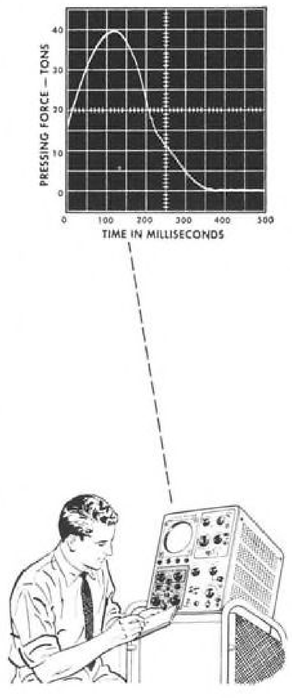
May 7-9—Electronic Components Conference, Institute of Electrical and Electronics Engineers, International Inn, Washington, D.C.

May 8-9—60th Meeting, National Aerospace Standards Committee of the Aerospace Industries Assn., Hotel Roosevelt, New York, N.Y.

May 8-10—Spring Meeting, Society for Ex-

(*Continued on page 9*)

USING STRAIN GAGES?



Information from strain gages and many resistive, capacitive, and inductive transducers can be displayed on the face of a cathode-ray tube . . . with the Type Q Plug-In Unit . . . and a Tektronix Letter-Series Plug-In Oscilloscope.

You get a detailed picture of this information plotted against time, from which accurate measurements can be made with ease. The illustration, a plot of a press stroke, is an example of a quality-control application.

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The Type Q Unit plugs directly into these oscilloscopes: Tektronix Types 531, 531A, 532, 533, 533A, 535, 535A, 536 (for X-Y plots), 541, 541A, 543, 543A, 545, 545A, 551 and 555 (dual beam), and all their rack-mounting versions. It can also be used in the Type 81 Plug-In Adapter with both the Type 581 and Type 585, and in the Tektronix 127 Preamplifier Power Supply with any standard laboratory oscilloscope and many other readout devices.

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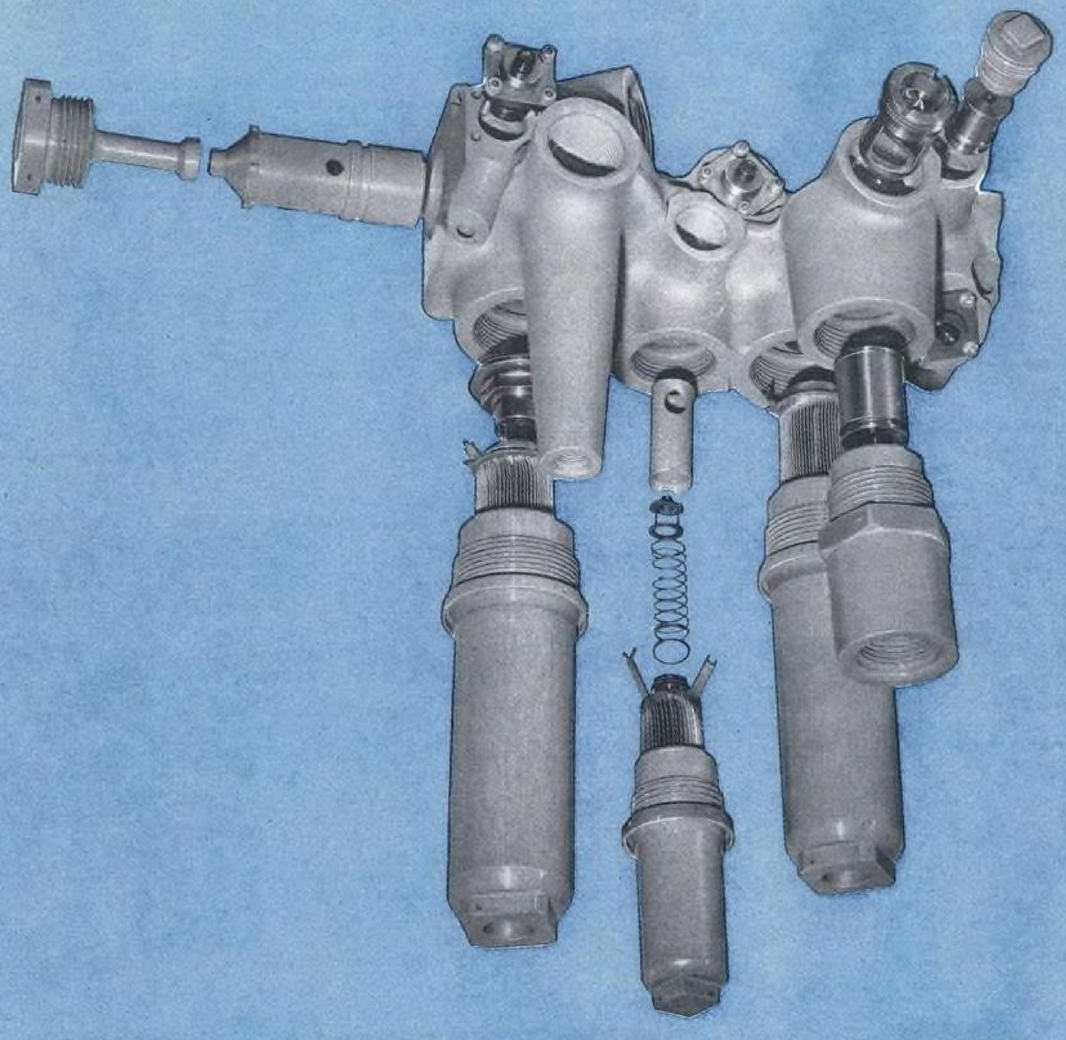
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This is typical of a number of Modular Manifolds designed and now in production at Aircraft Porous Media, Inc. If you're involved with the design or redesign of a fluid system, investigate this significant step toward centralizing system components. Write for descriptive literature . . . today.



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AEROSPACE CALENDAR

(*Continued from page 7*)

perimental Stress Analysis, Hotel Benjamin Franklin, Seattle, Wash.

May 9-10—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Fort Worth, Tex.

May 13-15—National Aerospace Electronics Conference, IEEE/AIAA, Dayton, Ohio.

May 15-16—Fourth Annual Symposium on High Speed Testing, Hotel Somerset, Boston, Mass. Sponsor: Plas-Tech Equipment Corp.

May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N. M.

May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 21-23—Symposium: Characteristics of the Lunar Surface, Boston, Mass. Sponsors: Air Force Cambridge Research Laboratories; Arthur D. Little, Inc.

May 21-24—25th Annual Meeting and News Conference, Aviation/Space Writers Assn., Adolphus Hotel, Dallas, Tex.

May 27-28—Seventh National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.

June 3-5—Symposium on Materials and Processes for Space Power and Primary Propulsion, Society of Aerospace Material and Process Engineers, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 3-11—COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland.

June 6-7—Symposium on the Exploration of Mars, Denver Hilton Hotel, Denver, Colo. Sponsor: American Astronautical Society. Co-sponsors: American Astronomical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections, NASA.

June 7-8—14th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 7-16—25th French International Air Show, Le Bourget, Paris, France.

June 11-14—Symposium on Plasma Space Science, The Catholic University of America, Washington, D. C., with the support of NASA and Goddard Space Flight Center.

June 12-14—Heat Transfer and Fluid Mechanics Institute, American Institute of Aeronautics and Astronautics, California Institute of Technology, Pasadena.

June 17-20—Summer Meeting, American Institute of Aeronautics and Astronautics (AIAA), Hotel Ambassador, Los Angeles, Calif.

June 17-21—Summer General Meeting, Institute of Electrical and Electronics Engineers, Toronto, Canada.

June 28-July 3—Second Annual Dorado Fly-In, Dorado Beach Hotel, Dorado, Puerto Rico.

If you wanted to build



a pipeline to the moon

chances are somewhere along the way

you'd use Janitrol cryogenic

and pneumatic valves



heat exchangers



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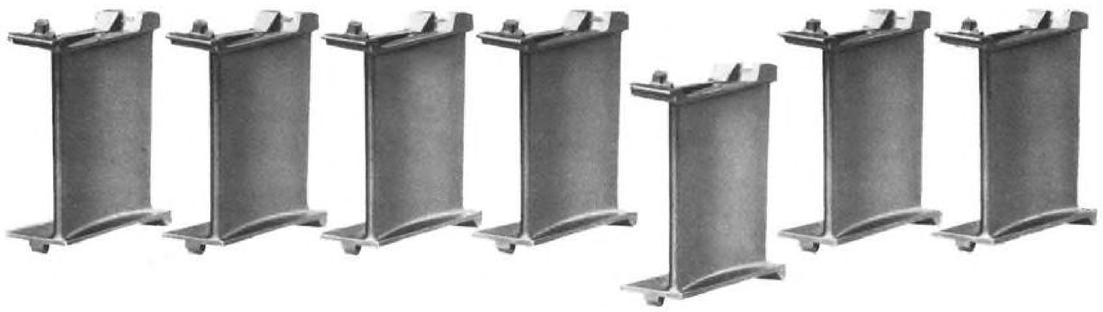


What do these 49 computers have in common?

They can "listen" and "speak" with punched tape (or electrical signals) from Teletype equipment. This means that Teletype equipment and tape-to-tape systems—connected by existing communications channels—put a centralized computer at the disposal of the most remote operation. Teletype equipment is available in a variety of code levels, with speeds ranging up to 1,050 bits per second.

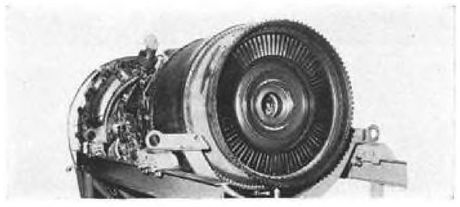
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Chromallized turbine vanes help Pratt & Whitney Aircraft engines attain excellent performance and long life.

Rechromallizing saves airlines substantial sums by reducing vane replacement costs



Chromallized cobalt-base super alloy vanes direct the hot gas stream onto the first stage turbine of Pratt & Whitney Aircraft JT-4 engines for upwards of 3500 hours at high turbine inlet temperatures.

Chromallizing, a protective alloy surfacing process, guards superalloy turbine parts against oxidation, intergranular attack and loss of strength due to alloy depletion. Materials which otherwise would deteriorate prematurely, now withstand the effects of high temperatures for longer periods of time.

Over a million Chromallized vanes have proved their reliability in service on the JT-4 and other Pratt & Whitney Aircraft engines.

But better performance is only part of the story. . .during engine overhaul, vanes can be recoated for less than one-fourth their replacement cost. Cost reductions realized by the major airlines using this approved procedure are substantial.

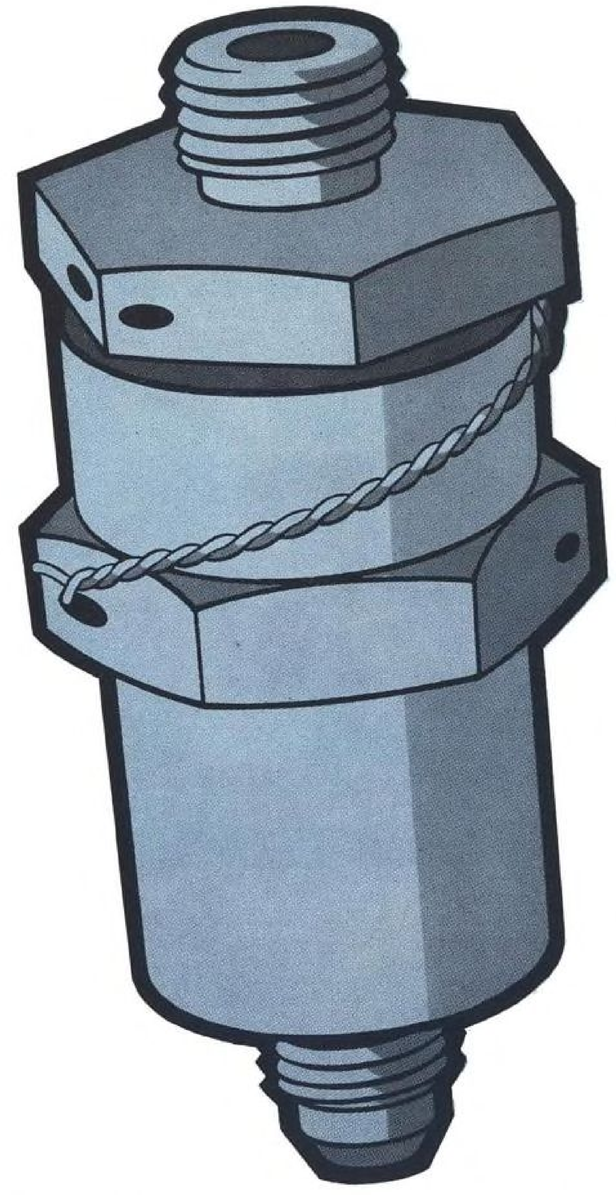
Briefly, Chromallizing is a pack cementation process in which alloying elements are diffused uniformly into a metal surface forming an integral alloy case that is highly resistant to oxidation, corrosion and wear. Depth of the alloy case can be controlled. And there is little or no dimensional change as a result of the process. Composition of the surface coating can be varied for iron, nickel, cobalt-base superalloys to meet service requirements.

In addition to turbine vanes, similar high temperature parts such as turbine blades, combustion chambers, burner tubes, etc., can be protected by Chromallizing. For more detailed information write for a free copy of CHROMALLIZING OF SUPER ALLOYS.

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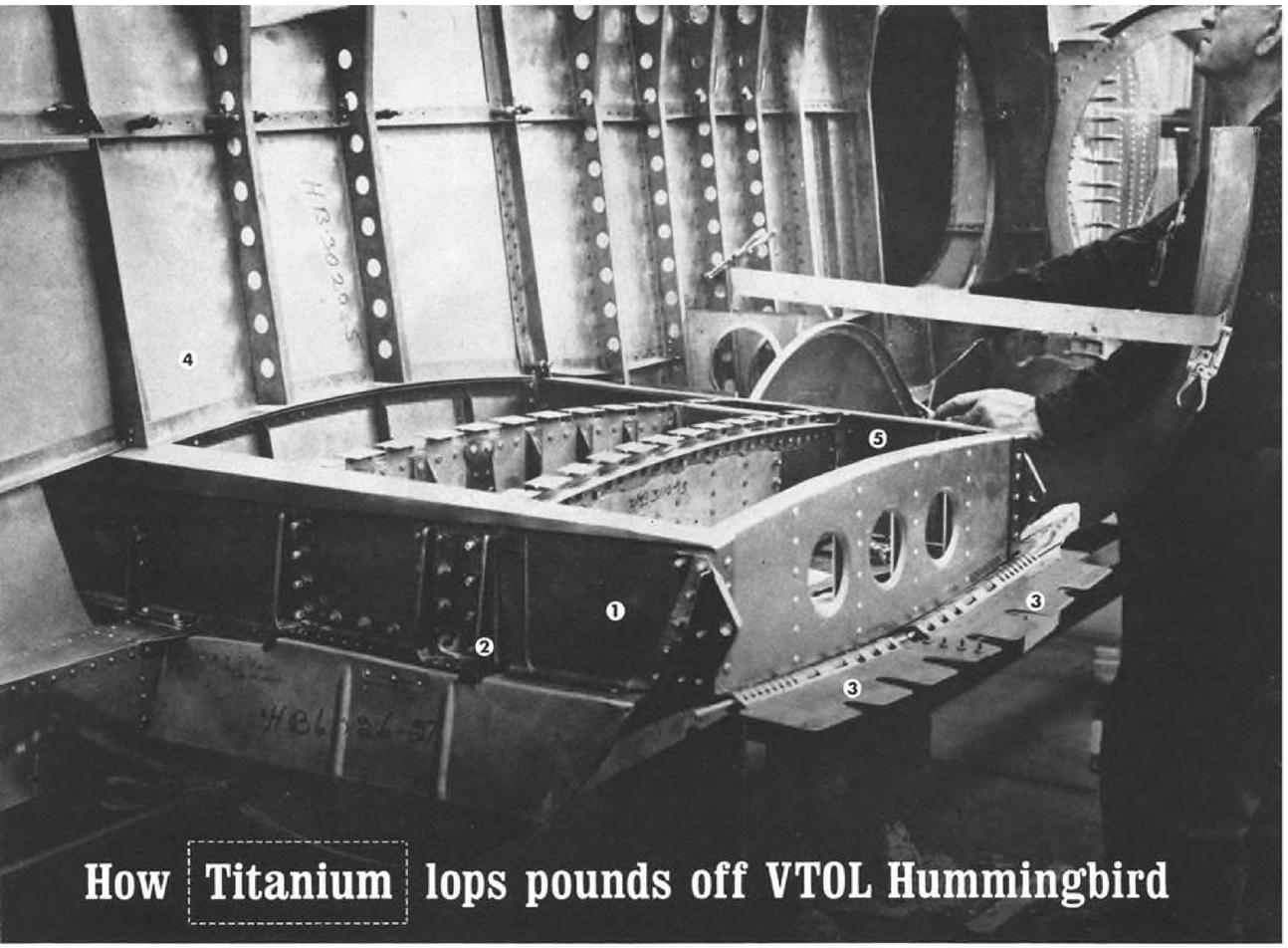


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Hydraulic-lubricating systems do, too. It's an in-line filter by Air-Maze, used for everything from anhydrous ammonia and hot gas to MIL-L 7808. Lightweight designs for all capacity requirements and pressures up to 3,000 psi. We build fluid filters for every aircraft and missile application, standard or special. We'll build them to your basic design, using the filter element you specify (pleated—disc—cylindrical—all metal construction) with the filtration you require. For detailed information, write or call Rockwell-Standard Corporation, Air-Maze Division, Cleveland 28, Ohio.

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How Titanium lops pounds off VTOL Hummingbird

–Shakes off 600° Heat
–Saves precious time

Here is where the Ti-6Al-4V titanium alloy has saved crucial weight on the Hummingbird: (1) forward wing spar; **(2)** main landing gear trunion, heat-treated to 150 ksi UTS; **(3)** outer wing attach brackets, heat-treated to 160 ksi UTS; **(4)** ejector duct wall; **(5)** aft wing spar.

Like the hummingbird for which it was named, Lockheed-Georgia's XV-4A (VTOL) is designed to take off straight up, land straight down, hover in mid-air and streak forward at jet speed. Lockheed engineers say their job was made easier by the use of titanium on critical components.

Strength in a hot spot. Two titanium wing spars, mounted forward and rear, give support to two jet thrust engines and a 25′ 8″ wing span. Exceptionally high strength-to-weight ratio wasn't the only reason for specifying titanium. Exhaust gases of 1300°F are diverted from the engines into a mixing chamber buried in the fuselage. Although a lot of this heat is contained, and some of it is dissipated, the center portions of the wing spars are exposed to 500-600F temperatures.

A high-strength steel alternate would have imposed a severe weight handicap on a plane which had to shed every superfluous ounce to achieve optimum performance.

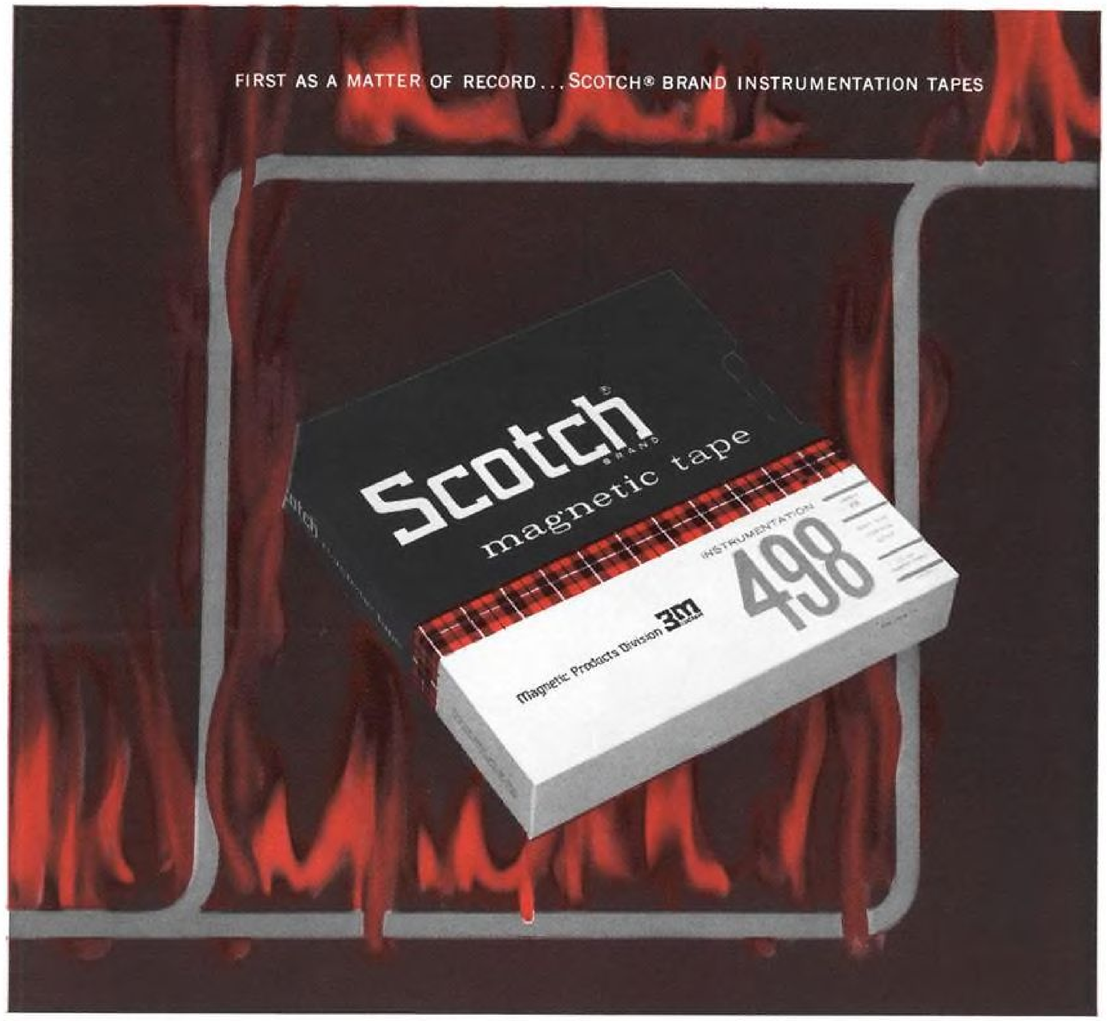
Cut production time. The fact that titanium alloy Ti-6Al-4V could be used in its mill-annealed condition (tensile strength of 130/150 ksi) saved precious time in a tight schedule. All alloys of steel would have had to be heat-treated to meet weight and strength requirements. This would have involved time-consuming machining and correcting the inevitable warping consequent to processing. Machining the spars, a difficult operation as it was, could not have been done on fully-treated steel.

Titanium was selected for other vital components, including the main landing gear trunion which carries the landing load into the plane's structure, face sheets on the fuselage in areas too hot for aluminium, and outer wing attach fittings.

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...comes through head heat unscathed!

Higher and higher recording speeds mean instrumentation progress—and *problems!* Increased speed and tension on tape generates friction that concentrates heat around recording heads and can make ordinary tape unreliable. Signal dropout or distortion can result when this localized, high-temperature build-up separates recording oxides from tape backing.

"SCOTCH" BRAND Heavy Duty Instrumentation Tapes carry signals coolly through head-heat environments. They withstand temperatures from −40°F up to +250°F. They last *at least* 15 times longer than ordinary tapes. Their heavy duty oxides and binders are formulated to resist heat extremes, minimize ruboff. Exclusive Silicone lubrication eases head wear, tape wear. They offer 1000 times more conductivity than ordinary tapes to drain off dust-gathering static.

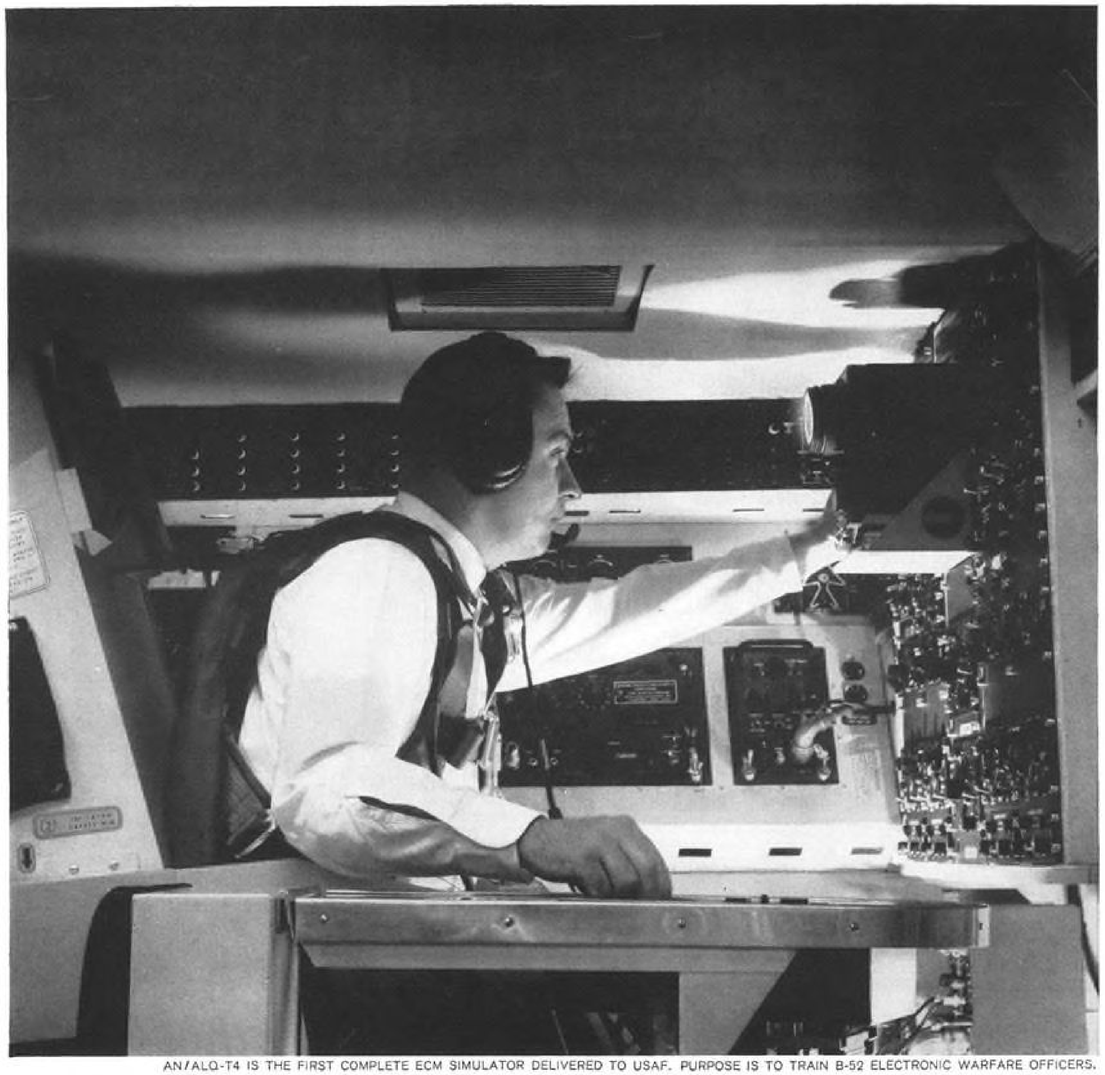


16 different "SCOTCH" Heavy Duty Tapes are available in 3 series. Polyester backings offered are .65, 1 and 1.5 mils. Choice of coating thicknesses includes .18 and .43 mils. "*400*" *series:* excellent high and low frequency resolution. "*500*" *series:* smooth, sharp resolution for broad band, other high frequency uses. "*900*" *series:* ultra-smooth surfaces for predetection recording systems, critical wide band needs.

TECHNICAL TALK Bulletin No. 3 explains temperature effects on recording tape, discusses heavy duty oxide and binder combinations. Free. Just write 3M Magnetic Products Division, Dept. MCJ 43, St. Paul 19, Minn.

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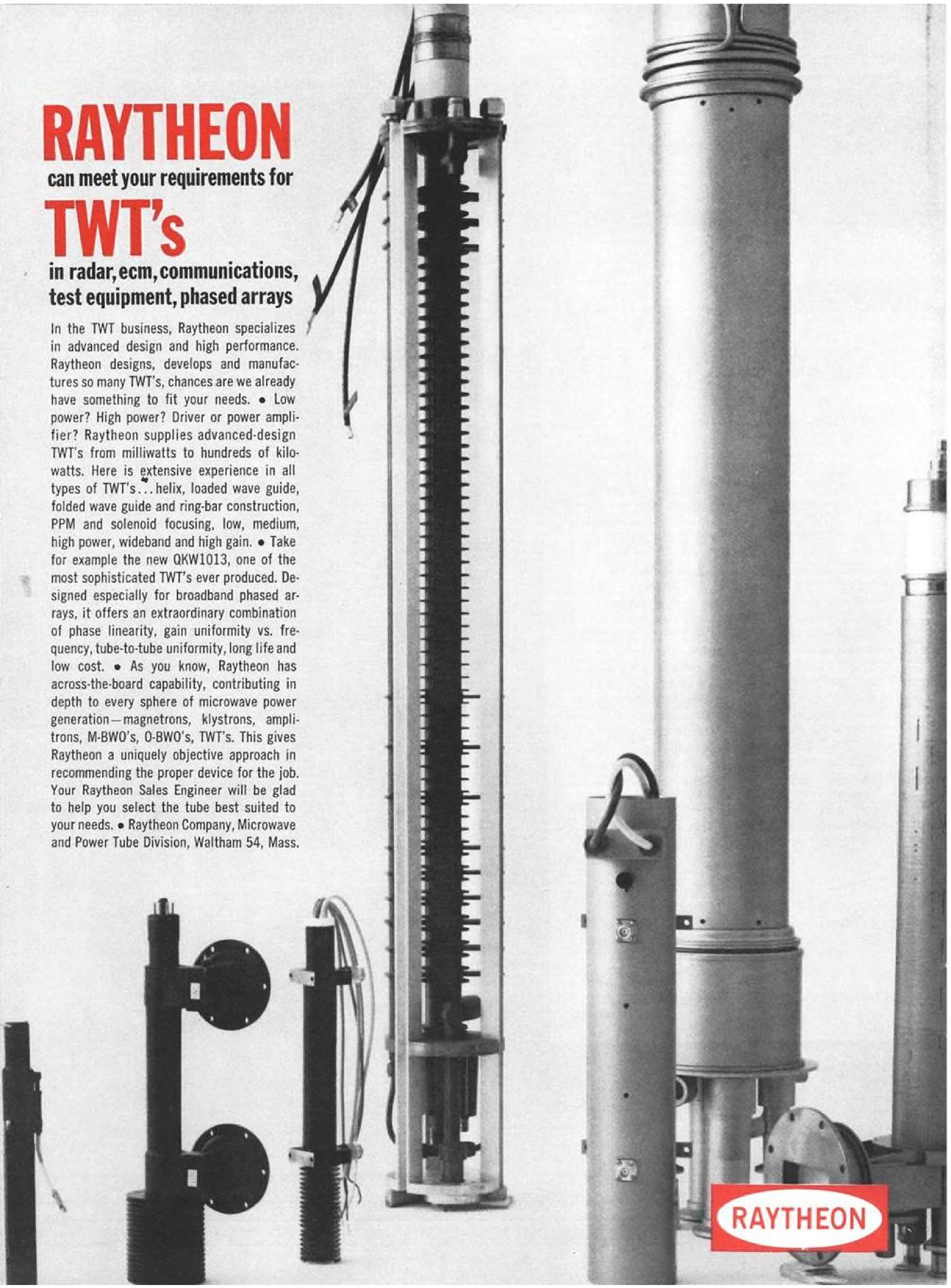
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Number 14

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April 8, 1963

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CONTENTS

SPACE TECHNOLOGY
EUROPEANS PUSH VIGOROUS MULTINATION SPACE PLAN 38
CAPE FACILITIES FOR SATURN 5/APOLLO, TITAN 3 54
SA-5 to Carry TV Camera 29
Apollo Spacecraft Boilerplate Production Advanced 30
Explorer 17 Returning High-Quality Data 34
U.K. Orders ELDO Comsat Study 38
USAF Modifies Astronaut Training 65
Vela Hotel Configuration Shown 72
Countdown for Apollo Detailed 99

AIR TRANSPORT
CONFUSION CLOUDS INTERNATIONAL AIR TRAVEL 40
CAB Consistently Curbed Pan American's Domestic Plans 42
United's Single-Class Fare Causes Concern 45
Locals Show Heavy February Gains 47
American Pessimistic Over 1963 Industry Profits 49
FAA May Rearrange ATC Manpower 49
Airline Observer 52
Shortlines 52

AERONAUTICAL ENGINEERING
WITNESSES CHALLENGE McNAMARA ON TFX 26
Thrust Reversers Now Considered for TFX 26
Pentagon Ends Probe of Top Officials Over Leak 27
Navy Officer Disputes McNamara TFX Claim 28
Kaman UH-2A Demonstrates All-Weather Capability 80
DSN-3 ASW Helicopter Completes Destroyer Tests 93
Carrier Tests Qualify KD2B-1 for Production 104
Production Briefing 100

MISSILE ENGINEERING
NEW PYROLYTIC GRAPHITE FORMATION METHOD EVALUATED 94
Liquid Propellant Rocket Research Facility Planned 98
AFOSR Awards 88

AVIONICS
DOD FUNDS $15 MILLION FOR LASER R&D 75
IBM Lab Taps European Science Skills 76
Filter Center 78

MANAGEMENT
DEMOCRATS TRY TO EASE NASA FUNDS CUT 32
McNamara De-emphasizes Military-Civilian Authority Dispute 33

BUSINESS FLYING
FAA USING REVISED LIGHT-TWIN TRAINING PROGRAM FOR INSPECTORS 102

SAFETY
CAB CITES SWAN IMPACT IN VISCOUNT CRASH 106

Washington Roundup 25
News Digest 39
Letters 122
Aerospace Calendar 5

EDITORIAL
Space Age Problems 21

COVER: North American Aviation's Space and Information Systems Div. Apollo boilerplate capsule No. 9 is shown during inspection at Downey, Calif. facility. Capsule was then shipped to Manned Spacecraft Center at Houston and is scheduled to be delivered to the Marshall Space Flight Center, Huntsville, Ala., this week for vibration testing. The boilerplate capsule eventually will be launched by a Saturn booster from Cape Canaveral (p. 30).

PICTURE CREDITS

Cover—Lou Ranier NAA; 41—Lockheed/Georgia; 43—British Aircraft Corp.; 31, 57, 58, 60, 67—NASA; 76, 77—IBM, Zurich Lab; 80, 81, 83, 85—Kaman; 87—General Electric; 88—Lockheed; 93, 94, 95—U. S. Navy; 94, 95—Aviation Week (top); 95—Space Age Materials Corp. (bottom); 97—UPI (top); 98—Pratt & Whitney; 109—Curtiss-Wright; 111—Martin/Orlando (top); Westland Aircraft Co. (bottom); 113-USAF.



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EDITORIAL

Space Age Problems

As the cost of the national space program climbs inexorably toward a $10-billion annual level, it is inevitable that there are increasing questions from U.S. taxpayers as to what they as individuals and the nation as a whole can expect in eventual dividends from this huge investment.

Recently, a distinguished group of educators, industrialists, social scientists and municipal-level officials met with the top stratum of National Aeronautics and Space Administration to determine what, if any, technical fallout from the space program will be applicable to the growing pains of the modern American urban community. They met in Dunsmuir House, a plush Victorian mansion built by a Scottish playboy as a present for his mistress of 17 years, just before their legal marriage.

Dunsmuir House, itself a near victim of urban growth, was recently rescued from a subdivider's bulldozer—purchased and refurbished by the city of Oakland. It is designed to shelter the type of thoughtful gathering that inaugurated its public use this month in a doughty effort to establish a transmission belt for carrying technical progress of the space age to harassed municipal governments grappling with the corrosive effects of the urban explosion.

Oakland was a fitting site for this contemplation because it sits in the middle of one of the most sprawling examples of urban growth in the country. The San Francisco Bay area is typical of how the face of urban life is changing with an explosive power equal to any space booster. California is targeted for more than half of the NASA Fiscal 1964 budget in industrial and academic contracts. So it should have intense interest as well as special skill in applying the new technology spawned by the space age to alleviate some of the most pressing problems here on earth.

Like most successful conferences, the Dunsmuir House meeting raised more questions than it answered. Among other things, it put several cracks in the suburban picture window through which most of us view our affluent society. It also detailed many of the reasons underlying the basic queasiness of the national economy and its stubborn refusal to start back on a healthy growth curve.

It was evident in the Dunsmuir discussions that while the space age budgets may provide a temporary stimulus to regional economies such as California and the Southwest, where $1.4 billion has already been spent during the past three years, it cannot possibly solve the real problems now slowing the needed growth of the national economy.

Although everybody gets a painful reminder this month, it is still staggering to see the growth curve of taxes as a percentage of gross national product during the postwar period and a similar mountain slope depicting the rise of federal, state and municipal employes living on tax dollars. It is also startling to be confronted with the projections of the increasing available labor force which show a rapidly widening gulf between this curve and the new jobs expected to be available in the future economy.

If the potential power of space technology as a new economic dynamo was scaled down considerably by the sober reflection at Dunsmuir House, it was also recognized that there will be considerable future economic power generated. But this technical fallout from the space age into the general economy will certainly not be automatic, and it may be highly unpredictable. If left to chance, its impact may be negligible. One of the clearer messages of Dunsmuir House is that industry, the social scientists and state and municipal officials must take an aggressive interest in space technology if they are to apply its benefits effectively to this nation's future.

NASA has already recognized this facet of the problem and is organizing a technical transmission belt from its programs to industry—using eight major technically oriented universities from CalTech to MIT as its power generators for this flow. It has also organized an applications center at the University of Indiana to test the effectiveness of the various methods NASA will use to transfer its technology to industry. NASA is also hoping to organize a program for feeding industry people through its research programs to search for specific applications. This type of technical fallout is still only a trickle, but NASA is hoping to organize its channels so effectively in advance that hardly a drop will be wasted and the economy will be well irrigated with its technical flow.

All of this, of course, is germane to the fundamental problem NASA and the space program face now and in the years ahead. This problem is simply how to convince the taxpayers who are backing the multi-billion-dollar NASA annual budget that they are making a sound investment in the future of this country and that all of the exploration of outer space will pay substantial dividends in a better life on earth. Although the competitive aspects of the space race with the Soviet Union are important, they will not generate the long-term public support for what, of necessity, must be a long-term technical effort to be successful.

NASA faces a double-barreled problem for the future, not only to reach its technical goals successfully with prudent management of its public funds, but also to convince the source of those funds that the space game is worth playing for a long time to come.

—Robert Hotz

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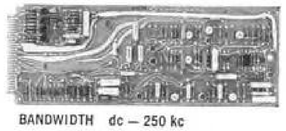
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8

WHO'S WHERE

In the Front Office

Dr. Knox Taylor Millsaps, chief scientist for the USAF's Office of Aerospace Research, will join the University of Florida as research professor of aerospace engineering as of Apr. 1.

John H. Baldwin, president, Daystrom, Ltd., Cooksville, Ontario, Canada, a subsidiary of Daystrom, Inc.

George M. Arisman, Jr., administrative vice president, Sanders Associates, Inc., Nashua, N.H.

Herbert A. Finke, president and chief executive officer, National Company, Inc., Malden, Mass.

William B. Lynch, president, Airaterra, Glendale, Calif., succeeding **D. L. Leavitt,** who continues as a consultant. Other new officers: **C. L. Wright,** executive vice president; **D. A. Derse,** vice president-engineering and marketing; **J. Chase Fielding,** vice president-Government Contracts Div.; **E. L. Searle,** secretary-treasurer.

George S. Freeman, executive vice president, Fenwal Electronics, Inc., Framingham, Mass.

Norman J. Philion, vice-president-international of the Air Transport Assn. of America, Washington, D.C. Also: **Brig. Gen. William T. Seawell,** vice president-operations and engineering; **William B. Becker,** assistant vice president-operations; **Walter A. Jensen,** assistant vice president-air navigation/traffic control; **Craig Lewis,** vice president-public relations.

John H. Escott, a vice president, Menasco Manufacturing Co., Burbank, Calif. Mr. Escott is president of the company's Texas Div., Ft. Worth. Other Menasco appointments: **Elmer J. Grommet,** vice president-finance; **Jack I. Hamilton,** vice president-sales and advertising; **John A. Jackson,** secretary; **Edward P. Tighe,** treasurer.

C. W. Brandt, vice president and manager of Systems Engineering for The Ralph M. Parsons Co., Los Angeles, Calif., now also manager of the Electronics Div., Pasadena, Calif. **J. N. Meason,** appointed operations manager of Systems Engineering and a vice president of Parsons.

Arthur W. Mack, vice president-administration, Ford Instrument Co., a division of Sperry Rand Corp., Long Island City, N.Y.

Aerojet-General Corp.'s Sacramento (Calif.) plants have named the following officials: **Vice President Dr. Werner R. Kirchner,** manager, Solid Rocket Plant, **G. Graham Whipple,** assistant general manager, and **Richard F. Cottrell,** assistant manager; **Ray C. Stiff, Jr.,** manager, Liquid Rocket Plant; **Robert Tripp,** manager-administration, consolidated plants.

Raymond J. Volluz, assistant to the vice president of North American-Rocketdyne's Solid Rocket Div., McGregor, Tex.

Dr. George L. Simpson, Jr., assistant administrator for Technology Utilization and Policy Planning, a newly established Office in the National Aeronautics and Space Administration, and **Julian Scheer,** deputy assistant administrator. Also: **Louis B. C. Fong,** director of technology utilization.

Sol M. Norman, vice president, Block Engineering, Inc., Cambridge, Mass.

(Continued on page 114)

INDUSTRY OBSERVER

► Phoenix air-to-air missile for the Air Force/Navy F-111 tactical fighter promises to be a big procurement item for the manufacturing segment of the aerospace industry. Present plans call for the missile, under development by Hughes Aircraft, to be produced in blocks of 1,000 units at a time.

► **Russian MiG-21 aircraft received in India last month have been assembled and test-flown. Site surveys for the two MiG manufacturing plants in India have been made by Soviet specialist teams.**

► Possible new fuel for Titan 2—a gel formulation of anhydrous hydrazine containing suspended aluminum particles—is being investigated by Aerojet-General under contract from USAF's Ballistic Systems Div. Problem areas include flow characteristics of the gel and radiative heat effects of the aluminum particles on the nozzle.

► **Bell SKMR-1 Hydroskimmer research vehicle under development for U. S. Navy Bureau of Ships is scheduled for rollout at the end of this month. After further fitting and preliminary tests, it will be accepted by Navy for its flight-test program, planned to start June 7, and be flown by a Bell crew.**

► Terrain-following system study and development by Cornell Aeronautical Laboratory has produced results applied to several near-operational aircraft systems, among them the equipment for British Aircraft Corp.'s TSR-2 strike-reconnaissance fighter. Cornell has been flying a modified Martin-built B-57 as a test aircraft for its own system development; pilots have made "hands-off" runs through rough country.

► **Fluorine-propellant rocket engine is being considered by National Aeronautics and Space Administration as a high-performance backup unit for the service module of the Apollo spacecraft.**

► U. S. funding for the development of plenum-chamber burning in the Bristol Siddeley BS.100 turbofan will be stopped at the end of this calendar year. British will support development of the complete program for the vectorable-thrust engine. Modified Vickers Valiant testbed aircraft has made its first flight, carrying a BS.53 Pegasus 5 with plenum-chamber burning.

► **Production of nozzles for solid-propellant rocket motors has become a major subcontracting item in the U. S. missile program. Dollar values of nozzle contracts are beginning to approach those for the motor cases.**

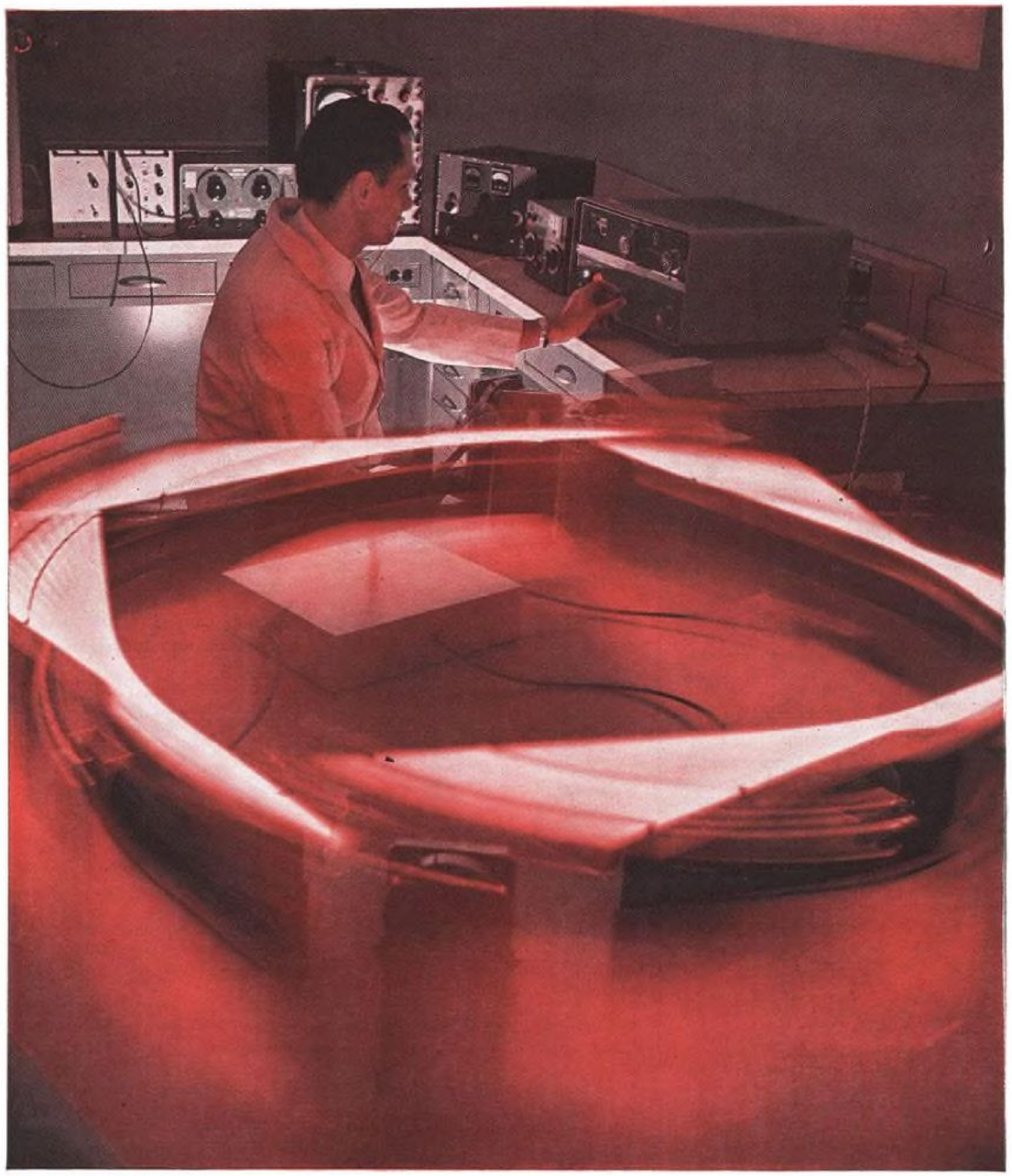
► Grain venting and re-ignition for intermittent shutdown of a solid-propellant rocket motor will be investigated in a study to be supported by NASA's Lewis Research Center. Competitive industry proposals were submitted at the end of March.

► **Sweden's Saab 401 hovercraft has entered the early test stage, reaching speeds approximating 44 mph. at Norrkoping airfield.**

► Techniques for thrust measurement of pulsed bi-propellant rocket motors will be studied in a program supported by NASA's Marshall Space Flight Center. Thrust range will be 50 to 200 lb.; pulse intervals will range from 10 to 100 millisec. Industry proposals for the study were submitted in mid-March to MSFC.

► **All command-post aircraft for the post-attack command and control systems (PACCS) will be in operation by the end of this fiscal year. They include specially equipped Boeing C-135 command-post aircraft and Boeing B-47 communications-relay aircraft. Most of the C-135s and all of the B-47s are now flying.**

► Russia's first gas turbine-powered hydrofoil boat is scheduled for launch this year. Maximum design speed of the craft is more than 53 kt. Russians are operating a number of Diesel-powered hydrofoil vessels, some carrying up to 300 passengers.



New Light. The first new direction-sensing device in 50 years, the traveling wave ring laser, may make future sea, air and space guidance systems simpler, lower in cost, more sensitive and more reliable. A marriage of the inertial and radiation sciences, it is only one result of Sperry research. □ Intensive basic studies at Sperry Rand Research Center concern materials, plasma physics, chemistry, solid state devices, geoastrophysics among others. And Sperry research is also continuing to develop advanced instruments and controls, acoustical and optical systems, new radar concepts, inertial components, sensor and surveillance systems, and many more. □ Through research successes...and failures...Sperry is shedding new light on fundamentals...and on the future. *General Offices, Great Neck, New York.*

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Washington Roundup

Project Forecast Begins

Project Forecast, an attempt to study the over-all future requirements of the Air Force, is getting under way in Los Angeles, away from the interruptions of Pentagon offices. Although it is being concentrated in Air Force Systems Command's Space Systems Div. complex there, it involves more than space and more than the command itself. USAF Chief of Staff Curtis LeMay, Lt. Gen. James Ferguson, deputy chief of staff for research and development, and deputies for plans and operations and for programs and requirements are expected to take part, as well as top officers of AFSC. Rand Corp. and Aerospace Corp. also will participate, giving the studies a strong civilian technical input. Although the effort is just getting under way, it is expected to be as complete a survey of future needs as the Air Force has done in many years.

Often explored question of whether the military services have a role in space and exactly what that role is—or should be—will be explored again this week by Rep. Olin Teague's House manned space flight subcommittee. Assistant Secretary of Defense for Research John Rubel and Air Force Systems Command's chief, Gen. Bernard A. Schriever, were scheduled to testify in closed hearings on Apr. 8.

British Defense Policies

Kennedy Administration will find quite different attitudes on its mutual defense problems with the United Kingdom if Harold Wilson, leader of the British Labor Party, should win the coming elections. Wilson said on a visit here he would be inclined to "survey the shambles" of British nuclear deterrent policy and then "renegotiate or denegotiate" the Nassau agreement that followed the Skybolt cancellation. Wilson said he saw a paramount need to increase Britain's support to conventional NATO forces—and to do so he would favor abandoning the "vain nuclear posturing" of a "so-called independent, so-called British, so-called deterrent." He also said he believed it would be a mistake to evacuate key military bases where there was a chance to remain, because "it is easier to stay than to re-enter" if trouble starts.

Wilson wants a great effort to create new industry, based on science, with the central thread being the remobilization of science and technology from missiles and warheads to civilian goods. He cited the example of hovercraft, developed by the tax-supported National Research Development Corp.

Canada and Bomarc

U. S.-Canadian relations, strained since State Dept. criticism of Canada's refusal to accept nuclear warheads for Bomarc helped topple Prime Minister John Diefenbaker's government last February, grew worse as the campaign to elect a new government entered its closing days. With the Apr. 8 election only 11 days away, the House Defense Appropriations Subcommittee released testimony in which Defense Secretary Robert McNamara said: "At the very least, they [the Bomarcs in Canada] would cause the Soviets to target missiles against them and thereby increase their missile requirements or draw missiles on to these Bomarc targets that would otherwise be available for other targets." Even though the Pentagon explained later that the U. S. has far more targets than Canada, and indicated that the quote was taken out of context, the Diefenbaker forces used the quotation to fan the already heated debate over Canada's nuclear role and its dependence on the U. S.

Increased accuracy of the improved Minuteman ICBM is expected to make it about four times more effective against hard targets than the earlier versions, McNamara told the subcommittee. Defense Dept. is asking for $190 million in Fiscal 1964 for continued development of the improved missile.

Nike X Cost Estimate

McNamara told the same subcommittee that the current Pentagon estimate of the cost of implementing a Nike X ballistic missile defense for the nation is $20 billion over a 10-year period. This is more than twice the Army estimates of several years ago, which were based on using the more expensive Nike Zeus system. McNamara added that "I personally will never recommend an anti-ICBM program unless a fallout program does accompany it."

When McNamara was asked in recent appropriations hearings about reports that President Kennedy had canceled air support for the Cuban Bay of Pigs invasion in 1961, he said: "There were no air strikes by U. S. forces planned or contemplated or considered at any time." But when he was asked about the air cover, he emphasized that he was talking about aircraft "for strike purposes," implying that he was making a distinction between the two types of support.

Marshal Sergei S. Biryuzov, who was made commander in chief of Soviet rocket forces last year after several years as commander of anti-aircraft defense, has been made chief of the general staff of the armed forces. No official announcement of the shift was made—Biryuzov's new rank turned up in an article in the military newspaper Red Star. He replaces Marshal Matvei V. Zakharov, who is 65.

—Washington Staff

Witnesses Challenge McNamara on TFX

Source selection board members, answering Defense chief's questions, dispute him on cost, commonality.

By George C. Wilson

Washington—Military witnesses strongly challenged Defense Secretary Robert S. McNamara's decision on the F-111 (TFX) contract by answering his own questions submitted to the Senate subcommittee investigating the award.

McNamara made the unusual request of Chairman John L. McClellan (D.-Ark.) that military members of the source selection board who recommended Boeing for the F-111 contract be asked a series of prepared questions while testifying before the Senate Permanent Investigations Subcommittee (AW Apr. 1, p. 26).

Sen. McClellan asked the questions last week and received responses disputing McNamara's claims that General Dynamics' F-111 design promised more commonality and more realistic costs than the competing Boeing design. These were highlights of the testimony given to the subcommittee:

• **Commonality.** Maj. Gen. Robert G. Ruegg, commander of the Aeronautical Systems Div. at Wright-Patterson AFB and chairman of the source selection board which recommended Boeing over General Dynamics, said that for the fourth evaluation General Dynamics used more identical parts to achieve a common Air Force-Navy fighter, while Boeing proposed machining down Air Force parts to obtain the lighter aircraft weight sought by the Navy.

Gen. Ruegg said that by milling down structures, cutting out mass or using lighter skin, Boeing made 19.7% of the parts for the Air Force-Navy version similar but not identical. He said 60.4% of the Boeing parts were identical, compared with 83% in the General Dynamics versions.

In the opinion of the source selection board, Gen. Ruegg said, the 1,450 lb. Boeing saved through this process "was worth it in as much as weight was one area of Navy requirements still considered critical. General Dynamics used more common parts and structure but used add-on wing area to meet the Navy requirement [for lower landing speeds]. Boeing used the same aerodynamic configuration and met the Navy requirements by using similar but lighter structural parts. I can see no basis for a conclusion that the Boeing aircraft will tend to diverge further during design while the General Dynamics aircraft are likely to retain the degree of interchangeability.

"Due to large difference in missions," he said, "divergence will probably be greatest in subsystems and equipment; and in the structural area, I would suspect there would be a convergence rather than a divergence." Asked about McNamara's contention that greater commonality of the General Dynamics design would simplify upkeep and logistics, Gen. Ruegg replied: "The degree of commonality that General Dynamics had over Boeing was in the parts that we do not normally stock and buy as spares." He said these were parts seldom replaced.

Brig. Gen. T. Allen Bennett, director of maintenance engineering at Logistics Command, Wright-Patterson AFB, said the commonality sought in the F-111 was in the building phase of the aircraft. ". . . Those parts such as bulkheads, wing sections and those large manufactured parts are not the types of parts that really cost us in the maintenance of our equipment as we get them into the inventory," he said. "They are not the high consumption parts . . . a contractor that has a higher degree of commonality in the construction of the weapon would not necessarily be the least costly to maintain as it got into the inventory. . . ." However, Gen. Bennett said it would be more economical to have one aircraft for two services if it could accomplish the separate missions successfully.

Thrust Reversers Now Considered for TFX

Washington—Air Force is studying the feasibility of adding the type of thrust reversers proposed for the Boeing F-111 (TFX) to the General Dynamics-Grumman design, but Pratt & Whitney, the engine manufacturer, is reluctant to take full responsibility for the job because redesign of the airframe would be required.

Ironically, Boeing's proposed use of thrust reversers is a reason Defense Secretary Robert S. McNamara and Air Force Secretary Eugene M. Zuckert gave for picking General Dynamics-Grumman for the $6.5-billion contract. McNamara said thrust reversers "complicated the development" of the F-111 and that "Boeing simply did not appreciate the complexities of developing the TFX."

But testimony developed by the Senate Permanent Investigations Subcommittee disclosed that since the award, the Air Force has arranged conferences between General Dynamics and Pratt & Whitney to explore the possibility of adding thrust reversers. USAF Col. Charles C. Gayle, project manager for the F-111 at Wright-Patterson AFB, told the subcommittee that after the contract award was made "we had specified to General Dynamics we would like for them to examine better means of deceleration." The General Dynamics design calls for air brakes and spoilers. Pratt & Whitney's JTF10A-20 engine was specified for both Boeing's and General Dynamics' F-111 proposals.

B. A. Schmickrath, engineering manager at Pratt & Whitney, wrote the Aeronautical Systems Div. at Wright-Patterson AFB on Sept. 13 that it would be better to have the airframe designer rather than the engine manufacturer develop the thrust reverser. Boeing designed the thrust reverser on its F-111 proposal, in cooperation with Pratt & Whitney, and included the cost in its bid. Schmickrath estimated it would cost $21.7 million for Pratt & Whitney to develop a thrust reverser for the General Dynamics design.

It is questionable, Schmickrath said in his letter to the Air Force, "whether the best interests of the weapon system will be served by giving sole responsibility for reverser design to the engine manufacturer. The problems of in-flight reversing at hi-Mach number in a fighter aircraft lie outside the experience of the contractors concerned, but it is safe to predict that the effect of the reverser on aircraft controllability will be critical, primarily because of the disturbance of flow over the aircraft airfoils. It is apparent therefore that the reverser must function as an integral part of the aircraft control system. In addition to the controllability aspect of integrating the reverser and aircraft, the problems of hot gas impingment on aircraft surfaces and reingestion of exhaust gases in the inlet duct must be handled carefully. The determination of circumferential and axial locations available for safe discharge of reverser air must be made by the aircraft contractor. . . These considerations which influence the aerodynamic concepts of the aircraft design have traditionally been the responsibility of the aircraft contractor."

Pentagon Ends Probe of Top Officials Over Leak

Washington—Defense Dept. ended its probe-within-a-probe in the F-111 (TFX) case last week, one day after it became known that more than 100 Defense Dept. officials—including the deputy secretary—had been asked to swear that they did not leak an unclassified document to a reporter, and to take lie detector tests if necessary.

Defense Secretary Robert S. McNamara ordered the Pentagon probe after the Washington Star published portions of an internal Air Force report claiming that investigators for the Senate Permanent Investigations Subcommittee had abused Air Force witnesses (AW Apr. 1, p. 28). McNamara told the subcommittee he "almost had indigestion" when he saw the story, because he had ordered the report locked in a safe a week earlier for fear of disrupting the Senate investigation.

McNamara turned the task over to Air Force Secretary Eugene Zuckert, who turned it over to Lt. Gen. W. H. Blanchard, USAF inspector general, who then turned around and questioned Zuckert. The general and his investigators also questioned Deputy Secretary Roswell L. Gilpatric, Navy Secretary Fred Korth, Assistant Secretary for Public Affairs Arthur Sylvester, and a number of other civilians and military men in the Air Force, Navy and Office of the Secretary of Defense.

Sylvester did not sign the statement swearing that the answers he gave investigators were true, but said he told investigators he would "if it made them any happier." He said he was not asked to sign a statement agreeing to a lie detector test.

Defense Dept. officials and President Kennedy—who was asked about the probe at his press conference—said no lie detector tests actually were given. Sylvester said the statement agreeing to take the test is "I understand, a regular technique of the inspector general."

Sylvester answered a number of questions about the investigation at his press briefing on Apr. 2. At one point, Maj. Gen. William H. Martin, Air Force chief of information, stood up in the back of the room and tried to get Sylvester's attention.

Sylvester, who—as an assistant secretary—outranks even four-star generals, said: "Sit down, general. Don't interrupt me, please."

Sylvester said Gen. Blanchard and his staff were "interviewing all key civilian and military personnel in the Navy, Air Force and OSD who might have had any connection" with the leaked report.

When Sylvester was asked: "Is this unusual for an investigation of this sort to be made regarding an unclassified document?" he replied, "We have an unusual situation here about which the [subcommittee] was highly unhappy with the release of this information, and the Secretary expressed his concern with them over it." Later, this exchange took place:

Question: [McNamara] said he had the thing locked in a safe.
Sylvester: That's what he said.
Question: In other words you are trying to find out somebody who might have cracked that safe?
Sylvester: No, but in these documents there are always copies.
Question: Why lock it in the safe if there are copies being circulated?
Sylvester: I don't believe he was aware as to how many were circulated.
Question: Art, do you think investigations of leaks here in the Pentagon, such as this one and prior ones, inhibit legitimate news sources in the building?
Sylvester: It didn't seem to in this case. . . .
Question: . . . The question is whether these investigations of leaks inhibit legitimate news sources.
Sylvester: My observation the last two years is that they haven't.

The next day the Defense Dept. issued this one-sentence press release: "The Air Force announced today that the Inspector General of the Air Force intends to conclude today his current investigation of the unauthorized release of an Air Force document."

The same day, President Kennedy said in response to a question at his news conference: ". . . I think that it was a mistake to suggest a polygraph, and I think Secretary McNamara, when he learned" about it "decided that that was in error, and he and Secretary Zuckert changed it. So I don't think we need concern ourselves in the future about it. As a matter of fact, no polygraph was given."

Rear Adm. Frederick L. Ashworth, a member of the board, disputed the logic in McNamara's assertion that General Dynamics was saving more money through commonality because it would cost General Dynamics $623 million more to build two separate airplanes for the Air Force and Navy while it would cost Boeing $397 million more to build separate aircraft. "There is only one conclusion that I can make from this—that Boeing would build two airplanes for less than General Dynamics would build two airplanes," Adm. Ashworth said. He also challenged McNamara's claim that the more common the bi-service airplanes are at the start of the contract the more chance there is to keep commonality.

"When the limit conditions are examined, either 100% common or 0% common, the absurdity of the reasoning becomes apparent," Adm. Ashworth said. "Let us assume that the Air Force and Navy versions were 100% common at the start. At best they could only stay that way—they certainly could not increase their commonness with time. Likewise, assume that they were totally different at the start, they could get no less different with time. It would appear that the tendency to change would be the opposite of that stated—the more common, the less likely they are to stay that way; the more uncommon, the more likely they are to become more common."

• **Technical risks.** Gen. Ruegg disputed McNamara's claim that the Boeing proposal incorporated highly questionable technical features. "Technical risk should be defined as the chance that the feature cannot be developed and applied successfully to the TFX in the time period or for the funds scheduled. . . . Both proposals were well within the state of the art and the board considered both proposals feasible within the time span."

George Spangenberg, evaluation division director at the Bureau of Naval Weapons, said "certainly the variable swept wing is the biggest risk item in the program, and it will offer the biggest advantages . . . General Dynamics would have a little higher risk than Boeing has. Their wing sweeps further forward and it sweeps further aft. The problem of course is what happens when the wing moves through its travel, and the technical problems to be solved will naturally increase with the angle of the sweep." This view counters the view of Dr. Harold Brown, director of defense research and engineering, who told the subcommittee the variable sweep wing is only an average risk.

• **Cost realism.** Gen. Ruegg said he agreed with McNamara's philosophy about avoiding costly overruns by making sure the government and contractors fully understood the job at hand before the contract was signed. But regarding McNamara's contention that the Boeing cost estimates were unrealistic, Gen. Ruegg said: "Our evaluation didn't show that one of them was completely optimistic and we proposed to get the most we could for the money."

Sen. Jacob K. Javits (R.-N.Y.) asked him whether the choice of aircraft was "such an open and shut question" that there was no room for the exercise of McNamara's judgment. "There certainly is room for judgments to vary in this area," Gen. Ruegg replied.

Admiral Viewed Boeing TFX as One Plane

Washington—Navy member of the source selection board has disputed Defense Secretary Robert S. McNamara's view that the Boeing Co. proposed essentially two aircraft for the USAF-Navy F-111 (TFX) tactical fighter while the General Dynamics-Grumman team offered a more nearly common aircraft for the two services.

Rear Adm. Frederick L. Ashworth said there were airframe differences in the USAF and Navy versions proposed by both Boeing and General Dynamics, but he told the Senate Permanent Investigations Subcommittee: "I don't consider them to be separate airplanes." Adm. Ashworth is assistant chief for research and development at the Bureau of Weapons and was the Navy's voting member on the bi-service F-111 source selection board. He said further that the Boeing proposal had more aerodynamic similarity in its USAF and Navy versions.

To blunt the impact of Adm. Ashworth's testimony, the Defense Dept.—on the day he testified—released portions of a formerly secret Navy evaluation which concluded on Nov. 2 that there was "no significant preference between the Navy versions of the two designs as submitted." Defense Dept. said this conclusion was among those reported to the source selection board by Capt. John T. Sheppard, who served as Navy co-chairman of the USAF-Navy F-111 evaluation group at Wright-Patterson AFB. The evaluation group consists of more than 200 people who make recommendations to the five-member source selection board.

Both McNamara and Air Force Secretary Eugene M. Zuckert, in defending their contract choice, have stressed that the General Dynamics design showed less divergence in the USAF and Navy versions of the F-111 (AW Mar. 25, p. 24). Their contention was challenged Mar. 27 in this exchange between Adm. Ashworth and Jerome Adlerman, subcommittee chief counsel:

Adlerman: . . . In the deliberations of the [source selection] board, did you consider that Boeing was proposing two separate designs in their attempt to meet the different requirements of the Air Force and the Navy?

Adm. Ashworth: No sir. I didn't consider that they were proposing two different designs.

Adlerman: Therefore, the statement made by Mr. McNamara that, in effect, they were proposing two different airplanes, that is not a correct statement, is that correct?

Adm. Ashworth: I think there are airframe differences in the two airplanes. There is no question about that.

Adlerman: There are also airframe differences in General Dynamics Navy and Air Force versions, are there not?

Adm. Ashworth: There are, yes sir.

Adlerman: So there are airframe differences in either the General Dynamics Navy or the Boeing Navy plane from the Air Force version?

Adm. Ashworth: Yes sir, that is correct.

Adlerman: Would you consider those as separate planes that were offered?

Adm. Ashworth: In the General Dynamics case or the Boeing case or both cases?

Adlerman: Both cases.

Adm. Ashworth: I don't consider them to be separate airplanes, in my opinion.

Adlerman: There may be some structural differences, but they are not separate planes?

Adm. Ashworth: This is my personal opinion, yes sir.

Additional testimony by Adm. Ashworth and other Navy officials traced the Bureau of Naval Weapons participation in the F-111 source selection process:

• **First evaluation.** On Jan. 8, 1962, the Bureau wrote the Aeronautical Systems Div. at Wright-Patterson AFB that "none of the designs as presented meets the minimum acceptable standards for Navy use. Two of the designs can be categorized as capable of carrier operations without major redesign. The other four designs are unacceptable for carrier operations without major changes." The two proposals which could be made acceptable without major redesign were those of Boeing and North American Aviation. The other four, termed by the Navy as "unacceptable without major changes," were: General Dynamics, Lockheed Aircraft Corp., McDonnell Aircraft Corp. and Republic Aviation Corp.

At a source selection board meeting Jan. 19, 1962, Adm. Ashworth said "it was evident that significant changes would be required in all designs before any would be fully acceptable to either the Air Force or the Navy. However, it was the unanimous view of the board that it had the responsibility to recommend a contractor source. The Navy voting member signified his willingness to select a contractor by joining in the unanimous vote of the board, as stated in the board report, 'for Boeing, presuming he will be directed to employ the Pratt & Whitney JTF 10A-20 engine.'" Adm. Ashworth said: "I was prepared to vote for Boeing as the source at that time, recognizing that some design changes must be made before it would be acceptable to the Navy."

Vice Adm. Paul D. Stroop, then chief of the Bureau of Naval Weapons, concurred with board's recommendation, stating in a memorandum to the Air Force Council on Jan. 23, 1962, that the Boeing proposal, "while not meeting all Navy requirements as submitted, clearly shows a thorough understanding of the problem presented by the work statement and submits the design which most nearly solved the problem. With the changes suggested by the board, especially substitution of the Pratt & Whitney engine, and rework of the missile installation, the design should produce a satisfactory Navy aircraft." McNamara, Zuckert and Navy Secretary Fred Korth reversed the board's recommendation and ordered the services to conduct a second competition between two of the six contractors—Boeing and General Dynamics.

• **Second evaluation.** Bureau of Naval Weapons evaluated the refined designs and then on May 1, 1962, wrote the Aeronautical Systems Div.: "Neither design is now acceptable from a carrier compatibility standpoint, but Boeing retains its substantial advantage over General Dynamics." But Navy went along with the Air Force in recommending Boeing at the source selection board meeting May 14, 1962. A Navy board member said Boeing's proposal "more nearly meets the requirements of the work statement," and that Navy "considers neither design acceptable" to it.

Adm. Stroop, on May 16, 1962, sent the board's recommendation to Adm. George W. Anderson, chief of naval operations. Although Adm. Stroop concurred in the choice of Boeing, he said: "It is significant that current proposals fail to meet performance requirements and weight goals by a greater margin than the original submissions . . . Therefore, any further effort to meet the joint requirements as presently established cannot be recommended."

Zuckert and Korth set up a third evaluation by giving Boeing and General Dynamics three weeks to redesign their proposals to meet Navy objections. Adm. Ashworth told the subcommittee that these new instructions amounted to encouraging divergence to achieve the objective of a bi-service fighter.

• **Third evaluation.** Although the source selection board again recommended Boeing on June 20, 1962, George Spangenberg, evaluation division director of the Bureau of Weapons, said aircraft designs deteriorated as the contractors sought to meet Navy objections. Through Deputy Secretary of Defense Roswell L. Gilpatric, McNamara directed the contractors to rework their designs again and submit to a fourth evaluation. Adm. Ashworth said a July 6, 1962, amendment to the original work statement encouraged the contractors to reduce the weight of the Navy version by considering the use of titanium. McNamara recently objected to Boeing's use of titanium in structural members (AW Mar. 25, p. 81).

• **Fourth evaluation.** In evaluating these final sets of designs, Navy concluded the Air Force version of the Boeing proposal would be able to land in a field 880 ft. shorter than could the General Dynamics aircraft. Air Force evaluators used contractor data and figured the Boeing edge would be 590 ft. Both designs were within the landing distance requirements. Adm. Ashworth told the subcommittee last week that the Navy was impressed with the Boeing aircraft's capability to land on a carrier with less wind over the deck than that required by the General Dynamics proposal. He said this "characterizes a growth capability" which would enable the Navy to load additional weight, such as new armament, on the aircraft without requiring an impractical wind-over-the-deck velocity. He said the General Dynamics-proposed Navy aircraft could not meet the original wind-over-the-deck requirement. The requirement ultimately was eased.

Air Force evaluators at Wright-Patterson, in their fourth evaluation report submitted to the source selection board, made these comments—censored later by Defense Dept.—about the landing capabilities of the competing aircraft:

• **Boeing**—"Thrust reversers with the associated high rotations per minute permits positive power control for pinpointing of touchdown spots. It also assures maximum wave-off acceleration for missed approaches. Once on the ground the same thrust reverser, coupled with positive braking, is expected to yield [blank] foot landing distances over a 50-ft. obstacle."

• **General Dynamics**—"The approach in such down speeds are remarkably low when compared to present aircraft, and landing distances over a 50-ft. obstacle are considerably shorter by [blank] feet than that required by the work statement. However, landing deceleration is accomplished by wheel brakes and spoilers only. This is satisfactory for dry field operation but the absence of a drag shoe or similar auxiliary deceleration device will make landing on short fields with wet or icy runways hazardous to the point that flying operations will probably have to be terminated."

Capt. John T. Sheppard, Navy co-chairman of the evaluation group, summarized the Navy's views of the carrier compatibility of the competing designs at the Nov. 2, 1962, meeting of the source selection board. He said at the time his recommendations were not binding on Adm. Ashworth, the Navy's voting member. Capt. Sheppard said both designs exceeded the weight desired by the Navy but were acceptable; both had excellent catapulting characteristics; Boeing had excellent and General Dynamics acceptable recovery performance; General Dynamics had "slightly superior" single-engine rate of climb; Boeing was considered acceptable and General Dynamics marginal for long-range missions; General Dynamics was easier to handle on the deck and more of its aircraft could be accommodated on a carrier; General Dynamics rated better at supersonic maneuverability because the aircraft was not limited at higher altitudes by top-mounted air inlets, and General Dynamics use of steel and aluminum was preferable to Boeing's choice of titanium.

Adm. Ashworth said he did not read the complete evaluation report but heard Capt. Sheppard's summary before voting for Boeing at the fourth evaluation. Adm. Ashworth and other members of the source selection board heard Air Force as well as Navy appraisals before voting unanimously for Boeing. The board was reversed by McNamara and award to General Dynamics-Grumman was announced Nov. 24, 1962.

Kennedy on TFX Award

Washington—President Kennedy, who told a press conference recently that he did not suggest to the Defense Dept. who should win the F-111 (TFX) competition (AW Apr. 1, p. 26), was asked at his press conference last week: "Mr. President, is it valid, sir, for the government to give a defense contract to a firm in order to keep that firm as part of the production arsenal of this country; and did that happen in the case of the TFX award to General Dynamics?"

"No to the last part," the President replied. "In the first case, if it is a hypothetical case, I would say it would depend on the circumstances, how great the need is. Is it for particular kinds of tools which we might need in the case of an emergency? I can think of cases where it would be valid. It has nothing to do with the TFX."

Maneuvering Satellite

Washington—USAF will brief major contractors this week on a competition for studies of a dual-purpose, maneuvering satellite capable of rendezvousing with another satellite and inspecting it. The maneuvering satellite would have to rendezvous with and without a crew.

USAF will select two companies to make the studies, which will include possible missions, boost vehicle and possible use of the satellite with Gemini.

SA-5 to Carry TV Camera

Huntsville, Ala.—Saturn SA-5, the fifth research and development vehicle, will carry a television camera to monitor separation of the S-1 booster and S-4 second stage later this summer. Built by the Radio Frequency Systems Section of the instrumentation development branch of Marshall Space Flight Center's Astrionics Div., the single camera will be mounted near the top of the S-1 stage.

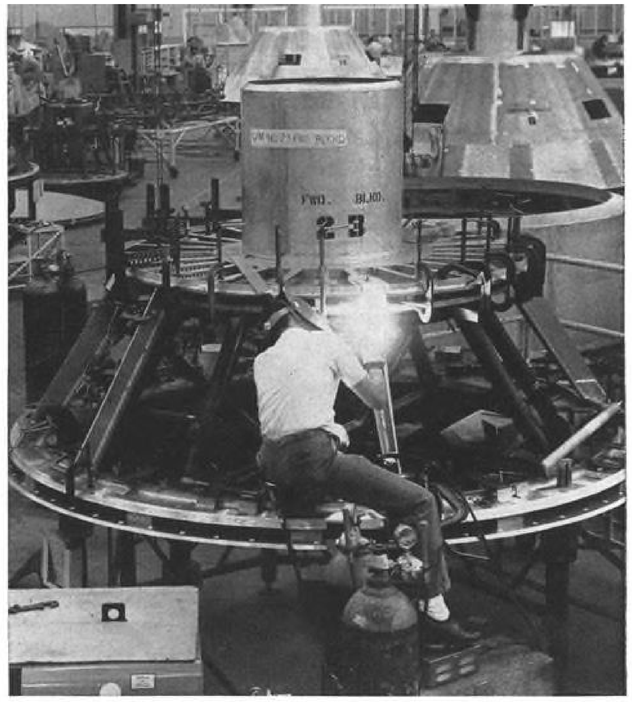
Camera will take 30 pictures per second, with each picture composed of 525 lines. Camera is an outgrowth of a similar experiment mounted on Mercury Redstone-2 (AW Feb. 6, 1961, p. 27) and will be evaluated as an optical instrumentation tool. Future flights may carry two or more TV cameras to monitor other booster areas. The system might eventually be used as an operational device aboard Saturn launch vehicles to provide data on vehicle parameters which best could be observed through optical, rather than electronic, instrumentation.

SA-5 also will carry eight movie cameras (AW Nov. 26, p. 87), mounted in pairs on four beam ends of the eight-legged spider beam assembly in the top of the S-1 stage. Four of the cameras will look at their areas through fiber-optic bundles. One will scan a 70-in.-dia. liquid oxygen tank and a second the 105-in.-dia. center liquid oxygen tank. Third and fourth fiber-optic cameras will look into the interstage area at chill-down of the RL-10 second-stage engines and separation of the S-1 and S-4 stages. Cameras, each weighing about 60 lb., will be ejected after burnout of the S-1 stage and will be recoverable downrange by individual paraballoons.

Solids Competition

Recommendations of USAF's source selection board in the large solid motor competition (AW Feb. 11, p. 50) include Thiokol for 260-in.-dia. motor (bid package 1), Aerojet for a parallel 260-in.-motor task and 156-in. motor with fixed nozzle (bid package 2), Lockheed Propulsion Co. for 156-in. motor using maraging steel and movable nozzle (bid package 3), and United Technology Center for 156-in. motor using tabs for thrust vector control and ablative nozzle. Contractors were scheduled for selection last week after review by USAF's Systems Command and headquarters and Defense Dept.

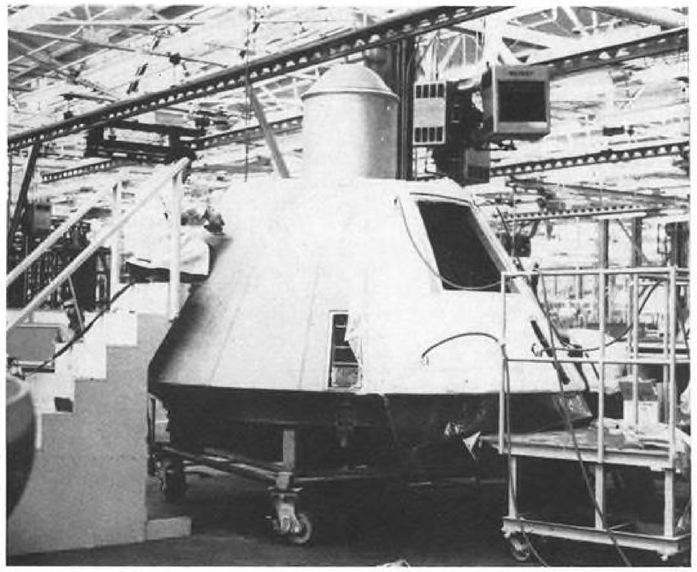




Plaster-covered master molds used in construction of 19 boilerplate command module spacecraft for impact, flight and abort testing are shown at left in North American Aviation's Space Systems and Information Div. facility at Downey, Calif. Molds shown are for main framework of spacecraft—forward and aft section—and heat shield, inner and outer skin. Three light-colored molds in lower row are 180-deg. molds for inner and outer skins of upper and lower sections of command module. Forward heat shield mold is dark-colored. Top row shows molds for inner and outer skins of glass fiber heat shield, aft heat shield wall (torus-shaped) and outside mold of heat shield crew compartment assembly. Boilerplate weld structure is shown in foreground. Forward half of boilerplate command module is under construction (right). Welder is welding top of longeron. Fabrication is mainly of aluminum. Cylinder on top is air-lock.

Apollo Spacecraft Boilerplate Production Advances

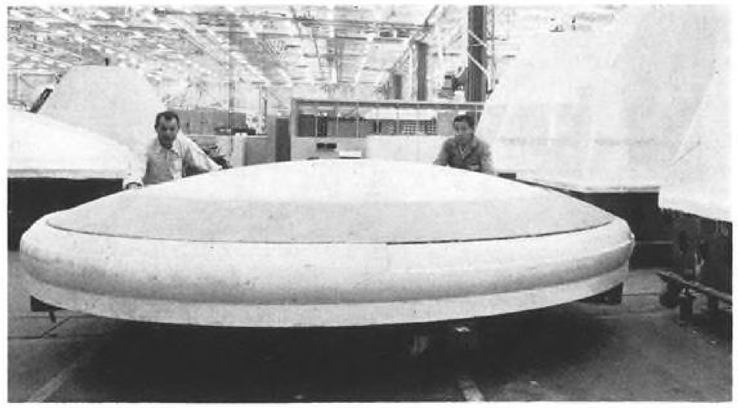




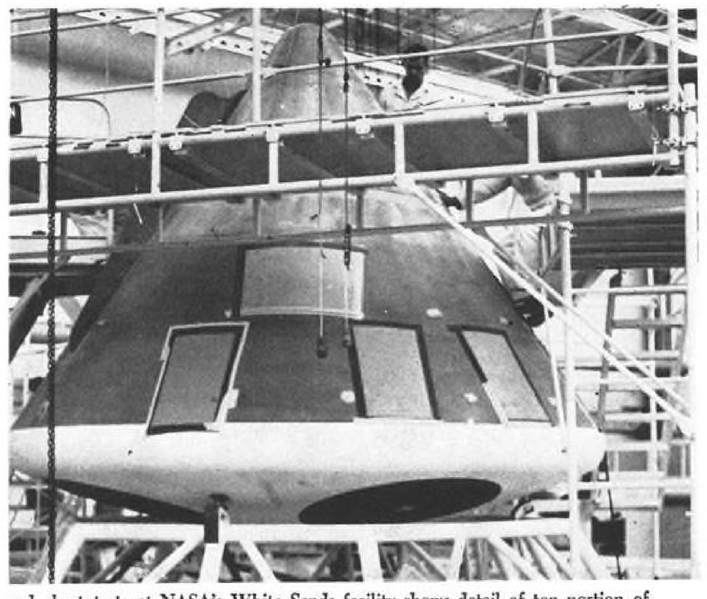
Boilerplate model of astronaut seat is fabricated of aluminum alloy. Titanium alloys are being considered for Apollo astronaut seat because of higher strength and lower weight. Workmen sand outer cork layer of Apollo spacecraft boilerplate model 13 which will be first model to be boosted into orbit with Saturn 1 booster to test spacecraft-booster compatibility (right). Cloth covering on right side of capsule keeps surface saturated with cleaning-oxidizing agent which etches surfaces slightly preparatory to cementing cork to surface. Outer layer of cork simulates ablative material for test purposes.



Open-end aluminum honeycomb, with protective spray coating is placed between outer skin of heat shield and inner skin of heat shield to achieve weight and strength of Apollo heat shield (above). All glass fiber heat shield would be too heavy. Glass fiber is used for test vehicles because of lower cost. Aft heat shield master facility tool (right) is used as reference after inner and outer skin of glass fiber heat shield are mated. Three master molds are necessary to fabricate the glass fiber heat shields, inner and outer skin and combination of the two. Command module master molds are at right. About 1,600 people are employed on the Downey, Calif., production line. North American eventually will turn out a total of 19 boilerplate spacecraft. All phases of production are either ahead or on schedule.







Forward heat shield of boilerplate model scheduled for pad abort tests at NASA's White Sands facility shows detail of top portion of strake added recently for better aerodynamic stability during re-entry (left). Boilerplate command module, which will be used for launch escape system tests at NASA's Manned Spacecraft Center White Sands missile operations site late this spring is shown at right. Two strakes, one on each side of spacecraft, made of ablative material, will increase aerodynamic stability of Apollo spacecraft during re-entry prior to main chute deployment. Black circle on heat shield is for optical tracking during pad abort tests.

Democrats Try to Ease NASA Funds Cut

By Alfred P. Alibrando

Washington—Kennedy Administration and Democratic leaders in Congress are making a concerted effort to save the $5.7-billion civilian space budget request from drastic cuts urged by the Republican leadership and some conservative Democrats.

Republicans are calling for reductions of up to $784 million in the new obligational authority being asked for the National Aeronautics and Space Administration in Fiscal 1964.

President Kennedy conceded last week that the NASA budget might stand a slight judicious trimming, but defended it against the reduction recommended by former President Eisenhower.

Congressional Decision

". . . Congress almost unanimously made a decision that the U. S. would not continue to be second in space," President Kennedy said. "We are second in space today because we started late.

"I don't think we should look with equanimity . . . on the prospect that we will be second all through the sixties and possibly the seventies. We have the potential not to be . . . having made the decision last year that we should make a major effort to be first in space . . . we should continue to do so. This is not a new position for [President Eisenhower]. It is a position . . . he took from the time of Sputnik One."

In New York, Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, told the American Institute of Aeronautics and Astronautics that the U. S. cannot afford to cut back its space program from either the standpoint of national survival or the country's prestige throughout the world.

Welsh said there can be "no sound basis for doubting that the USSR will . . . employ its growing space competence for military purposes if it finds that such action is effective. We must be able to handle such a threat."

He predicted more Russian space spectaculars this year, including "the docking of two spacecraft."

Most voluminous, detailed and basic defense of the space budget request was made by House Majority Leader Carl Albert (D.-Okla.), a ranking member of the House space committee. He issued a report which listed the "consequences" of the $784-million cut urged by Republicans.

Albert said this reduction would cut into the Apollo program, delaying a manned landing on the moon, and threaten the jobs of 65,730 persons—30,730 of them working at identifiable contractor locations in 16 states and 35,000 employed by subcontractors at various unidentified places.

Albert's figures were based on the assumption that most of the reduction would come out of the manned flight program, which is not likely. But the fact that cuts anywhere in the space program means loss of jobs has been an effective argument in Congress.

Committee Hearings

House space committee authorization hearings on NASA's budget request, now about two-thirds complete, indicate that the subcommittee on manned flight probably will recommend a cut of about $100 million to $115 million, in the form of deferred construction of facilities not needed immediately. Subcommittees on space science, advanced research and technology and application satellites also are expected to recommend reductions.

Following the launch of Lunik 4 by the Soviet Union last week (see box, p. 33) the House space subcommittee on manned space flight again took a close look at the pace of the U. S. manned lunar landing program. Subcommittee members asked D. Brainerd Holmes, NASA's director of manned space flight, if the U. S. program was geared to "win the race" to the moon.

His reply contained a subtle but distinct departure from the position NASA officials took when they announced acceleration of the Apollo program in May, 1961. At that time, Dr. Hugh L. Dryden and NASA Administrator James E. Webb said the program was being accelerated because the manned lunar landing offered a distant goal, allowing the U. S. time to overtake the Soviet Union and land men on the moon before Russia.

"To be successful [in Apollo]," Holmes said last week, "it is not necessary to win [the race]."

He said the objectives are broader and include extending the nation's space flight capability and the level of technical and scientific education.

He warned against both slowing down the program and spending at a radically increased rate.

"We're running a reasonable engineering and scientific program within our capability that is not based on reaction to Soviet activities," he said.

Military Systems

Prior to Holmes' appearance, Norman V. Petersen, Air Force technical director at the Edwards, Calif., Flight Research Center, said the use of the earth orbit rendezvous method for accomplishing manned lunar flight offered greater opportunity for developing systems which would be of military value.

Holmes, asked if the Defense Dept. had concurred in the decision to use the lunar orbit rendezvous method in the Apollo program, said the military had been consulted and made no objection.

Petersen said he would not be surprised to see the Russians make a manned circumlunar flight "tomorrow" using the earth orbit method.

Holmes also disputed this. He said the Russians have not displayed the booster capability for such flights.

Frick Resigns

Apollo project manager Charles W. Frick has resigned from his post at NASA's Manned Spacecraft Center, Houston, Tex., stating that pressing personal reasons dictated his return to the aerospace industry. MSC Director Dr. Robert Gilruth said that he accepted Frick's resignation with reluctance.

Robert O. Piland becomes acting project manager for Apollo, and Robert Decker has been named chief of the Lunar Excursion Module program, a position formerly held by Piland.

Frick became Apollo manager in February, 1962, after serving as consultant on the program since December, 1961, while employed by General Dynamics.

NASA Advisory Group

Washington — Five-member advisory committee has been appointed by the National Aeronautics and Space Administration to analyze the organization and management of NASA's manned flight programs.

Chairman is Dr. Marvin J. Kelly, Short Hills, N. J., retired president and chairman of the board of Bell Telephone Laboratories. Members are Dr. Hendrik W. Bode, Summit, N. J., vice president, Military Development and Systems Engineering, Bell Telephone Laboratories; James McCormack, Boston, retired Air Force major general now serving as vice president of the Massachusetts Institute of Technology; Dr. Arthur E. Raymond, Los Angeles, retired senior vice president in charge of engineering for the Douglas Aircraft Co. and now a consultant to the NASA administrator, and Dr. Hector R. Skifter, Manhasset, N. Y., president of Airborne Instruments Laboratory, Long Island, N. Y.

Soviets Launch Lunik 4

Washington—Soviet Union launched a 3,128-lb. Lunik 4 "automatic station" from a parking orbit into a 3½-day trajectory toward the moon on Apr. 2 without disclosing its basic mission.

The 1½-ton station was aboard the final stage of the launching rocket, according to the Soviet news agency Tass. Lunik 3, which made the first photographs of the backside of the moon in October of 1959, weighed only 614 lb. Lunik 4 is the first announced Soviet lunar probe since Lunik 3.

Comments by Soviet scientists during the first two days of flight covered all the possibilities—lunar photography on a single pass, as Lunik 3 made; lunar orbiter; lunar soft-lander and lunar roving vehicle. The term "automatic station" has been used in the past to refer to Russia's Venus and Mars probes, Lunik 3 and proposed lunar landers.

The station was transmitting normally on 183.6 mc., Russia said. Cosmonaut Yuri Gagarin said he believed there would be more flights of automatic stations and animals before manned flight to the moon.

McNamara Says Primacy of Top Leaders Is Main Pentagon Issue

By Katherine Johnsen

Washington – Fundamental issue in the Defense Dept. is the primacy of the individual – civilian or military – who bears total department-wide responsibility, rather than an issue of civilian vs. military control, according to Defense Secretary Robert S. McNamara.

McNamara downgraded the military vs. civilian aspect of the current Pentagon power fight recently in response to questions by members of the Joint Congressional Economic Committee.

Sen. Jacob Javits (R.-N. Y.) suggested to McNamara that military officers who were zealous to promote their service were giving him formidable opposition.

McNamara replied that "it is not primarily the primacy of the civilian vs. a military authority, but rather the primacy of an individual, military or civilian, who bears the total responsibility and can see the total problem in all of its aspects."

Representatives of individual services, he said, "have resisted, not out of any desire, I think, to advance their personal position or the power of their particular department, but rather because of an honest belief that it would . . . penalize the combat readiness of our establishment."

This was McNamara's first appearance before the economic committee, headed by Sen. Paul Douglas (D.-Ill.). This committee has supported his management policies and applauded his cooperation with General Accounting Office in its efforts to bring about cost reduction.

McNamara told the committee that he personally reviews all GAO reports on Defense Dept. waste and inefficiency, and that all GAO correspondence is reviewed and initialed by either himself or Deputy Defense Secretary Roswell Gilpatric.

"It is extremely difficult to change the traditional way of doing things in the defense establishment," McNamara observed. "Many of the actions we have taken during the last two years to improve the management of our procurement and logistics operations were recommended by this and other committees of the Congress and by various non-governmental committees and commissions, 10 and even 15 years ago.

"For example, the reorganization of the Army technical services, which we put into effect last year, had been recommended to the President by Secretary of Defense Robert Lovett in 1952 with the comment that 'a reorganization of the technical services would be no more painful than backing into a buzz saw, but I believe that it is long overdue' ".

McNamara stressed three policies to assure against the waste of billions of dollars on weapons systems: acquire "technical building blocks" first, carefully define a program before "bending metal", and then eliminate parallel projects.

He explained the "building blocks" as the new technologies and critical components, acquired through research and development, needed for major systems development.

"We cannot do a proper job of engineering development, least of all operational systems development, unless these building blocks are available," McNamara commented. "Lack of attention to this principle in the past has been one of the major causes of waste and inefficiency. . . ." He gave these examples:

• **Nuclear-powered aircraft.** After a 15-year effort and expenditure of about $1 billion, the aircraft nuclear propulsion program was terminated by McNamara in 1961 (AW Apr. 1, p. 81).

"Throughout its history the program was characterized by attempts to find shortcuts to early flight," McNamara related. "Only a relatively small fraction of the money expended was applied to the really critical pacing item, namely the development of an efficient reactor with a potentially high performance. . ."

• **Jet flying boat.** McNamara used the Martin P6M seaplane as an example of a project advanced into the production phase before even the basic design problems were solved. He set the cost of the eight-year effort at $450 million, including $200 million on the production contract.

McNamara said development was continued even though model tests in 1953-54 disclosed serious design deficiencies. A production contract for an operational plane was placed in 1956, even though flight tests in 1955-56 showed technical deficiencies, he said. It was canceled in 1959.

During the program definition period, McNamara told the committee, Defense Dept. and contractor teams explore in depth the many unknowns in any new effort. Two or more competing approaches may be supported, he said.

"Prior planning, and even feasibility testing of 'pacing' components, are a lot cheaper than having to reorient, stretch out, or terminate expensive projects after they have been started," McNamara said.

Developments such as atomic and hydrogen bombs and intercontinental ballistic missiles, which add a new dimension to military capability, justify great costs, but such developments are rare, he said.

"The typical development promises, if successful, to achieve a capability that can also be achieved in other ways or represents an improvement of but modest proportions," he continued. "In these cases, the urgency is not as great and the employment of a more measured and orderly approach to development and production is fully justified. . ."

The F-111 (TFX) Air Force-Navy fighter (see p. 26) was cited by McNamara as his most significant action so far to eliminate parallel projects for the same general mission.

McNamara elaborated extensively on the theme that with parallel projects, huge development costs must be duplicated, two production lines must be set up, two separate pipelines of spares and unique support equipment must be established, and some disposition must be made of the two sets of obsolete spares and support equipment that eventually will accumulate.

Explorer 17 Returning High-Quality Data

By George Alexander

Cape Canaveral, Fla.—Quantity and quality of data being returned from space by Explorer 17 satellite last week is expected to enable National Aeronautics and Space Administration to make the first detailed and comprehensive analysis of the earth's atmospheric structure.

Previous American and Soviet satellites have sampled only selected parts of the earth atmosphere. Explorer 17 is the first satellite designed solely for broad investigation of the density, pressure, composition and temperatures of the upper atmosphere.

Explorer 17, built by NASA's Goddard Space Flight Center, Greenbelt, Md., was launched here at 9 p.m. (EST) Apr. 2 by the Douglas three-stage Delta vehicle. Preliminary analysis indicated the satellite achieved an apogee of 569.8 stat. mi., a perigee of 158.4 stat. mi., a period of 96.4 min., and an inclination of 57.63 deg.—all extremely close to pre-calculated parameters.

Explorer 17, designated S-6 prior to its successful launch, carried eight instruments aloft to measure the atmosphere—two mass spectrometers, four vacuum gages and two electrostatic probes. The satellite is a 35-in.-dia., 405-lb. stainless steel sphere, with the instruments protruding from its surface.

Mass spectrometers, built by Consolidated Systems Corp., Monrovia, Calif., are designed to detect the amounts of helium, atomic oxygen and nitrogen and molecular oxygen and nitrogen in the altitude regions attained by the satellite.

Spectrometers, resembling Faraday cups, generate two magnetic fields. The first extends about 16 cu. mm. in front of the spectrometer, and the second exists within the device.

Particles trapped in the first field are ionized by a probe extending in front of the instrument mouth and are funneled into the interior of the unit. There, the ions encounter the second magnetic field, which is of constant strength, and are deflected according to their mass to one of six collector plates. Particle impingement on a plate causes a current flow which can be measured to indicate the amount of particles collected by the spectrometer.

Four vacuum pressure gages—two built by the Equipment Co. of National Research Corp., Newton, Mass., and two by Westinghouse Electron Tube Div., Elmira, N. Y.—are providing data on the diurnal variations of particle distribution in the ionosphere. Devices flown on earlier satellites have confirmed that the earth's atmosphere expands on the side facing the sun and contracts on the shadowed, or night, side.

National Research Corp. gages are of the Redhead variety (named after Canadian scientist Dr. P. A. Redhead) and are more sensitive to the lower pressures of higher altitudes. Their range is about 10^{-11} to 10^{-6} mm. Hg. Westinghouse gages are of the Bayard-Alpert type and are most effective for pressures ranging between 2×10^{-10} to 2×10^{-4} mm. Hg.

Operational ranges of the different gages, both of which ionize particles to generate a measurable flow on collector plates, complement each other.

Electrostatic probes, of the Langmiur type and provided by the University of Michigan, extend about 12 in. from the surface of the satellite shell. A sawtooth voltage is applied between the cylindrical probe and the shell. Particles flowing through this potential induce a current flow, the magnitude and shape of which are dependent upon the quantity and temperatures of ions and electrons at those altitudes.

Because Explorer 17 has no data storage capacity, it operates directly upon command of ground stations at Blossom Point, Md., St. Johns, Newfoundland, and Woomera, Australia. As the satellite comes within view of one of these stations, a command is sent to it, ordering the spacecraft to turn itself on.

Second command is then sent to a 10-stop rotary switch, selecting the sequence of the instruments to be operated. There are eight possible combinations:

- **Two Redhead gages only.**
- **Two spectrometers only.**
- **Two Bayard-Alpert gages only.**
- **Two electrostatic probes only.**
- **Spectrometers,** two of the vacuum gages and electrostatic probes.
- **Spectrometers,** the other two vacuum gages and electrostatic probes.
- **All four vacuum gages** and electrostatic probes.
- **All eight instruments.**

Ninth and tenth stops on the switch are back-up commands for turning the equipment on and off.

After the sequence has been decided, the instruments operate for 270 sec., and then automatically shut off. Readout is direct to the ground station observing the satellite on that particular pass.

Explorer 17 also lacks solar cells, relying entirely on 150 lb. of silver-zinc batteries for electrical power. Batteries, ranging from 1 amp.-hr. to 359 amp.-hr. capacity, are expected to have an operating lifetime of about 75 hr. Total lifetime of the satellite, which will operate only 4.5 min. out of every 96-min. orbital pass, is estimated at two to three months.

Explorer 17 is spin-stabilized at 1.5 rpm. An aspect system, consisting of a digital-fan sensor, a split-fan sensor and infrared horizon scanners, will indicate to the ground station the orientation of the satellite in relation to the earth and either the sun or the moon. This orientation reference will facilitate later data analysis.

Explorer 17 is the first scientific satellite to use a pulse code-modulated (PCM) telemetry system. The system provides 40 channels of digital data, with each channel capable of 20 nine-bit words every second. Four turnstile

Thermosphere Probe

Cape Canaveral, Fla. — Data being gathered by the Explorer 17 satellite, orbited from here last week, will be correlated with information collected by a 20-lb. sphere to be launched from Wallops Island, Va., within the next two or three weeks

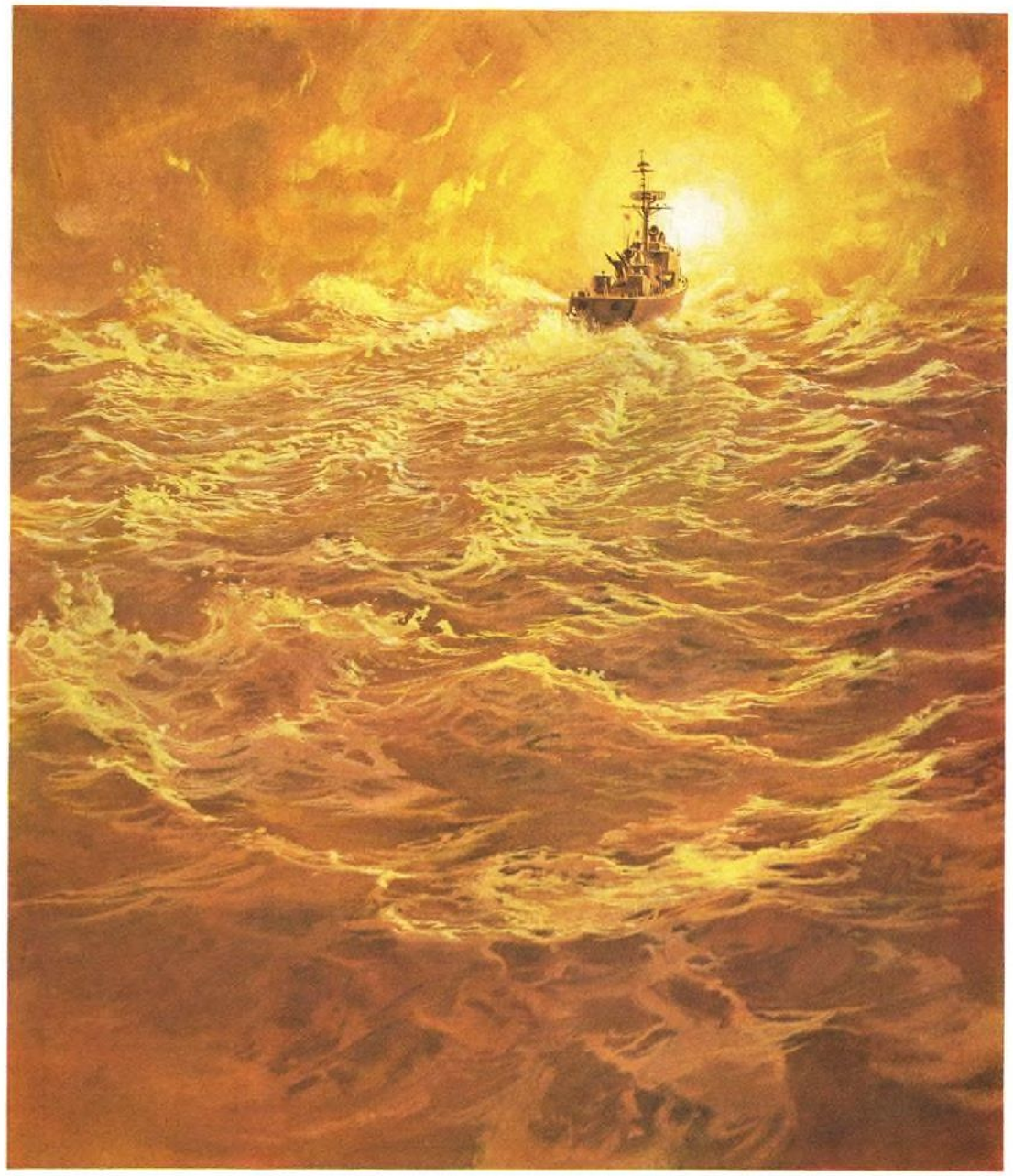
The sphere, to be lifted to an altitude of about 250 mi. by an Aerojet-General Aerobee 300A two-stage rocket, will contain a mass spectrometer and an electrostatic probe similar to units aboard Explorer 17. The spectrometer, however, will detect only nitrogen.

The sphere will be launched as Explorer 17 passes over Wallops Island. Data derived from the sphere, called the Thermosphere Probe, will give NASA scientists a vertical profile of the atmosphere which then can be correlated with the horizontal samples of Explorer 17.

Advanced Engine Study

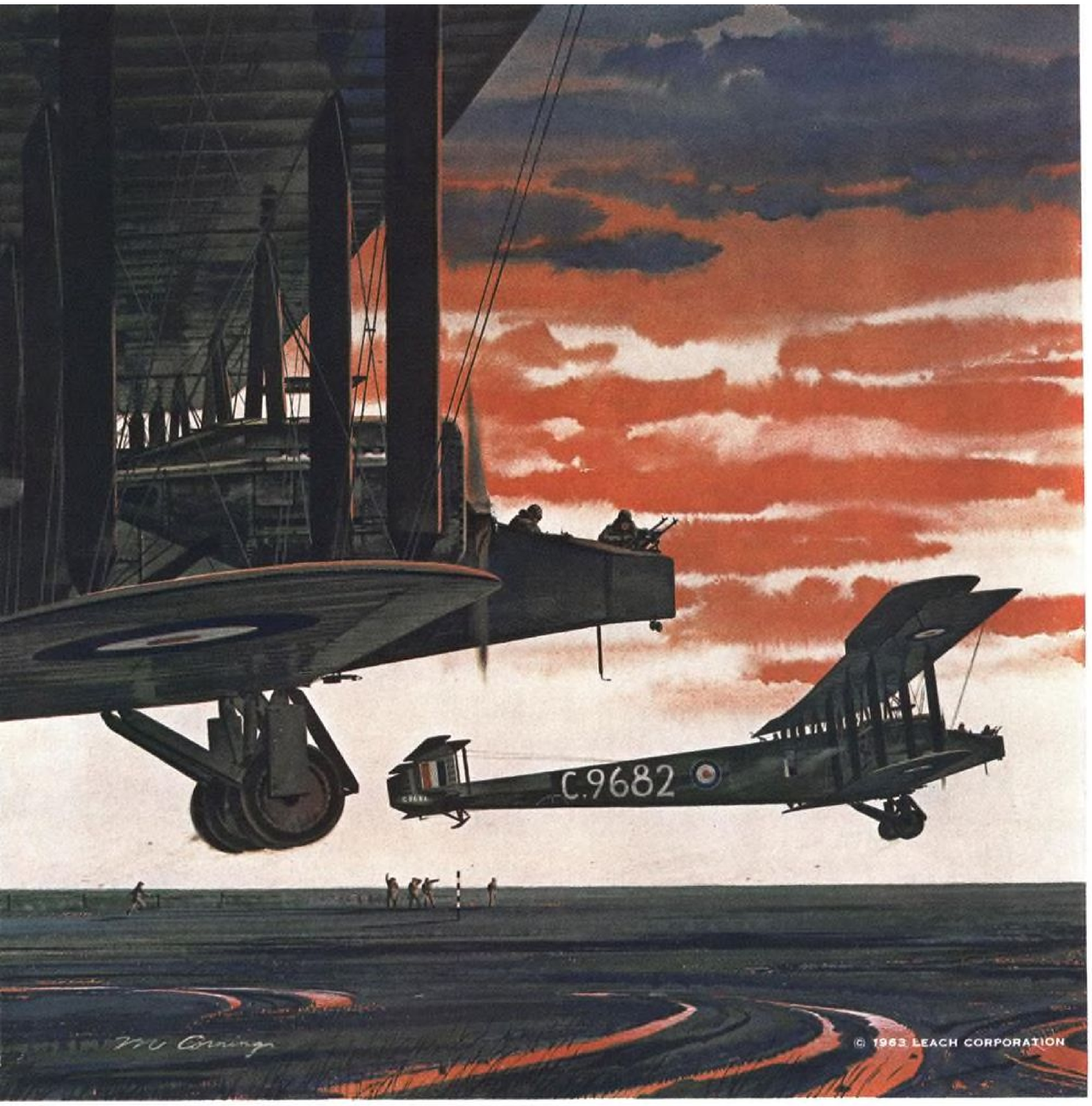
Investigation of an advanced, controllable-thrust, liquid oxygen-hydrogen engine incorporating operating characteristics required for earth orbit rendezvous or planetary landings will be sponsored by NASA's Western Operations Office, Santa Monica, Calif., in a 12-month, $300,000 effort.

Industry proposals will be submitted Apr. 20 for the task, which will include a design study and dynamic analysis of the pressure-feed propulsion system having a full thrust scaleable within a range of 2,000 lb.-40,000 lb. Requirement will be to vary thrust continuously from full value to 1/10 full. Total duration of thrust will be 500 sec. Engine will be restartable, incorporate thrust vector control and will have to be compatible with future change to fluorine as the oxidizer.



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BLOODY PARALYSER

LEACH HERITAGE OF THE AIR—25

It was 8:00 P.M. on the night of August 25, 1918. The sun was setting over the airfield at Ochey, France. Captain W. B. Lawson and Lieutenant M. C. Purvis, followed by their observers, climbed up to the front cockpits of their Handley-Page 0/400 bombers. Their mission: to bomb Mannheim's Badische chemical works, manufacturers of poison gas.

It was another night raid designed to demoralize the Germans and destroy their industrial might. What began as another routine bombing mission toward the end of the war, really had its beginnings almost four years before.

In December 1914, the British Admiralty sent out a call for help. They desperately wanted a plane capable of making Channel crossings with a heavy load of bombs. Specifically, they wanted a plane with two engines, two crewmen, six 112-pound bombs and a maximum speed of 72 miles per hour.

Frederick Handley Page, one of England's foremost airframe designers, presented his biplane specifications to Commodore Murray F. Sueter, Director of the Admiralty's Air Department. Impressed by what he saw, Commodore Sueter asked for more. In what is perhaps the greatest over-simplification of all time, he said "give me a bloody paralyser of an aeroplane." The result was the Handley-Page 0/100 — the first strategic bomber in the history of aerial warfare.

The builders of the Handley-Page 0/100 had their work cut out for them. It was the biggest plane ever assembled in Britain up to that time. The 62½-foot-long fuselage had to be built in three parts, with the center portion holding the bomb bay.

The wings were also built in sections and folded to fit the plane into a hangar. The top wing had a span of 100 feet, the lower, 70 feet. The top of the top wing stood two stories off the ground.

The 250 h.p. Rolls Royce engines were mounted between the wings. The forward section held a side-by-side cockpit for the pilot and co-pilot and in the extreme nose a pit for the forward gunner-bombardier. Another gunner's position was behind the wings. There were no brakes—the big plane stopped by means of a giant sprung tail-skid.

The Handley-Page first saw action in November 1916 while attached to the 5th Wing of the Royal Naval Air Service in Dunkerque. It was originally used on daylight patrols off the coast of France. On April 23, 1917, three planes, each loaded with fourteen 65-pound bombs, attacked five German destroyers off Ostende and left one listing.

But in a similar raid three days later, an 0/100 was shot down. From that time on, the Handley-Page became a night bomber.

In the beginning, only one Handley-Page would go out on a night raid. But that was enough. One 0/100, carrying sixteen 112-pound bombs and a crew of three, could do as much damage as six DeHavilland-4 bombers with a total crew of 12. Moreover, the 0/100 needed only 54 gallons to fly 100 miles, versus 120 gallons for the D.H. 4s.

On October 2, 1917, four 0/100s were transferred to the new Naval "A" Squadron attached to the 41st Wing at Ochey, France. This wing was later to become part of the Independent Force, R.A.F.

The only heavy bomber group of the R.A.F. in France until August 9, 1918, it was later equipped with Handley-Page 0/400s — a slightly modified version of the 0/100s. As many as 40 planes at one time bombed such cities as Kaiserslautern, Saarbrucken, Duren, Darmstadt and Mannheim.

The attack on the Badische works in Mannheim by Lawson and Purvis was a particularly daring one. The first plane barely missed the tops of the smoke stacks as it passed 200 feet over the factories. The second plane dropped its bombs and emptied its machine guns from 500 feet up.

Strategic bombing raids by the Handley-Pages were minor disturbances when compared to similar missions of World War II. But they brought the war to the enemy. And they established the Handley-Page bomber as the "bloody paralyser" of World War I.

Did the Bloody Paralyser carry Leach Relays?

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What kind of relays?

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Can Relay is one of our newest. It was designed specifically for printed circuit applications.

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That's right. Our command receivers are now in use in many Air Force missile projects. And we're a leader in the miniature tape recorder field. Our latest recorder weighs 14½ pounds and is being developed for Project Apollo. Our



smallest one is this 26-ounce unit that takes up to 2000 G's of shock in temperatures from −100°F to +180°F.

How do I get in touch with Leach?

We've just built our new corporate headquarters in San Marino, California. But we have other offices in Los Angeles, Azusa, San Francisco, New York, Washington, D. C., Dayton, Seattle, Boston, Huntsville, Zurich, Munich and sales representatives around the world. For more about what we do and can do for you, write:

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antennas, mounted on the bottom of the satellite, provide omnidirectional transmission propagation.

It also was the first pressure-tight scientific satellite. The 78-lb., 0.025-in. thin steel shell, built by the Budd Co., Philadelphia, Pa., was designed to be leak-proof so that no earth gases would be carried aloft to mislead instruments. The shell was pressurized to one earth atmosphere with gaseous nitrogen.

Trajectory flown by the Delta vehicle was described as "low and hot" by NASA project personnel from Goddard's Field Projects Branch, which conducted the launch. Thor first stage burned for 145 sec. Second stage then separated and, after coasting for 4 sec., burned for 156 sec. After 30 sec. of second-stage burning, the shroud protecting the spacecraft was jettisoned.

A 71-sec. coast followed second-stage burnout. At T+376 sec., the third-stage, solid-propellant motor ignited and burned for 40 sec., injecting Explorer 17 into orbit.

Orbital injection of Explorer 17 was the sixteenth consecutive success with the Delta, which has failed only in its first attempt. A 1-sec. bias was deliberately introduced into the countdown Apr. 2 so that the vehicle, which had been meeting all countdown checks perfectly, would not place the satellite into orbit too early. Liftoff, therefore, occurred at 2.2 sec. past 9 p.m.

Satellite had a 3-hr. launch window between 9 p.m. and midnight so that the earth sensor of the aspect system would not accidentally lock on the sun and sustain solar radiation damage.

First command to be sent to Explorer 17 was issued about one hour after launch from the Woomera station and ordered the opening of the four vacuum gages. These units had been evacuated and sealed prior to launch. The second command—initiating normal operations—was given 45 min. later by the Newfoundland station.

NASA Biotechnology

NASA's Flight Research Center, Edwards AFB, will fund a design study for a psychophysiological information acquisition, processing and control system for use in biotechnology and human research programs. Task is being undertaken because no system of the type desired, for lab and flight use, has been developed.

The study will aim to sense, correlate and predict the critical parameters which define the dynamic state of the man and the environment external to, but not independent of, the man and the machine. The system is intended for use with humans, but the sensor subsystem design will be oriented for use with animals. Industry proposals for the study effort are due Apr. 22.

West Europe Firms Pushing Space Efforts

By Cecil Brownlow

Geneva—Potentially powerful West European aerospace industry association, Eurospace, is actively pushing plans for a multinational-developed communications satellite program which might create stiff competition for the U. S. in this area of space technology.

Other Eurospace proposals for coordinated research, development and production on a multilateral basis between West European nations are keyed to stepped-up manned and unmanned space flight programs and related technology. These proposals call for an eventual West European manned lunar landing program.

Plan, agreed upon by 110 active member firms in eight West European nations, including several of the area's largest and most influential companies, is now being circulated among agencies of the various governments involved for comment and hoped-for support.

Program was evolved after more than a year's study by members of Eurospace. The relatively new industry association is promoting a vigorous space program within Western Europe, rather than what it considers the somewhat mild plan being evolved on a governmental level for the European Space Research Organization (ESRO).

Early indications are that the Eurospace plan is getting mixed receptions, depending upon the agency and nation involved and their respective outlooks.

Great Britain, for example, is planning its own national communications satellite program (see box). Several influential French officials, on the other hand, favor a multination communications satellite program but, with U. S. efforts at an advanced stage, want to cooperate actively with Americans in this area rather than begin from scratch, as Eurospace advocates.

West Germany, with its space effort responsibility divided among a maze of agencies, apparently does not yet have a firm objective within the communications satellite field.

Eurospace plan, however, cannot fail to have a substantial impact, whatever its ultimate future. In addition to its West European active members, the organization has eight U. S. industry "corresponding members" who joined in hopes of contractual fallouts, and, perhaps as importantly, three major banking associates—France's Credit Lyonnais and Banque Commerciale de Paris and England's Barclay's Bank, Ltd.

While manned space flight, lunar landings and Martian probes are envisioned as advanced projects, the most immediate goal is multinational development of an equatorial communications satellite system. The Eurospace program proposes both stationary and non-stationary systems, the former backed by a French firm, the latter by a British member. Proposed operational date for the first non-stationary system is 1968. Its stationary counterpart could be launched in 1968 or 1969, according to the Eurospace schedule.

Eurospace supporters contend that a comprehensive space program cannot be financially and technologically supported by any European nation alone. Consequently, Great Britain's recent announcement of national communications satellite project is causing some concern.

Many observers, however, consider the announcement as primarily a tactical maneuver within the realm of the Common Market "cold war" now being waged between the United Kingdom, which wants to join the organization, and France, which opposes British membership, at least for the present.

Equatorial, non-stationary communications satellite proposal by Eurospace envisions use of 12 satellites in simultaneous orbit at an altitude of approximately 7,600 naut. mi.

Launch vehicle, at least in the early firings, would be a three-stage booster unit now under development by Great Britain, France and West Germany as the first step in the government-sponsored European Launcher Development Organization (ELDO) program. The ELDO vehicle also is scheduled to launch the first satellite systems for ESRO, whose present plans do not include a communications satellite.

Experimental Eurospace satellite subsystems would be launched by France's Diamant rocket.

Satellites would be attitude-stabilized and have payload weights ranging between a minimum of 400 lb. and a maximum of 800 lb. First-generation payloads would incorporate traveling wavelength transmitters and have a capability of 600 two-way telephone circuits. Solar cells and other supply packs could furnish power for follow-on units.

Envisioned total cost of the Eurospace non-stationary communications satellite program over an eight-year period, including research and development, is approximately $542 million.

Proposed stationary system would consist of two satellites stationed in equatorial orbit at an altitude between 19,500 mi. and 19,370 mi. Normal payload weight would be about 500 lb., although it could range up to slightly more than 1,000 lb.

Launch vehicle possibly could be the initial ELDO booster now under development or one of two more advanced units now under consideration for probable development. The latter might be more preferable, but more expensive. These are designated in the Eurospace report as ELDO Baker and ELDO Charlie. The proposal says ELDO Baker could be operational in 1968-69, ELDO Charlie in 1970-71.

U.K. Orders ELDO Comsat Study

London—British government last week ordered a design study to determine a suitable communications satellite system which would be put into orbit in cooperation with the European Launcher Development Organization (ELDO).

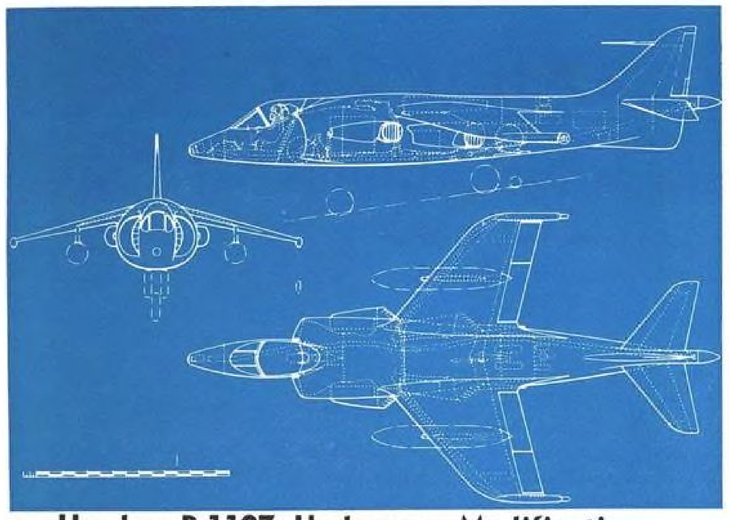
Minister of Aviation Julian Amery said studies will be undertaken by Royal Aircraft Establishment at Farnborough and the Signals Research Development Establishment at Christchurch. Under consideration are:

- Medium orbit of 7,500 naut. mi., calling for a large number of satellites, probably at least 12.
- Stationary orbit, calling for a much smaller number of satellites launched to a height of 22,300 stat. mi.
- Use of Woomera rocket range, Australia, which Amery said probably will meet every requirement during development phase of the communications satellite system.

Although the studies will be carried out in the government's own research facilities, results will be made available to private industry. Amery also said contracts to industry will be awarded soon for construction of the Ariel 3 satellite, the third of the joint U. S.-U. K. satellites but the first to be entirely British-built.

As it now stands, the ELDO launch vehicle will be a de Havilland Blue Streak for the first stage, with a French second stage and German third stage. Amery said ELDO, however, plans to use the Saunders-Roe Black Knight for a number of test shots after the Blue Streak is fired at Woomera, probably in about a year.

Amery also said that Great Britain ratified the ELDO convention last week, following the signing by Australia. He said he expects other member nations—France Belgium, Holland, West Germany and Italy—to ratify the convention by this fall.



Hawker P.1127 Undergoes Modifications

Major design changes, including new wing geometry, have been made to the Hawker P.1127 in the program transition from prototype flight test to development evaluation. Wing geometry has been changed from 30-deg. swept panels to 35-deg. Wing taper ratio has been modified from approximately 4:1 to 2:1; wingspan was reduced from 24 ft. 4 in. to about 22 ft. 5 in. Constant-chord ailerons and flaps have replaced the varying chord surfaces of the original P.1127. Extra fuel has been added externally in pylon-mounted tanks, one under each wing. Fuselage has been lengthened, nose and midsection contours have been altered. Inlet duct configuration has been modified, and the face of the duct now slopes instead of being perpendicular to the fuselage centerline. Vertical tail has been increased slightly, horizontal tail has been increased considerably, and all evaluation aircraft will have anhedral on the horizontal tail.

First of the two proposed satellites would be utilized to connect Europe with North and South America, Africa, and the Near and Middle East. The second would link Central Europe with Central and Southeast Asia, including Japan, Australia and much of Africa.

Each payload would have 1,200 one-way channels, and television transmission capability would be added as a later step in the program.

Total cost over an eight-year period of the synchronous systems is estimated by Eurospace at $249 million. This figure, the organization contends, can be reduced if ELDO Able—the designation adopted by Eurospace for the initial ELDO launch vehicle—proves feasible as a booster.

Initial costs over a four-year period for both the stationary and non-stationary communications satellite systems, most of which would be consumed in research and development, is estimated at about $56 million.

Diamant subsystem launch unit also is proposed in a number of configurations, including a three-stage unit which, Eurospace spokesmen say, could place an 800-lb. payload into a 160-naut. mi. polar orbit.

Approach to manned space flight, as envisioned by Eurospace, essentially would begin with a recoverable space-transporter that could place a payload in orbit and return to earth, possibly after a rendezvous mission.

In an effort to bypass development of large chemical second stage units for its more advanced boosters, Eurospace proposes development of a nuclear-power system with a possible availability date of 1975. Approximate characteristics would be:

- **Solid core** of graphite and uranium 235.
- **Ground-level thrust** of about 50 tons.
- **Neutron power** of 3,500 mw.
- **Thermal power** of 2,600 mw.
- **Propulsive fluid** would be liquid hydrogen.
- **Specific impulse** of 800 sec.

Eurospace says such a design, employing an oxygen-kerosene first stage, should be capable of placing 10-ton payload into a 300-naut. mi. orbit.

Other advanced projects in this area:

- **Manned earth orbiting stations.**
- **Lunar satellites.**
- **Unmanned lunar stations.**
- **Manned lunar rockets.**
- **Martian probes.**

Still other projects proposed by Eurospace include meteorological, navigational and time synchronization satellites, electric propulsion, orbit transfer and orbit and altitude correction.

Eurospace members include firms in Belgium, France, Italy, Norway, Holland, Switzerland, West Germany and Great Britain. "Corresponding members" from the U. S. are Aerojet-General, Boeing, Douglas, Garrett Corp., GE, Lockheed, Martin and Republic.

News Digest

Kaman K-1125 helicopter made its first flight last week powered by two Canadian Pratt & Whitney PT-6B engines. Aircraft was aloft about 30 min. It formerly was powered by Boeing T60 engines (AW Oct. 8, p. 102).

Sud Aviation's helicopter division is building a bi-turbine prototype assault helicopter which should fly by the end of 1964. Designated SA 330, prototype grosses 13,640 lb. and will carry 12 soldiers plus a crew of three. Single rotor will be powered by two 1,300-hp. turbines, probably modified Turbomeca Bastans.

Discovery of a relatively dense hydrogen ring around the earth at an altitude of 6,200 mi. was claimed last week by the Soviet Union. The ring lies in the plane of the ecliptic and is about 1,000 times denser than interplanetary gas, according to the Soviet news agency Tass. The ring resembles those of Saturn and was detected with astronomical instruments "50 times more sensitive than previously had been used."

McDonnell Aircraft last week signed a $456.6-million contract for production of 13 flight-rated Gemini spacecraft and other equipment and services connected with NASA's Gemini program.

New York Airways has suspended helicopter service at La Guardia Airport due to the reduction of airline service there. The field is being reconstructed, and several major carriers such as United Air Lines and Trans World Airlines have halted operation from it. New York Airways said the move brought no reduction of frequencies on its retained routes which link Idlewild, Newark and the Wall Street district.

Correction

Garrett Corp.'s AiResearch Div. is offering heat transfer data to all competitors in the Navy's regenerative turboprop engine competition, and does not have an exclusive agreement with Curtiss Wright Corp. as reported in Aviation Week & Space Technology (Apr. 1, p. 29). AiResearch gained extensive knowledge in this field under a BuWeps recuperator research and development contract and has provided data to Allison Div. of General Motors, Lycoming Div. of Avco Corp. and Pratt & Whitney, as well as to Curtiss Wright.

Lycoming, which was reported to have agreed to accept a controversial data rights clause in the competition has denied that it had made such a statement.

Confusion Clouds International Air Travel

U. S. wins some backing on IATA fares, but new delay in aviation policy release stirs uncertainty abroad.

By L. L. Doty

Washington—Relations among nations involved in international air transportation became chaotic last week as an open-rate situation appeared on Atlantic and Pacific routes and the new U.S. international policy for civil aviation again became bogged down at the White House.

As of late last week, the bitter fare conflict (AW Apr. 1, p. 25) has plunged the industry into wide-spread confusion, making it difficult to determine the exact stand each government was taking. This much was clear, however: the U.S. now is not facing the solid opposition it originally confronted.

The fare hassle now involves the entire international airline industry, with Great Britain and France championing the cause of a fare increase and the U.S. adamant in its stand against the increase. Last week, Canada unofficially told the U.S. it would disapprove all fares, including cargo rates, adopted at Chandler, Ariz.

Japan, Mexico and—reportedly—Chile had also sided with the U.S. position, and several European nations were not holding as firm on the issue as originally indicated. The latter group, it was revealed, was not so much opposed to the rate increase as it was disturbed over the Civil Aeronautics Board's delaying tactics in reaching a decision.

The international situation was further complicated by tension created among U.S. and foreign flag carriers as a result of the White House's continuing delay in releasing the long-awaited policy on international air transportation (AW Mar. 25, p. 21).

A major factor in postponement of the policy's release has been a new look by White House staff members at that portion of the policy pertaining to competition. The policy originally stated that competition between U.S. airlines on international routes should be maintained, and that these carriers should continue to compete with foreign flag airlines on a free enterprise basis.

This provision dampened the merger hopes of Pan American and TWA, and quashed the chosen instrument concept (see p. 42). But later last month, AFL-CIO President George Meany, prompted by a group of Pan American pilots who have always endorsed controlled foreign competition, intervened in the policy program. In discussions with White House aides and Labor Secretary Willard Wirtz, Meany stressed that the guiding principle of any policy should be the strengthening of U.S. carriers to protect airline industry employes.

The action forced the White House to reconsider whether a single carrier operation in competition with foreign carriers can be termed a monopoly, and thus again raised the question of a U.S. chosen instrument. Reportedly, a compromise solution had been reached, but as of late last week, there were no indications of the degree to which the basic policy had been revised.

Indirectly, the rate fracas stems from the Civil Aeronautics Board's application of the new policy's dictum on lower fares. The feeling was that as the policy called for a lowering of rates, it would be weakened substantially at the outset by approval of higher fares.

New German STOL

Donauworth—West Germany's Siebelwerke-ATG GmbH. is completing design plans for a short-to-medium-range STOL turbojet transport designated the Siat Super STOL 311A. Scaled-down mockup of the 20-passenger DC-3 replacement will be shown at the Paris Air Show in June.

Final decision as to actual development and production of the aircraft, which also has been designed to carry up to 2 tons of cargo in an alternative freighter configuration, will depend largely upon the possibility of receiving active government financial support.

Ernst Heinkel Flugzeugbau also has been actively seeking government financing for a similar transport design, the HE 211-B1, but none has been forthcoming thus far. Deutsche Lufthansa West German airlines, however, has stated a probable future requirement for an aircraft in this category (AW Mar. 11, p. 295).

It is generally conceded that the effect of the revised rates on traffic would be slight, but the increase would bolster declining revenues of the carriers considerably. New rate structure, which European governments generally endorse, would reduce discount for round-trip economy fares over Atlantic and Pacific from 10% to 5%. This would raise round-trip fares by 5% and, since the vast majority of tickets purchased for overseas travel are round trip, would affect all but a few travelers.

The new fares were to be effective Apr. 1. CAB's veto of the rates means that an open rate situation in the Atlantic and Pacific areas now exists, since the old rates expired Mar. 31. This, in turn, means that enforcement officers of the International Air Transport Assn. have no jurisdiction during the open-rate period which, some airline officials fear, may start a rash of fare discounts and price-cutting.

Settlement of the rate issue will now be handled by the governments involved. Under the terms of bilateral agreements, diplomatic complaints will be filed and then an "expression of dissatisfaction" will be submitted to the U. S. by nations opposing the CAB action. This will require consultations within 15 days to negotiate a settlement.

European governments with national carriers operating transatlantic and transpacific routes appear determined to raise round-trip economy fares for these routes despite the U. S. rejection.

The British government already has instructed British Overseas Airways Corp. to raise its rates after Apr. 29, and the Ministry of Aviation has said it expects other carriers operating into the British Isles to follow suit. A number of other airlines are expected to follow this lead, but not all of these carriers are inflexible in their views.

The pattern for the British stand was adopted Mar. 30 in Geneva in an "informal" but tightly closed session among representatives of 12 affected nations. A second Geneva meeting has been scheduled for next week.

First formal reaction to the Board decision came about 24 hr. after the Geneva meeting when the Ministry of Aviation reaffirmed its support of the new IATA fares and said that only these fares would be approved for scheduled commercial flights into England after Apr. 29. This date was selected because at least 30 days notice must be given either party if a fare change is planned under the terms of a bilateral agreement.

In New York, IATA President J. F. Dempsey, president of Aer Lingus, agreed that the fare situation had caused confusion and was bad for business. Dempsey said that the fare problem was moving out of IATA's hands and into the field of governments, a transition he deplored. He said IATA is the best machinery that can be employed for settling fare issues and added, "to substitute government 'rassling' for IATA 'rassling' is a very retrograde step."

The fare dispute also involves other phases of the new U. S. policy, and could force an immediate determination of how firmly the U. S. intends to adhere to it. To surrender or even waver on any of the policy's points at this stage undoubtedly would damage the force of the over-all policy.

The policy views international air transportation as a private business or industry, not as a civil air arm or merchant air fleet as most other countries accept it. FAA Administrator N. E. Halaby has said that the U.S. considers the "fuselage is for fares, not flags."

The CAB action, however, has had the effect of removing pricing, the common denominator of any private enterprise, from the airlines and placing it in the hands of the government. Unless the CAB changes its decision within the next 30 days, which is not considered likely here, further negotiations on the fare issue will be conducted on a diplomatic level between governments, rendering the IATA traffic conference useless and leaving U. S. carriers with no say in the establishment of fares. Thus, the private enterprise phase of the policy will be contradicted.

The Board disapproved an IATA fare increase on only one other occasion, but in this instance, IATA members agreed to a compromise fare under the terms of the CAB ruling. There are no signs that foreign flag carriers will bow to the Board action this time. But the U. S. industry is optimistic that order will eventually emerge from the crisis.

The policy also suggests that persuasion rather than force should be used in negotiations with other nations. The Board action unilaterally forces its own tariff views on virtually all carriers of other major nations, so that the Board, by adhering to the policy on fares, has violated the provision on persuasion.

Bitterness over the fare issue has created a poor atmosphere for the presentation of the new U. S. policy to European governments. Tentatively, representatives of the State Dept., CAB, FAA and the White House steering committee are scheduled to visit several European nations as a group to discuss the policy, beginning Apr. 15.

These plans have been postponed on several occasions, and unless the fare issue is settled by the middle of this month, another postponement can be expected. Meanwhile, the delay is creating apprehension among foreign flag carriers as to U. S. intentions, so that when and if the policy is presented, it will probably have a guarded, skeptical reception.

SST Research Awards

Washington—Federal Aviation Agency last week awarded contracts for supersonic transport airframe research to Lockheed-California Co., Boeing Co. and North American Aviation.

The research will be conducted under a government-industry cost-sharing agreement whereby industry will contribute $1.6 million and the government $1.8 million toward the total program costs of $3.4 million. Lockheed will perform research in three study areas under a $950,000 contract and Boeing and North American will perform research jointly in six areas under an $850,000 contract.

Lockheed will study the areas of wing box fuel-tank design, material fatigue and fail-safe construction. Boeing and North American will work together in these areas: variable sweep wing pivots, material sheet fracture toughness, material thick section fracture toughness, fusion welding, landing and maneuver loads.



C-141 Wing Section Joined to Fuselage

Workers at Lockheed-Georgia Co. lower left wing of C-141 StarLifter, USAF jet transport, into assembly jig to join it to aircraft fuselage. Right wing is already in place. In mating process, air cushion is used to float wing above jig and reduce friction. Workers push wing last few inches to fuselage and bolt it in place. Each wing section weighs 8½ tons.

Pan American's Bid for Chosen Instrument Status–Part 3

CAB Reflects U.S. Anti-Monopoly Attitude

By L. L. Doty

Washington—Civil Aeronautics Board, almost since the time it was created under the Civil Aeronautics Act of 1938, has consistently blocked moves by Pan American World Airways to restore its chosen instrument status and to compete with U. S. domestic carriers.

A major factor frustrating Pan American's chosen instrument goal has been the U. S. government's historic anti-monopoly attitude, which has understandably borne strong influence on the Board's decisions in merger and route cases. The Board's stand in barring Pan American from domestic operations is not as clear cut, however, and appears to rest on tradition as much as economic and legal reasoning.

The CAB has leaned heavily on the wording of the Civil Aeronautics Act of 1938, and its later amendments, to justify its opposition to a single carrier operation in international services. The act reads, in part, that the Board should consider as being in the public interest "competition to the extent necessary to assure the sound development of an air transportation system properly adapted to the needs of the foreign and domestic commerce of the United States. . . ."

Juan T. Trippe, Pan American's president, takes issue with the phrase "to the extent necessary," and terms it ambiguous with respect to international air transportation. He has asked, "Does 'competition to the extent necessary' mean controlled competition between American flag carriers in addition to the competition supplied by foreign flag-carrier monopoly? Does it mean that we shall have a zone system to meet foreign competition or does it mean that we should have a united American flag effort to take on the united operations set up by the principal trading nations to represent them in the international field?"

Trippe probably never drew a direct verbal answer from the government, but these questions were answered firmly and bluntly by CAB action as early as 1940, when the Board granted a transatlantic route temporary certificate to American Export Airlines, and as late as 1962, when the Board staff enunciated a new zoning or regional concept.

The award of a certificate to a Pan American competitor was a difficult move in 1940 since, a year earlier, the CAB had stated it was opposed to "uneconomic, restrictive competition and wasteful duplication of services."

Nevertheless, the anti-monopoly philosophy of the U. S. began to influence CAB thinking at this time, and the question of whether the U. S. should cling to the single carrier policy or foster regulated competition was raised.

The answer apparently came easily. The Board reasoned that there was sufficient business to justify the operation of two carriers and that this traffic would continue to grow, particularly during the post-war period. In addition, the Board found that it had substantially less authority over international operations than over domestic services, and therefore, competition was needed in order to check abuses that possibly could arise from a monopoly operation.

By 1945, the CAB was ready to reaffirm its policy of competition with renewed confidence. In the Northeast Airlines, et al., North Atlantic Route Case it cited the "competition to the extent necessary" section of the act and added:

"That is the national policy which we are called upon to administer in our decisions and any arguments or contentions directed to the validity of such policy are properly addressed to the Congress and not to this Board."

To make certain that there would be no misunderstanding as to the decision's intent and meaning, CAB bluntly stated that U. S. "participation in international air service in the European area should not be restricted to one company."

Trippe, meanwhile, lost no time in taking his case to the Congress (AW Apr. 1, p. 41).

In arriving at its conclusions, the Board admitted that foreign flag carrier competition would increase and develop, but found that this was not an adequate reason for abandoning the current statutory policy of the government—that is, the policy implicit in the Civil Aeronautics Act. The Board added: "The public interest as defined by statute requires the operation of more than one U. S. carrier. To restrict international air transportation to one carrier would place upon a small managerial group responsibility for handling matters having tremendous national importance."

The statement is valid enough to withstand rebuttal, but it ignored one fact: until 1940, Pan American's small managerial group had served U. S. international air transport interests singly and successfully since 1927, although it did have the advantage of heavy air mail payments from the Post Office Dept. during that period.

In the same case, CAB denied Pan American the right to operate within the domestic route complex. The reasoning behind this decision appears to have been developed to support a preconceived decision. The Board admitted that domestic carriers operating internationally would have "some advantage" over Pan American were Pan American restricted to the international field.

But this advantage would be minimized by the operation of Pan American into the major ports of entry in the U. S., by the "widespread character of Pan American's operations" and by the fact that it is firmly rooted in international trade in various parts of the world, the Board concluded. This specious argument proved to be sufficient grounds for the Board to decide that the public convenience and necessity would best be served by permitting domestic air carriers to engage in international air transportation in competition with Pan American, and to prevent Pan American from competing domestically with domestic airlines.

The Board stated that the policy on the two issues should not be accepted as permanent. But temporary certificates for air transportation between the U. S. and Europe were issued to TWA for the first time and extended for American Export Airlines, and there has been no noticeable deviation.

At the same time the CAB released its decision in the 1945 North Atlantic Route Case, it approved the purchase of American Export Airlines by American Airlines on grounds that the transaction would not create a "monopoly and thereby restrain competition or jeopardize another carrier not a party to the acquisition."

Heavy losses on the international operation of American Overseas Airlines prompted C. R. Smith the carrier's board chairman and chief executive officer, to offer the foreign routes to Pan American in 1948. Losses reportedly stemmed from operations of the Boeing 377 Stratocruiser fleet, then in its shake-down phase, which went to Pan American along with the routes under the purchase agreement.

In May, 1950, the CAB ruled 3-2 against the acquisition of American Overseas Airlines, but when the decision was overruled by President Truman, CAB approved the transaction but gave new routes to TWA to provide, in the words of President Truman, "vigorous competitive growth by our airlines."

That year, Pan American made its last major bid for a network of domestic routes. It petitioned the CAB for a U. S. domestic route system that connected all its coastal and inland ports of entry with one another, but which, in the process, also paralleled the major route segments or backbones of the systems operated then by American, Eastern, Delta, National, Northwest, Northeast, TWA and United. The Board voted against this in July, 1950.

During the ensuing decade, Pan American held to its goals but made no outward move to reach them until the latest merger with TWA was proposed.

Meanwhile, during that time, the airline has thrived despite its setbacks (see table). Total assets of the company rose from $189 million in 1951 to $595 million in 1961. Revenue passenger miles spiraled from 1.5 billion in 1951 to more than 5.3 billion in 1961. The carrier's net profit for 1962 is an estimated $14 million, undoubtedly the largest net profit that will be shown for that year by any of the world's scheduled airlines.

(This is the last of three articles on Pan American World Airways' bid to become the U. S. chosen instrument and to annex domestic routes to its international system).

Pan American's Growth—1951—1961

Following table illustrates the growth of Pan American World Airways during the 10 years following its acquisition of American Overseas Airlines.

	1951	1953	1957	1959	1961
Revenue passenger miles (000)					
First class	1,241,716	1,163,075	1,225,572	1,265,300	998,550
Coach	309,483	817,303	2,210,626	1,661,841	.....
Economy	.....	.....	153,505	1,304,477	4,365,834
Total	1,551,199	1,980,378	3,589,883	4,231,618	5,364,384
Total available seat miles (000)	2,530,987	3,162,362	5,497,558	6,089,942	9,538,392
Load factor (%)	61.3	62.6	65.3	69.5	56.2
Revenue passengers per aircraft	29.6	34.8	40.6	49	66
Operating revenues (000)	$169,085	$202,447	$308,163	$351,909	$452,273
Operating expenses (000)	163,027	189,768	297,764	339,851	435,273
Stockholder equity (000)	92,127	106,917	121,693	133,721	137,284
Rate of return of stockholder equity (%)	7.10	9.55	8.13	5.51	5.29
Rate of return on total investment (%)	6.56	8.20	6.55	4.01	5.16
Total current assets (000)	$77,308	$82,895	$87,932	$119,593	$172,332
Total assets (000)	188,855	215,731	292,731	485,703	594,329
Long-term debt (000)	27,750	43,125	81,100	247,471	290,920

CAB Route Action

Washington—Pan American World Airways faces a severe adjustment of its present route structure if the following current Civil Aeronautics Board moves are either finally approved or allowed to stand:

- **Board order E-18301, dated May 4, 1962, would terminate service into Paris and Rome.**
- **Board order E-18120, dated March, 1962, would terminate the airline's entire Alaskan operation.**
- **Board order E-18301, dated May 4, 1962, would terminate the airline's Miami-Europe via Puerto Rico service, only U. S. flag service on this route.**
- **Board order E-117289, dated Aug. 8, 1961, terminates Pan American's 33-year old route between Miami and the Canal Zone. Same order would remove Pan Am service from Sao Paulo, Brazil.**
- **Board staff proposal, dated Oct. 8, 1962, would eliminate Pan American service into St. Croix, St. Martin, Guadeloupe, Martinique, Antigua and Barbados.**



First BAC 111 for BUA Nears Completion

First British Aircraft Corp. BAC 111 twin-jet transport scheduled for delivery to British United Airways is in final stages of construction at Vickers-Armstrongs (Aircraft) plant at Hurn, England. In foreground are two Rolls-Royce Spey powerplants. Main fuselage test specimen completed proof pressure tests to 15 psi. late last month.



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United Single-Class Fare Causes Concern

By James R. Ashlock

New York—Industry is closely observing United Air Lines' single-fare experiment for clues that might help solve the complex fare problems causing concern among domestic trunk carriers.

Many airline officials readily admit that the confusing variety of fares now available has compounded rather than eased the frustrations of abundant seats and deficient revenues.

"I don't believe anyone can seriously say that a justifiable amount of new business has been generated by this fare mess," one airline spokesman said.

United's contention is that rather than make another trial-and-error bid for market expansion, it is simply trying for a larger share of the available traffic, particularly business and government travelers. The service is priced slightly above coach and substantially under the standard transcontinental first-class fares.

"We've never said that single-class would expand the market," a United official said. "But we do believe that many business travelers whose firms restrict them to coach service will be attracted by it. The many complimentary letters received from corporations indicates wide interest."

Strong Opposition

United inaugurated the service Mar. 10 from Chicago to San Francisco amid strong advertising opposition from American Airlines and Trans World Airlines. American advertisements in Chicago read, "Do you really want us to raise fares?" TWA and American put Convair 990s and 880s, both with five-abreast coach seating and standard coach fares, into competition with United's single-class Boeing 720s.

Single-class was inaugurated with high load factors out of Chicago, but has since tapered back to where it is only a few percentage points above United's system load factor, which averages about 46%.

United is expanding the service to include Cleveland-Chicago and San Francisco-Seattle in addition to Newark-Chicago-San Francisco. It will decide about June whether to convert more aircraft to single-class for further expansion of the experiment.

Many sources feel the single-class trial can't prove itself conclusively until it is attempted in a highly competitive market, such as Idlewild-Los Angeles. American is believed to be considering a transcontinental single-fare effort effective Apr. 28—the date when carriers alter schedules to conform with daylight saving time.

Despite widespread use of the term "market expansion," airline officials concede that fare philosophies are still based on taking more business away from the competition.

"There are as many different opinions on fare levels as there are airlines," a spokesman in American said. "The fare structure is based on traffic volumes. If an upswing in business developed, you'd see airlines shedding these wild fare schemes quickly."

Special fares, spokesmen explain, are simply competitive price cutting wrapped in a tinsel of "public benefit" to help their approval by the Civil Aeronautics Board. And the Board has readily approved almost every fare scheme that offers lower rates, regardless of special conditions such as type of aircraft, time of travel or size of the traveling group.

"Two members of the Board will always endorse lower fares, or perhaps I should say any fare that dilutes airline revenues," a spokesman said. "The chairman is on the fence, but he usually votes for lower fares."

However, CAB did deny TWA's revival of its 12-30 day transcontinental excursion fare, which would have equaled the coach rate to Chicago plus the third-class fare on to Los Angeles as introduced by Continental Air Lines.

Whenever a carrier obtains a fare reduction, its competitors feel pressed to meet it. The only reason United's competitors haven't begun single-fare moves is because it is considered a fare increase.

Result of the competitive fare scramble has been the emergence of eight different fares for transcontinental travel, ranging from the $186.90 jet first-class rate down to a 50% coach fare for servicemen, who take seats on a space available basis. Even the abandoned family fares have been revived, whereby a wife can travel half-fare if her husband buys first class.

Transcontinental fares are simple compared with the East Coast situation spawned by the scramble for Florida travelers. As many as 100 different fare combinations to Florida have evolved, including individual rates for travel at night, day of week, month, type of aircraft, etc.

The discouraging result has been that instead of expanding traffic, the only expansion has been in airline clerical expense and ticket-counter confusion. Travel agents are complaining that their costs for time in explaining the fares are exceeding commissions on the actual sales.

Eastern Air Lines, which admits it has been a leader in formulating special fares, has now asked the CAB for an investigation toward simplifying the fare structure. L. B. Maytag, president of National Airlines, has endorsed the proposal.

"The result of all this activity in the area of promotional fares is a muddle which few but tariff experts can comprehend," Eastern said in asking for the probe. "It is time for the Board to take positive, corrective action to simplify the price structure."

CAB Stand

CAB isn't taking the blame for the fare problem, with some justification. The carriers, not the Board, developed the current pattern. But many officials within airlines feel the Board should evaluate more closely what a proposed fare means to the industry over-all, rather than to the individual carrier proposing it.

Continental's three-class service from Chicago is an often-cited example.

"That was a pure and simple effort to divert traffic into Chicago to compensate for Continental's not having a route on into New York," a Continental competitor said. "And while it may have helped Continental, it hasn't done a thing but handicap the three northern transcontinental carriers."

Nor do the fare planners for the airlines see any major change on the horizon that might remedy the situation. The overriding influence is still to reap a larger share of the available market, and spokesmen feel there will be a continuance of fare experimentaion by individual carriers, with the competition forced to follow suit.

A spokesman in TWA said most promotional fares are a "shot in the arm" strategy, an effort to grab off a bit of extra business in off-peak seasons. That's why they usually have a cut-off

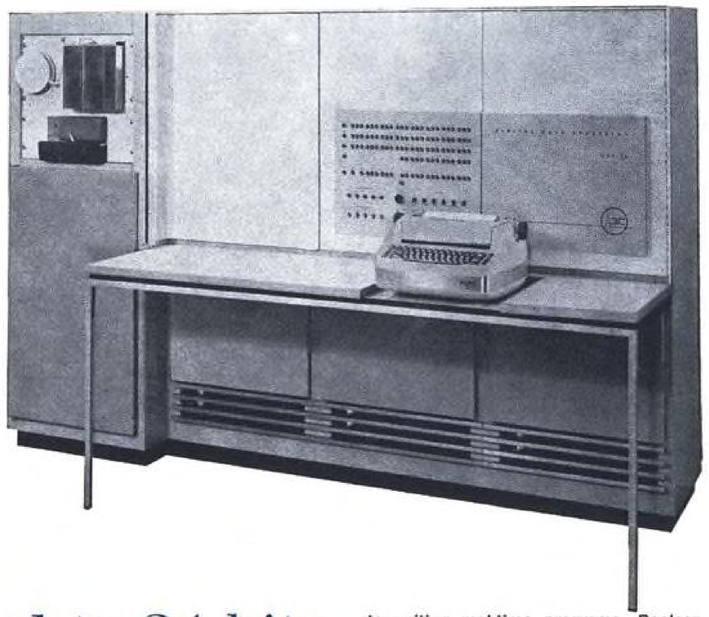
Allegheny Investments

Washington—Allegheny Airlines invested $739,000 in subsidiary and affiliated firms in 1962 under a diversification program.

Leslie O. Barnes, Allegheny president, said here recently that two wholly-owned subsidiary companies, Allegheny Ventura Corp. and Allegheny Services Corp., were activated by the airline last year.

In addition, the carrier has purchased controlling interest in International Air Services, a Puerto Rican firm which operates six airports in the Caribbean and is a major aviation parts distributor in that area.

$87,000



*DDP-24 IS NOT designed to be all things to all people. DDP-24 IS a fast digital computer, versatile, a sophisticated "component" built to move in company with a precision team in complex real-time on-line configurations. Equally comfortable performing off-line engineering and scientific computations. Reliable? Very.**

DDP-24 pays for itself on a diet of challenge. DDP-24 hardware, comprehensive software, user services and options belong in the hands of qualified professionals who know their applications and how to evaluate a computer against these selected applications. Under these conditions DDP-24's are a lot of computer for the money.

DDP expanded to 24 bits
Faster arithmetic unit
Comprehensive software

DDP-24 is a parallel 24-bit word, core memory, sign-magnitude, binary, general purpose computer, with indexing and indirect addressing. Instruction repertoire includes multiply and divide, load and store, shifting, logical, jump, index, and input/output. Standard memory capacity is 4096 words (optionally expandable).

Simplicity, maintainability, user convenience are factors of design. Regulated power supplies and power failure protection preserve integrity of computation. Ready and interrupt modes give DDP-24 master or slave relationship with external equipment. Optional independent memory banks and fully buffered channels give true input, output, and compute overlap.

SPEED

Computation rate is 100,000 additions per second. Multiplication takes 31 microseconds, division 33 microseconds. Times include instruction and operand access. Other arithmetic speeds:

Add floating point	125μ/secs. max.
Multiply floating point	99μ/secs.
Add double precision fixed	55μ/secs.
Add double precision floating	181μ/secs.
Multiply double precision fixed	263μ/secs.
Multiply double precision floating	371μ/secs.

Core memory cycle time is five microseconds with three microsecond access. Input and output can occur asynchronously and be interleaved with processing at transfer rates up to 166,000 24-bit words per second.

INPUT-OUTPUT

Strong input-output capabilities enhance communication with surrounding equipment; offer unique freedom of system implementation. Standard DDP-24 incorporates an eight-bit I/O character buffer register and channels, a 24-bit parallel input channel, a 24-bit parallel output channel, sixteen lines for external sense inputs, eight output control pulse lines, and four interrupt lines capable of asynchronous operation with the associated four basic input-output channels. Standard I/O equipment: typewriter, paper tape reader, punch.

SOFTWARE

Programming software provided with the DDP-24 is comprehensive; satisfying professional programmers writing complex routines, mathematical analysts, and the occasional user. Fortran II, DAP, and DIP are modular, patterned after SHARE, easily adapted to specific hardware configurations. Diagnostics for rapid isolation of programming and system faults are included. Also provided: mathematical subroutines, number conversion, memory dump, library routines, master executive program, load program, and computer exercise routines.

Fortran II compiler permits investigation and development of math models prior to writing real-time programs. Boolean augmentation and macro calls are provided.

DAP — DDP-24 Assembler Program — with one-to-one and one-to-many assembly, facilitates tight real-time programs in convenient language.

DIP — DDP-24 Interpretive Program — permits users with minimum programming experience to generate scientific computation routines after only half a day's study.

OPTIONS

To offer still greater system adaptability and functional capabilities, extensive standard options and peripheral equipment are available for the DDP-24:

☐ core memory expansion to 16,384 words, with special expansion 32,768 words. (directly addressable) ☐ additional index register ☐ word forming buffers ☐ character I/O buffer registers ☐ interrupt lines ☐ eight level hardware interrupt priority system ☐ additional sense lines ☐ output control pulses ☐ parallel I/O channels.

I/O control units for maximized interlace and truly simultaneous operation: ☐ direct memory access control unit with unlimited channels ☐ fully buffered I/O control unit with unlimited channels.

Peripheral equipment optionally available: Magnetic tape control and transport units, A/D, D/A converters, card adapter, high speed line printer and adapter, digital plotter and adapter. Digital Resolver, satellite computer, increases DDP speed up to 10 times for algebraic and trigonometric functions. Other peripheral requirements can be fulfilled. Write for the full story.

3C

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**Design is typical 3C. Modular construction is with S-PAC digital logic modules. Based upon a million PAC-hours of life test without failure the DDP-24 calculated MTBF is over 4000 hours.*

date after several months, he explained.

Consequently, the industry growth factor over the long run is leveling off to just about average the national population increase, which ranges approximately 3-5% annually. Researchers are telling sales staffs that the only way their airlines can realize greater yearly increases is to attract traffic away from the competition.

Military Traffic

"Some of these promotional fares are all right, considering the overcapacity situation," an American spokesman said. "We've been getting about 85 military travelers a day out of Los Angeles with this 50% fare, and half a fare is better than no fare at all."

General feeling also exists that promotional fares, particularly low-cost group travel, have also been justified on North Atlantic routes. But domestically, the great mass of the public remains unwilling to invest the several hundred dollars required for a transcontinental family vacation.

"The vacation traveler is the one we need," a spokesman said. "We've taken business travel away from surface transportation, but we've yet to develop a formula that will expand pleasure travel in conformance with the great availability of seats."

No sympathy is evident for the flight-frequency reduction proposed by Charles C. Tillinghast, Jr., president of TWA. American and United officials say that business still comes to the carriers who offer the most service. Nor is anyone advocating elimination of first-class accommodations, which, despite low load factors, are still taking up some of the revenue slack created by the low promotional fares.

"Our Caravelles and Viscounts operating from Newark are all first-class configuration," a United official said, "and 81% of our business out of there is first class. Besides, why add more coach seats when we're not filling up the ones we have now?"

Despite general feeling that a simpler fare structure is needed, few, if any, spokesmen foresee a serious industry-wide move toward this end.

"There'll always be some maverick who throws in a special fare to counteract some advantage of his competition," a spokesman said.

Locals Show Heavy February Gains, But Trunkline Figures Vary Widely

Washington—Local service airlines have reported substantial gains in passenger traffic for February, while the volume of revenue passenger miles generated during the month by individual domestic trunklines varied widely. Early indications are that both groups will show improvement in March.

Local service carriers reported a 19% increase in revenue passenger miles for the month compared with February, 1962, but a 21% increase in available seat miles pulled the load factor down from 40.4% to 39.9%. Domestic trunklines, with a 4.7% gain in revenue passenger miles, suffered a decline in load factors from 52.6% to 49.4%.

Two trunk carriers—American and Eastern—failed to register a gain in revenue passenger miles during the month. Braniff reported only a slight increase of 2%.

However, National recorded a 26% increase, followed by Northwest with a 22% increase.

Northeast Highest

Best load factor among the trunk carriers was Northeast, with 63%. Delta's load factor was 58%, and National's stood at 56%. Continental, Northwest, TWA and United reported load factors below 50%.

In the local service group, Bonanza topped the 13 carriers with a 59% load factor. Pacific was a poor second with 49%, followed by Mohawk and Ozark, each with 46%.

Load factor of all other local service carriers was below 40%.

Bonanza continued to show major gains in revenue passenger miles, but in February, it was outstripped by Frontier and Piedmont.

Trunk Figures

Trunk carriers continued to reduce the volume of first-class available seat miles during the month in hopes of arresting falling load factors in that category.

All 11 trunklines had a decline in first-class revenue passenger miles and the industry first-class load factor toppled from 48% in February, 1962, to 43% in February of this year.

Trunk coach traffic during the month rose 18%, but a 24% gain in available seat miles depressed load factors from 56% to 53%. Major improvements in coach revenue passenger miles were reported by Continental, Delta, Northwest and Western, each with a 40% or more increase over February of last year.

With few exceptions, coach load factors were strong: Northeast with 69%, Delta with 65% and National with 59%. Coach load factors of Continental, Northwest, TWA and United were slightly below 50%.

Mexicana Will Expand Service, Seat Capacity

Dallas—Expansion of service and seat capacity using its present de Havilland Comet 4 and Douglas DC-6 fleet is planned by Mexicana Airlines following a period in which emphasis was placed on cutting operating costs to an "irreducible minimum."

Cost-reduction programs in the past year and a half have resulted in savings of approximately 12%, according to Mexicana's general manager, Max Healey. Unit cost per available ton-kilometer has been lowered from $2.85 to $2.25, he notes.

A major factor in this program has been the reduction of employes from 3,185 at the end of 1961 to approximately 2,773.

Service expansion is keyed to greater utilization of the Comet 4, which Mexicana will now use on a full-time basis. It had previously leased a portion of its Comet flight time to Guest Aerovias Mexico for use on that carrier's international services.

As of May 2, Mexicana will inaugurate daily Comet 4 service from Mexico City to Monterrey, replacing a DC-6 operation on this route. Comet 4 service will also be initiated to Guadalajara and Mazatlan, on a run from Mexico City to Los Angeles, in June. This will double Mexico City-Los Angeles jet service by the carrier. It currently operates a single non-stop Comet 4 run from Mexico City to Los Angeles. Service to Guadalajara and Mazatlan are awaiting airport improvements.

Mexicana already has started five-times-weekly service to Merida with the Comet 4 to capitalize on the appeal of this tourist center. The carrier also has reinstated all-jet daily service to Chicago with the Comet. Chicago formerly had been serviced by Mexicana's Comets and DC-6s.

Seat capacity is being increased in the Comet fleet and the nine DC-6s. This is in line with Mexicana's plans to expand its domestic single-class service into its international operations.

By eliminating a galley in the Comet, passenger seats are being increased from 82 to 86. On the DC-6s, seats are being increased from 62 to 74.

One-class fare proposal is similar to that of United Air Lines (see p. 45), falling between coach and first-class.

Beginning this month, Mexicana is granting tourists arriving in the country via Mexicana a 25% discount on the airline's domestic flights for 30 days after arrival. Passengers who have to stay overnight in Mexico City during international flights on Mexicana will be given free transportation from and to the airport, hotel accommodations and meals.



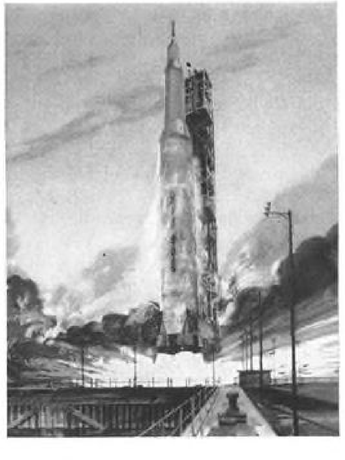
WORLD'S NEWEST JET. Boeing 727, America's first short-range jetliner, is shown taking off on early test flight. Powered by three rear-mounted turbofan engines, the 727 can operate from 5000-foot runways. It will bring jet-travel advantages to hundreds of smaller cities. The 727 can carry 70 to 114 passengers at speeds up to 600 mph. Now undergoing one of the most intensive test programs in airliner history, the 727 enters service early next year. These airlines have ordered 131 Boeing 727s: American, Ansett-ANA, Eastern, Lufthansa, Trans-Australia, TWA, and United.

Capability has many faces at Boeing



X-20 DYNA-SOAR, the U. S. Air Force's space glider, shown in drawing above, will rocket into earth orbit atop booster. Pilot will be able to fly X-20 back through atmosphere for landing at field of his choice. Boeing is X-20 system contractor.

SATURN V in drawing, right, will be world's largest rocket, some 350 feet high. Boeing holds NASA contract to develop, build and test the S-1C first-stage booster, which will develop thrust equal to about 160,000,000 horse power.





PUMP JET is experimental boat built by Boeing to test submerged foil systems and water-jet propulsion. Pump, driven by Boeing turbine, exhausts 30-foot stream of water developing 2,000 pounds of thrust, and speeds to 45 knots.

BOEING

Space Technology • Missiles • Military Aircraft Systems • 707, 720 and 727 Jetliners • Systems Management • Helicopters • Marine Vehicles • Gas Turbine Engines • Also, Boeing Scientific Research Laboratories

American Airlines Pessimistic Over Increased 1963 Industry Profits

New York—American Airlines continues to take a pessimistic view of the possibility for increased profits in 1963 for the industry, and American's annual report issued last week revealed that American's 1962 earnings—though termed above the average of its main competitors—failed to cover its $1 common stock dividend paid since 1956.

American did pay the $1 dividend and to do so deducted $1,408,000 from its retained earnings account to provide the difference between its profit figure of $7,098,000 and total dividend payments of $8,506,000.

Despite the squeeze on earnings, American's balance sheet shows the airline is in strong basic financial health. At Dec. 31, 1962, American had $119.8 million invested in government and other securities. With its cash accounts and receivables, totaling $99 million, American was in a position to meet all its current liabilities of $118 million and also pay—without recourse to any borrowing—$92 million due this year in payments for its Boeing 727 order. American expects to pay the entire $183 million cost of the 727 program out of internally generated funds.

In 1961, American was able to cover its common stock dividend because of extension of the useful lives of its jet equipment, which resulted in lower depreciation charges and consequently higher earnings.

Now American plans to exercise its option to purchase all currently leased engines of its Convair 990 and Boeing 720 fleet. It already has purchased the engines and propellers of its Lockheed Electras that formerly were leased, which resulted in a $300,000 increase in earnings in 1962 and a retroactive adjustment of 1961 figures to increase earnings that year by $1,277,000.

Under the lease system, cost of the engines was, in effect, paid out over a seven-year period. With purchase, the engines and propellers will be depreciated over the 12-year useful life schedule adopted for American's turbine-powered aircraft. The result is smaller charges against income and higher net earnings. The 1962 increase resulted despite accelerated depreciation for American's DC-7s that partly offset the increase in earnings.

Declining load factor resulting from increased competition on routes and increased capacity of jets combined with cost increases were the cause of the earnings decline, according to American President C. R. Smith. Equipment maintenance was one area of disproportional cost increase for American, and an intensive effort is under way to bring these costs in line. Depreciation and interest charges also increased sharply, a result of the transition to jets.

American's total revenues rose from $421 million in 1961 to $463 million, and expenses from $414 million to $457 million. Available ton miles rose from 1,370 million to 1,562 million while revenue ton miles rose from 764 million to 844 million. A strike affected 1961 results, however, and the 764 million figure was a decline from 782 million revenue ton miles in 1960.

American Pilot Pact

New York—Negotiator for American Airlines pilots has said that they are determined to sign a new contract with the carrier despite the Air Line Pilots Assn.'s objections to the proposed pact (AW Mar. 18, p. 41).

Capt. Nicholas J. O'Connell expressed the stand during hearings last week on an ALPA request for an injunction to block the contract. Hearings are continuing before Judge I. B. Wyatt in federal district court here.

Although American's management favors the contract, it is withholding a signing until judgment is rendered on the requested injunction.

Charles Ruby, president of ALPA, reiterated the union's objection to the contract's omission of a requirement that the flight engineer have a commercial and instrument pilot's rating.

American's pilots, in reducing cockpit crews from four to three men, feel there is no need for this provision. Elimination of the pilot training would save American about $7 million, which would be passed on to crews through added fringe benefits and reduced monthly flight time requirements.

Accounting Office, FAA Study Utilization of Traffic Controllers

Washington—Federal Aviation Agency's use of air traffic control manpower may be rearranged later this year as the result of an agency study now in progress or a separate survey now being made by the General Accounting Office.

While the studies are not directly related, a major purpose of both is to explore whether the most efficient use is being made of FAA's force of controllers, who account for more than half of the agency's regional staff of 34,000 employes.

GAO considers its study as typical of many which it conducts in other areas of government for checking whether proper and efficient management methods are being used. It has not made a study of air traffic control personnel use before, and was prompted to do so at this time because of the large part of FAA's budget needed for air traffic control.

The main purpose of the GAO effort —known as a manpower utilization study —is to determine whether FAA is "overstaffing" in this area, a spokesman explained. The survey will require about six months to complete.

Meanwhile, FAA's Office of Management Services is conducting its own study. Comparative figures gathered so far are inconclusive, but are expected eventually to provide more accurate readings on the exact number of personnel needed in air traffic control and to pinpoint where the greatest manpower force should be applied among the agency's seven regions.

These are some of the study's more significant findings:

• **Controller force** numbered 17,643, each of whom—on a statistical basis—handled 571 aircraft during Fiscal 1962, for a daily average of 1.6 aircraft. Largest volume of aircraft was handled by the Eastern region, with 2,483,547 movements handled by 4,305 controllers. Greatest controller workload was in the Central region, where 3,400 controllers handled 2,368,583 aircraft, or 697 each at the rate of 1.9 per day.

• **En route traffic control** centers handled 10,080,122 aircraft during the year, statistically spread among 6,237 center positions for a year-end total of 1,616 aircraft handled by each position. This rate amounts to a theoretical daily rate of 4.4 per position.

• **Airport control tower** operators totaled 3,819 personnel, who handled 27,416,000 aircraft operations during the year. The rate per individual controller was calculated at 7,179 operations for the year, or roughly 20 per day. They include both itinerant and local traffic landings and takeoffs. The Eastern region, with 1,154 tower operators, had the largest staff, but the largest rate in the continental U. S. was handled by 414 Southwest region tower controllers who had an individual annual rate of 9,188 operations.

However, the Alaska region, with only 27 tower operators, had a rate of 14,741 aircraft operations per operator, based on a Fiscal 1962 total of only 398,000 operations.



DC-8s have flown the equivalent of 27,000 times around the world!

New orders from airlines double 1963 production schedule as giant jetliners complete 1-1/4 million hours of flying in 3-1/2 years.

Douglas transports have the happy faculty of growing even more impressive the longer they are in service. And the latest, greatest of them all, the DC-8, is proving no exception to this rule.

Witness these facts:

- The DC-8 has flown higher, faster and farther than any other jetliner (exceeding the speed of sound during a test flight).
- It has transported more than 24 million passengers, and flies regular schedules across every ocean and continent in the world.
- A leading international airline reports that in more than 2,000 departures, its DC-8's had the lowest percentage of delays over a month's period for any transport in the airline's history.
- Since the maiden flight of the first DC-8 4-1/2 years ago, the DC-8 has improved constantly in performance. Today, it has greater speed, greater range and greater payload than ever before. It has greater take-off thrust and takes off with less runway at a given weight.

An impressive showing—but if the performance of previous Douglas transports can be taken as a guide, the DC-8 record will grow even more imposing the longer these great jetliners fly.

DOUGLAS BUILDS GREAT TRANSPORTS

DOUGLAS AIRCRAFT DIVISION

AIRLINE OBSERVER

► Watch for Aer Lingus to order the British BAC 111 short-haul jet transport. The airline has studied the Boeing 727, the de Havilland Trident and the Sud Caravelle as well, but the 200-300 mi. stage lengths and traffic requirements within Europe point to an airplane grossing about 80,000 lb. The Douglas DC-9, if it goes into production, also would fit this category. Negotiations for financing new aircraft through the Irish government are under way.

► British West Indies Airlines is countinuing flights over Cuba on its Jamaica-U. S. routes. The carrier's Vickers Viscount fleet thus avoids an extreme time disadvantage in competing with jet services operated by Pan American or BOAC, which must follow a dog-leg route pattern to by-pass Cuba and its territorial waters. Cuba has not barred the Trinidad airline from flying over the island.

► Eastern Air Lines' loss of $14,895,365 in 1962 (AW Mar. 25, p. 37) would have been greater if it had not made a change in the depreciation schedule for its jet aircraft. Depreciation period was extended from 10 to 12 years, and residual value from 10 to 15%. Citing an example of the resultant tax saving, Eastern said the new scale would have increased depreciation expense by $2.1 million if applied to 1961 figures.

► Civil Aeronautics Board has said no new trunkline service case hearings will be set before July 1. Priority will be given these cases: Pacific Northwest-Alaska Case, U. S.-South America Route Case, Service to Spokane Case, Dallas-Ft. Worth Regional Case, Transatlantic Route Renewal Case and proceedings growing out of Pan American-Grace-Panagra anti-trust case. In the local service area, staff efforts will be focused on "use it or lose it," area airport program, route alignments and possible trunkline route suspensions. Supplemental carriers denied certificates will be given priority hearings on their applications.

► British Overseas Airways Corp. lost about $39 million for its fiscal year ended last week. The precise figure will not be released until a report on BOAC's financial structure (AW Nov. 5, p. 52) is made to Minister of Aviation Julian Amery this spring.

► Federal Aviation Agency has ordered eight radar bright display systems costing a total of $3.4 million from Raytheon Co. Units will be installed as part of FAA program to institute high altitude positive control of aircraft operating above 24,000 ft.

► All local service carriers will show a profit for 1962. According to a study prepared by Systems Analysis and Research Corp. for the Assn. of Local Transport Airlines, annual rate of subsidy paid the local service carriers will decline about $1.5 million in 1963.

► KLM Royal Dutch Airlines is studying a reorganization of its management structure to break its overseas operations into larger regions, with regional heads reporting directly to E. H. Larive, KLM's new executive vice president. One possibility would be to combine the now separate areas of the U.S., Canada and Mexico into one region. KLM sales structure within the U.S. may also be reorganized into five major sales regions, with sales representatives added at eight more cities besides the 29 U. S. offices now operated by the airline.

► Trans-Canada Air Lines is planning to acquire one type of transport to replace both its turboprop Vickers Viscounts and Vanguards. This would give the carrier basically a two-aircraft fleet—its present Douglas DC-8s and the new transport. The Boeing 727 is favored by some in the airline because of the relatively long-range as well as short-haul requirements in the carrier's route structure. TCA recently phased out the last of its piston aircraft—two Douglas DC-3s—and is offering six Viscounts for sale, although the aircraft are still in service.

SHORTLINES

► **British Overseas Airways Corp.** is eliminating the regional marketing concept in its U. S. sales operations and will centralize managerial activities in New York, with the sales force throughout the U. S. reporting directly there.

► **Chicago's O'Hare International** Airport was the nation's busiest air terminal in 1962, pushing 1961's leader, Los Angeles International Airport, into second place. Chicago's Midway, once the perennial leader in total operations, ranked 97th.

► **Civil Aeronautics Board** last week found that local airline service between Boise, Idaho, and Las Vegas, Nev., is not required. Three local service carriers had applied for the route.

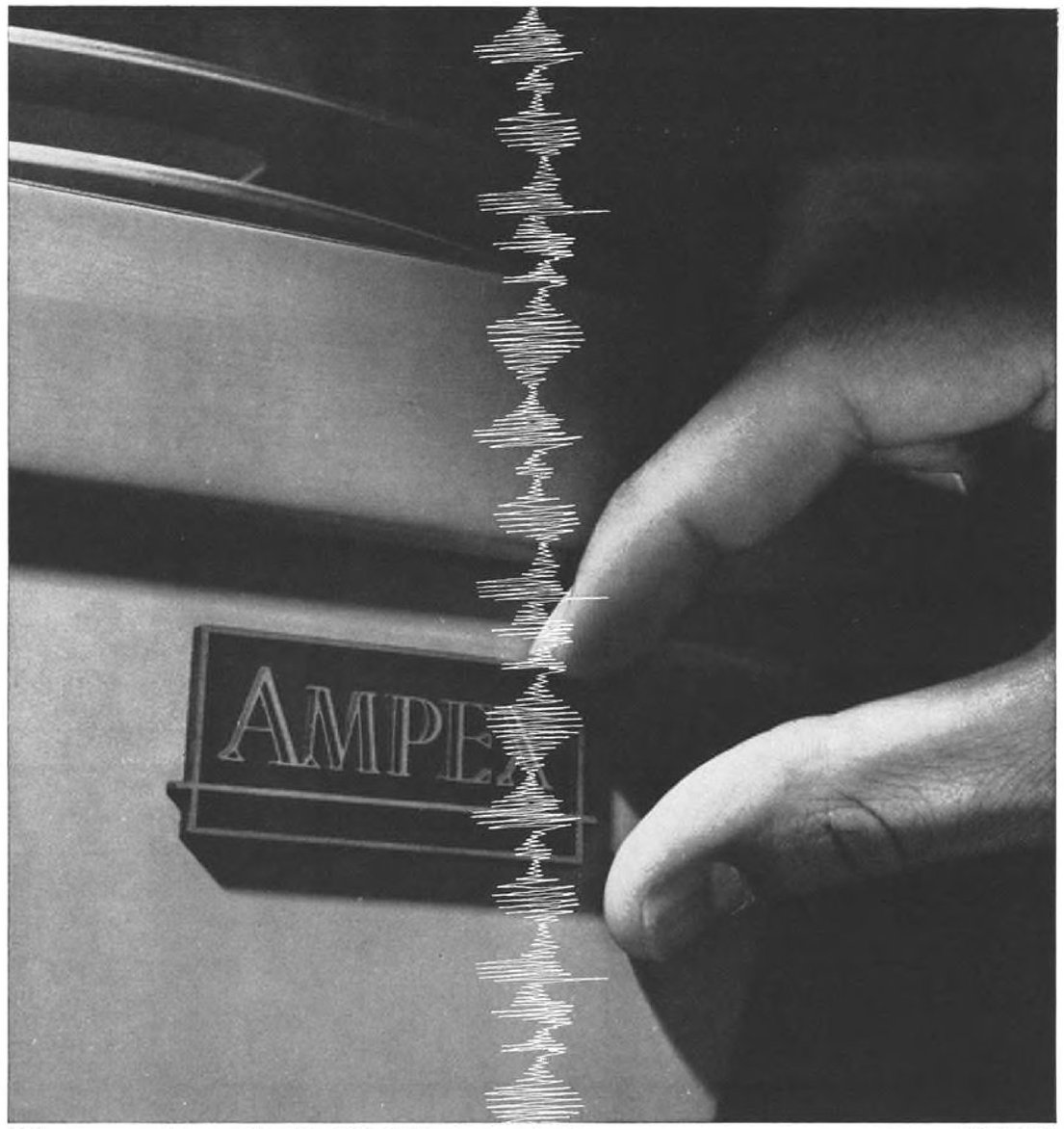
► **Federal Aviation Agency** has lowered the landing limit for parallel approaches and landings at Chicago's O'Hare Airport. New minimums allow parallel landings with 400 ft. ceilings and 1 mi. visibility. Previous limits were 500 ft., 1.5 mi. Non-parallel limits are 200 ft., ½ mi.

► **Fourteen supplemental airlines** were granted unlimited overseas and foreign cargo charter rights last week by a 3-2 CAB decision. Dissenting members Chan Gurney and Whitney Gillilland said operating rights should not be expanded pending a full and complete evidentiary hearing on their applications.

► **Lufthansa German Airlines** has started Europe's first "Air-Shuttle" operation between Frankfurt and Hamburg. Malcolm A. MacIntyre, president of Eastern Air Lines, which originated the shuttle plan, was in Frankfurt to participate in inauguration ceremonies for the services.

► **National Air Carrier Assn.** said the seven supplemental air carriers belonging to NACA operated slightly more than 1 billion passenger miles in 1962 and 259 million cargo ton miles without a passenger or crew fatality. According to NACA, its members operate 75% of all certificated supplemental airline passenger miles currently flown.

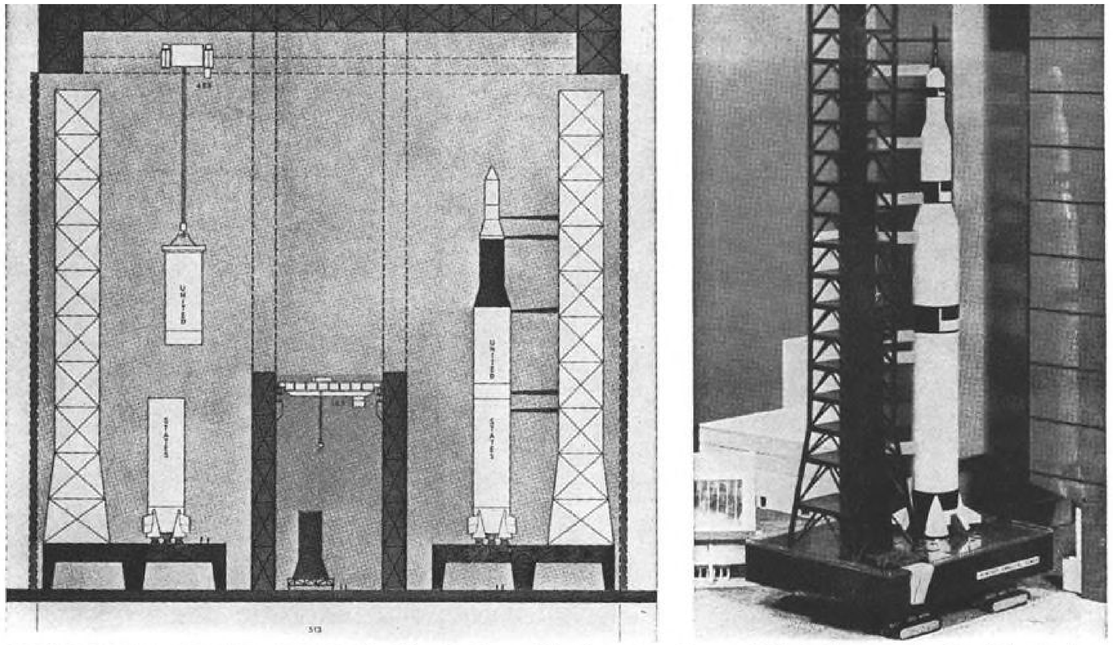
► **United Air Lines** paid $88,810 to employes in 1962 through the company's suggestion program. Top award went to W. L. Williams, who received $9,495 for developing a method of repairing aircraft hydraulic system pump components.



What name is on the first 1.5 Mc recorder? **AMPEX**

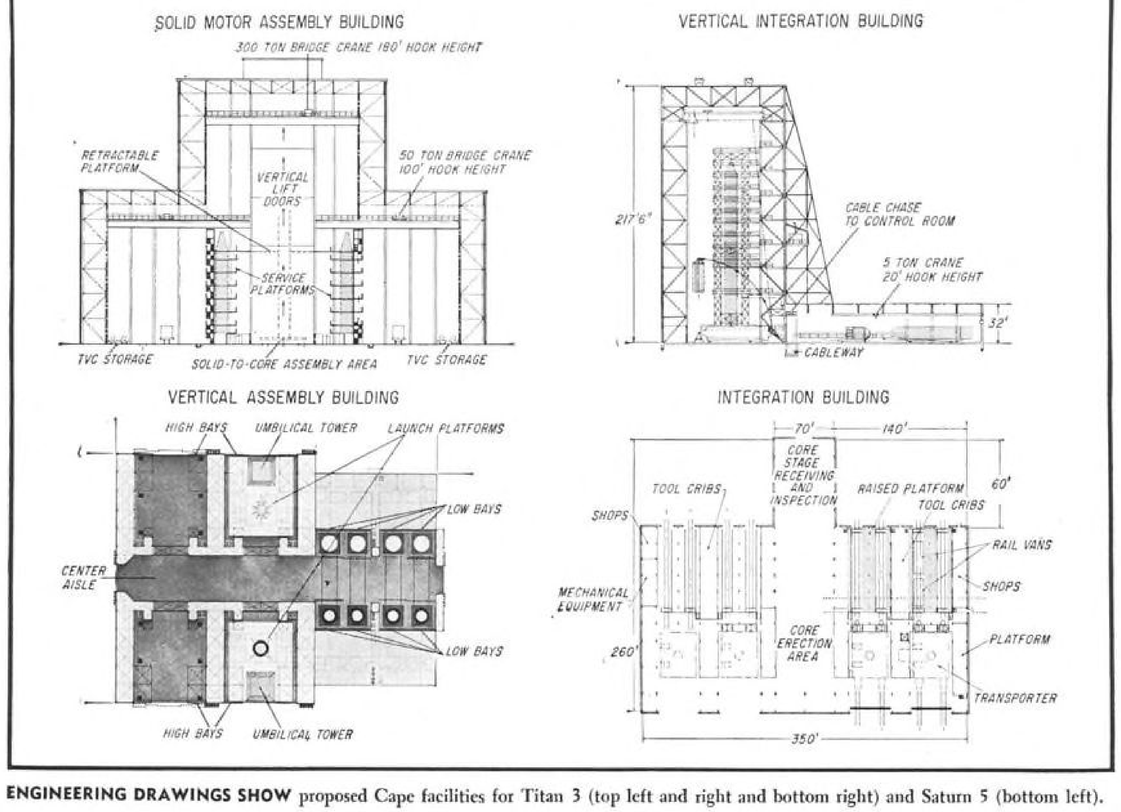
Here it is: a 1.5 Mc per track, multi-track recorder! And Ampex is the first to have it. It's called the FR-1400. It will give you the broadest bandwidth yet in longitudinal recording. What's more, it utilizes solid state electronics throughout—all in one rack. It has four speeds, each electrically switchable with no adjustments needed. And it comes with tape search and shuttle to provide quick data location and permit any portion of the tape to run repeatedly without operator attention. What about performance? Outstanding! It offers better rise time and minimum ringing on square waves, low intermodulation distortion, and improved flutter. Ampex also brings you a new 1.5 Mc tape. In both you'll find the same engineering precision, the same superior quality, that has made Ampex first in the field of magnetic recording. Write the only company providing recorders and tape for every application: Ampex Corp., 934 Charter St., Redwood City, Calif. Worldwide sales and service. AMPEX



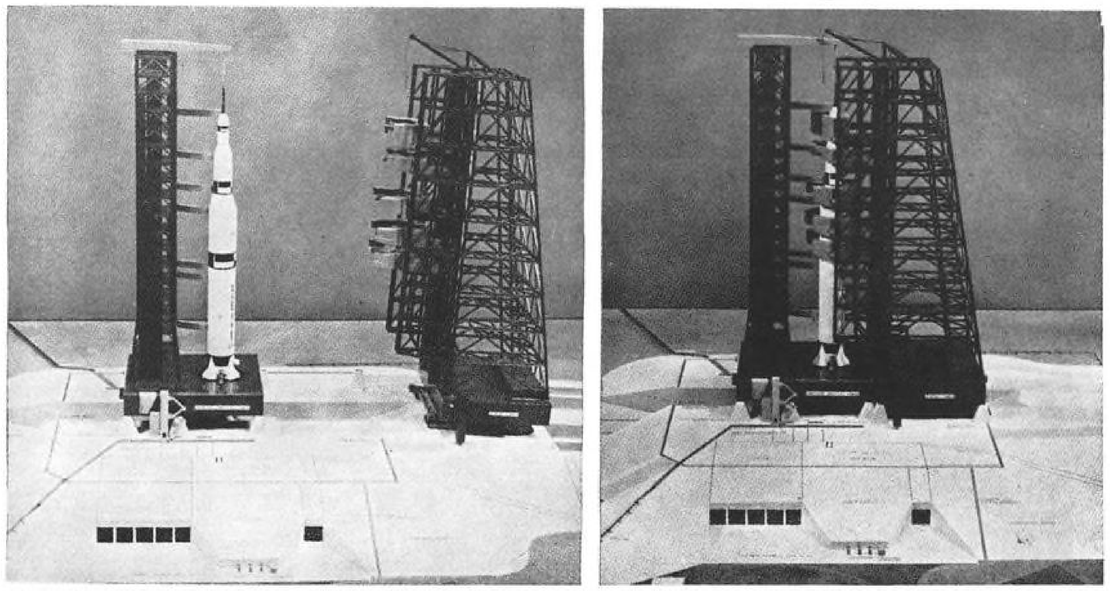


CROSS SECTION OF VERTICAL ASSEMBLY building for Saturn 5/Apollo at Cape Canaveral, left, indicates massive size of the structure. Scale model, right, shows Saturn 5/Apollo on its launcher-umbilical tower platform before leaving vertical assembly building.

Cape Facilities for Saturn 5/Apollo, Titan 3



ENGINEERING DRAWINGS SHOW proposed Cape facilities for Titan 3 (top left and right and bottom right) and Saturn 5 (bottom left).



ARMING TOWER IS BROUGHT to launch stand, left, by crawler-transporter also used to move launch platform to pad. Emplaced arming tower, right, encloses launch vehicle and capsule while retrorockets, ullage rockets, escape rockets and separation mechanisms are installed.

Keyed to Delivery of Flight-Ready Boosters

By George Alexander

Cape Canaveral, Fla.—Delivery of flight-ready boosters and spacecraft to the launch stand constitutes the basic element in the design of facilities now under construction for the Saturn 5/Apollo and Titan 3 programs, representatives of the National Aeronautics and Space Administration and the Air Force stressed at a recent meeting here.

Speaking before the space flight testing conference of the American Institute of Aeronautics and Astronautics, Lt. Col. Rocco A. Petrone and Col. Clarence Bidgood, Army officers on loan to NASA's Launch Operations Center, and James F. Lammorte, Aerospace Corp., discussing the Air Force Titan 3 program, presented details on the facilities being built for their respective programs.

Design approach of both programs is similar—the complete launch vehicle and spacecraft system will be assembled and checked out in a facility built for that express purpose and will be rolled out to the launch stand only when ready for flight. All three speakers said that the concept will allow high frequency launch rates, increased system reliability and reduced time and cost.

Petrone, chief of the heavy space vehicle systems office in the Launch Operations Center, said that the increased size and complexity of the Saturn 5/Apollo system and the varying launch rates, fast re-cycle times and unprecedented reliability demanded of it, necessitated a new approach to the design of launch facilities.

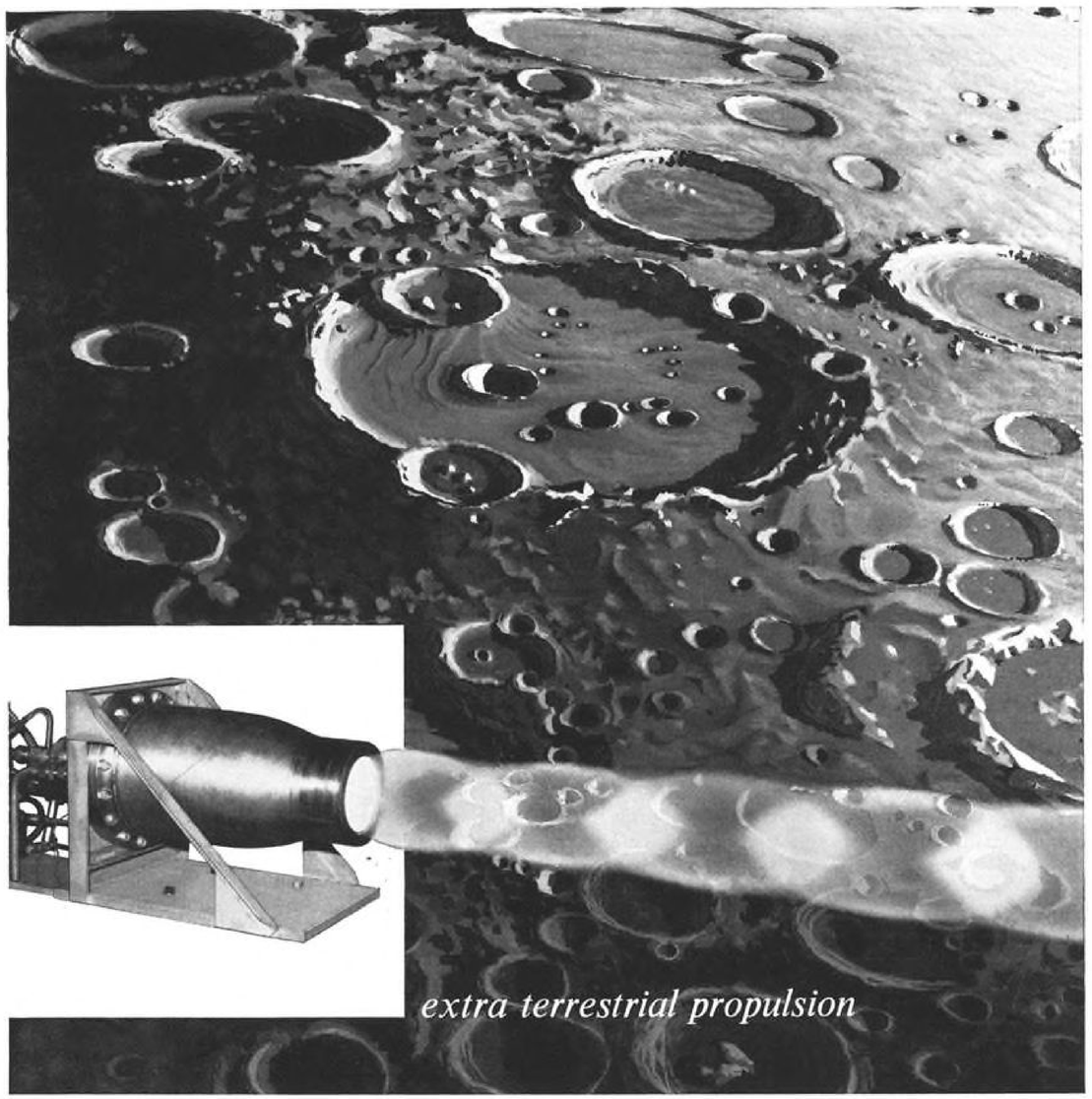
Central element of Complex 39, from which Apollo missions will be staged, will be the vertical assembly building (AW July 2, p. 135). This will consist of a high and a low bay area, the former 524 ft. tall, with a base 513 ft. wide and 432 ft. long and the latter 209 ft. tall, with a base 256 ft. long and 437 ft. wide.

High bay area will consist of two pairs of assembly and checkout bays, separated by a central transfer aisle 90 ft. wide extending through the length of the building. Each set of bays will be serviced by a 250-ton bridge crane with a hook height of 456 ft. One 175-ton overhead bridge crane will operate in the transfer aisle which extends from the high bay area into the low bay end of the building. Each bay also will contain four personnel elevators to provide rapid access to the higher levels of the structure.

Low bay area will consist of eight upper-stage preparation and checkout cells, each with vertically adjustable telescoping work platforms. S-2 and S-4B stages, second and third stages, respectively, of the Saturn 5 launch vehicle, will be routed through the low bay area before mating to the over-all vehicle; the S-1C booster, or first stage, will proceed into a high bay.

In operation, a launcher-umbilical tower—a mobile assembly, checkout and launch platform—will be driven into one of the high bays. An S-1C booster, having been delivered to NASA's Merritt Island Launch Area (site of the vertical assembly building) by barge, will be rolled into the transfer aisle on a horizontal transporter. Slings then will be attached to the 144-ton (dry weight) S-1C and the 250-ton and 175-ton cranes will lift the stage from its dolly and place it in a vertical position. The stage then will be lowered onto four holddown-support arms on the launch table and secured.

After work platforms have been dropped around the S-1C, the unit will be examined for handling damage. Four semi-conical fairings will be installed over the four outboard F-1 engines of the booster, followed by installation of four stabilizing fins (AW Aug. 13, p. 52). S-1C then will be ready for checkout. S-1C will be connected to ground support equipment contained within the launcher-umbilical tower and this will be connected through a high-speed digital data link to the launch control center at one side of the building. Test and checkout exercises will be conducted with actual launch control equipment and will be based on the building-block concept—tests will



517

Many space missions require rocket engines whose thrust level can be accurately controlled over a wide range. STL scientists and engineers are developing a family of such engines, including the 5000 pound bipropellant rocket engine shown above. These engines can vary their thrust across a throttle range greater than 40 to 1 while maintaining high combustion efficiency and limiting propellant residuals. With each test firing of the 5000 pound engine (and its 500 pound counterpart), the insight of STL scientists and engineers grows keener in areas of extra terrestrial propulsion. New positions have been created by this project, by STL's work as prime contractor for NASA's OGO, by its prime contractor assignment on a new series of Air Force-ARPA spacecraft, by its Systems Management activities for the Air Force's Atlas, Titan and Minuteman programs, and by other space responsibilities. Openings are in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern Calif., or Cape Canaveral positions, write Dr. R. C. Potter, Dept. A-4, One Space Park, Redondo Beach, Calif., or P. O. Box 4277, Patrick AFB, Fla. STL is an equal opportunity employer.

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begin on the component level and then progress to subsystems, systems and finally, composite systems.

An instrument unit will be positioned above the S-1C at a height of 314 ft. in the bay. This will be a 260-in. dia., 3-ft. tall, 2-ton module containing the Saturn 5's guidance and control computers, gyro-stabilized platform, flight sequencer, command receivers and decoders, measuring system equipment, telemetry, tracking transponders and electrical distributors. It will be connected to the umbilical tower through the same cabling that will be used later for launch. S-1C and the instrument unit will be electronically coupled through S-2 and S-4B stage simulators for interface tests. These simulators will be housed in test station rooms at levels within the high bay corresponding to the height of the actual stages.

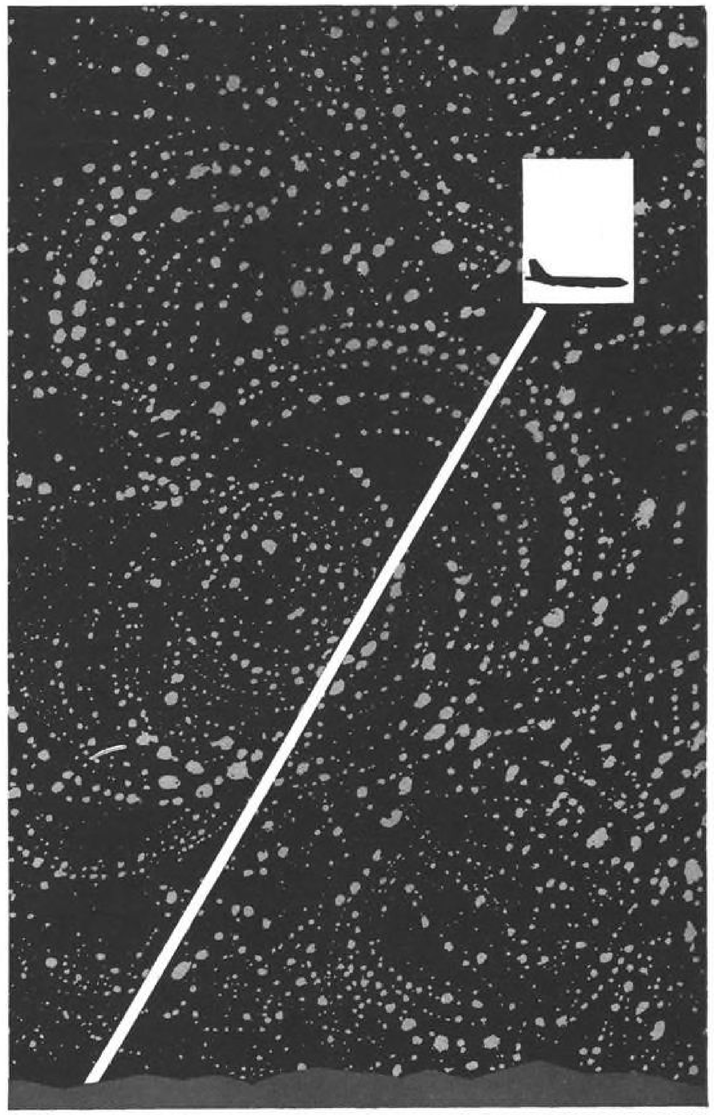
All test data will be relayed to the control center on the same high-speed link.

After solo tests of the S-1C, an all-systems test series of the S-1C, the S-2 and S-4B simulators and the instrument unit will be run. NASA engineers then will proceed to mating the actual S-2 and S-4B stages to the S-1C booster. It is expected that checkout of the S-1C will take about eight weeks.

While the S-1C is undergoing checkout, the S-2 and S-4B stages will be put through similar tests in separate cells in the low bay area. The ground support equipment which will be used in these exercises will be identical to that used at the manufacturer's plant and at static test stands.

After checkout, the 37.5-ton (dry weight) S-2 stage will be moved into the transfer aisle and mated to the S-1C interstage adapter section. It will be moved to the high bay area by the 175-ton crane, which has a hook height of 165 ft., and there transferred to the 250-ton crane. The latter then will lift it atop the S-1C for mating. A similar procedure will be followed with the 14-ton (dry weight) S-4B third stage. The instrument unit will be disconnected from the umbilical tower at the completion of the S-1C test program to allow mating of the S-2 and S-4B stages. After the three stages have been assembled together, the instrument unit will be installed atop the S-4B and all stages connected to the umbilical tower. A series of stage compatibility tests then will be run, including controls, simulated ordnance and radio-frequency exercises, followed by an over-all launch vehicle systems test.

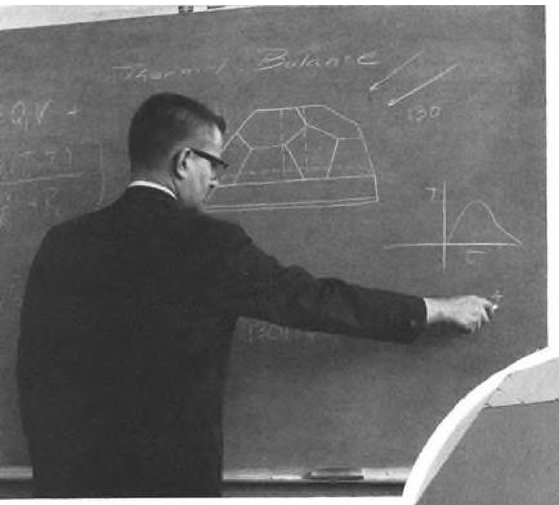
At the end of this approximate 12-week assembly and checkout process, the Saturn 5 will be ready to accept the Apollo spacecraft system. The three-man command module and its associated modules, which will have already



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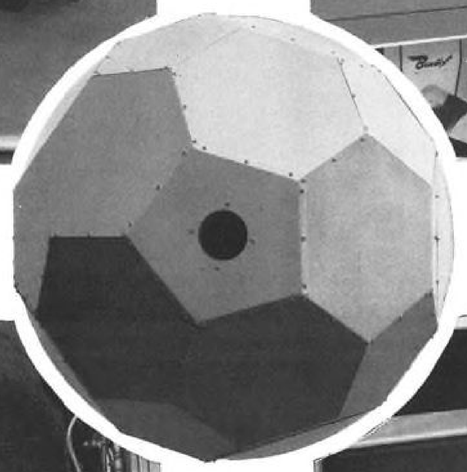
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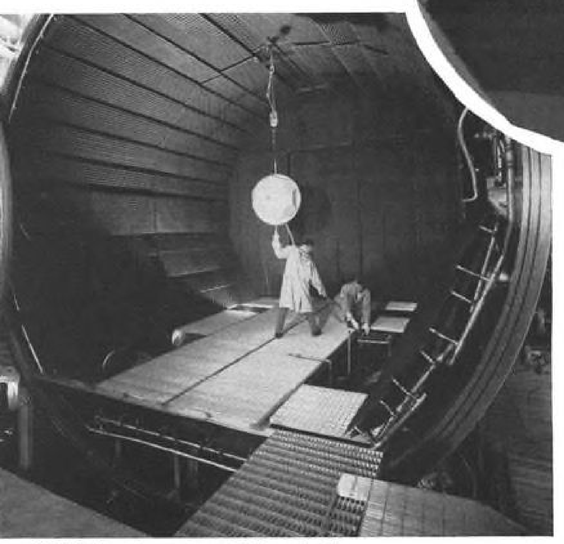


CONFIGURE—The mathematical model for satellite thermal balance is established from the configuration and material properties.



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undergone 14 weeks of tests in the operations and checkout building, also in the Merritt Island Launch Area, will be delivered in two sections: the command module and service module as an integral unit and the Lunar Excursion Module as a separate unit.

These spacecraft modules will be delivered to the high bay in the vertical assembly building and assembled into one complete system on the launch platform. Interface tests will be run on the spacecraft and launch vehicle before mating the two. The 250-ton crane then will place the Apollo on the instrument unit adapter section.

After mating, a combined spacecraft and launch vehicle systems test will be conducted, including ejection and retraction of umbilical connections, internal power on flight batteries and electrical disconnect of stages during a sequential exercise. As many flight systems as possible will be used "live." A simulated flight test, approximating as closely as possible a realistic countdown and flight, then will be conducted and all systems must perform satisfactorily before a decision will be made to transport the complete vehicle to the launch stand.

The launcher-umbilical tower upon which all this activity will take place basically is a platform with an integral umbilical tower. It consists of five major elements:

• **Launch platform.** This will be a two-story steel structure, 25 ft. tall, 160 ft. long and 135 ft. wide, upon which the Saturn 5/Apollo will be assembled and from which it later will be flown. On the top deck of the platform, four dual-purpose arms will protrude to support the stages and spacecraft during assembly and to restrain the launch vehicle at the time of launch until full thrust develops in the five F-1 engines of the booster. Each arm will be 11 ft. long, with a 9 x 6 ft. base, and will weigh 20,000 lb.

Beneath the deck, the launch platform will be divided into 24 compartments on each of two levels. The compartments, varying in size from 350 to 1,600 sq. ft., will house computers, propellant serving racks, checkout and launch-associated equipment. Platform will have a cut-out through its center to allow exhaust of the booster engines.

• **Umbilical tower.** 380 ft. tall, 60 sq. ft. at its base and 40 sq. ft. above the 80 ft. mark, the umbilical tower will be mounted on one end of the launch platform. A hammer-head crane, capable of 360 deg. rotation, will be mounted on top of the tower and will have a maximum hook height of 376 ft. It will have a lifting capacity of 12 to 25 tons, depending on the variable hook traverse radius of 50 to 80 ft. Two 600-fpm. elevators will be centrally



How the world became flat

Across Canada, over the pole, ringing Europe, to the Middle East, leaping the Pacific and linking much of Southeast Asia is a microwave military communications network, binding together the community of free nations. ■ Billions of bits of data and countless phone conversations and teletype messages are exchanged daily. Contact time from one command point to any other is typically only a matter of seconds. This took some doing.[1] ■ Figuratively speaking, the earth had to be flattened to permit contact between transmitter and receiver. Over-the-horizon communications at microwave frequencies was made possible by forward-scatter tropospheric propagation—"tropo" for short. Kilowatts of microwave energy are needed. They are generated by amplifier klystron tubes. ■ The modern power klystron had its beginnings in the discovery of the principle of velocity modulation at Göttingen in 1934.[2] Other brilliant expressions of the same basic principle developed independently in the U. S. in 1937 and 1939. ■ The power klystron is inherently large. Because it is also essentially simple, it may, with skill, be designed simultaneously for high power, high gain, long life and military ruggedness. All these are essential to the task of "tropo" communications. So successful was this approach to the problem that the klystron is the sole microwave power source for every element in the network. ■ And so successful has one company been that its amplifier communications klystrons are used almost exclusively. That company is Eitel-McCullough. Eimac has designed, developed and delivered over 95% of these communications klystrons. The life of an Eimac power klystron in this service ordinarily exceeds 25,000 hours. *More than a few are now past the 50,000 hour mark.* ■ Upon such formidable foundations, Eimac continues to forge into other areas. It is now at work in a government-sponsored effort intent on achieving a million watts of continuous microwave energy at a frequency whose limit today is about 50,000 watts. (This is an almost unbelievable accomplishment, if anyone can do it. There is good reason to think Eimac can.) ■ Eimac ground-station klystron amplifiers are now in worldwide service in satellite relay transmission. And Eimac has developed new ultra-lightweight driver klystrons for the world's largest linear accelerator. All largely on self-sponsored research programs. ■ These are typical of Eimac's technical achievements in electron power tube development. Anyone can prove the earth is round. It takes special skill and capability to flatten it.

1. *This story is told more fully in "The World is a Puddle" booklet. Write for your free copy.*
2. *By coincidence, this was also the year Eitel-McCullough, Inc. was founded. The discoverer of the velocity modulation principle is now an Associate Director of Research at Eimac. A reprint of his historic 1935 report on the discovery is yours for the asking.*

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located within the tower and will service 18 stops, the lowest being the upper compartment of the launch platform, about 35 ft. above the ground, and the highest being 340 ft. above ground.

• **Umbilical swing arms.** Eight umbilical swing arms, varying in length from 35 to 45 ft., will join the tower to the launch vehicle. Of steel-truss construction, the 100-in. tall and 60-in. wide arms will provide personnel access, power, propellant and pneumatic lines to all three stages. Pilots will enter their spacecraft on a special 68-ft. long enclosed catwalk. All arms will have flexible end-extensions to keep work platforms in place during wind sway and will be capable of supporting up to 1,000 lb.—or approximately five men—at their ends. Each arm will have two independent pneumatic push-off piston systems to guarantee disconnection of the arms at the proper time during the countdown.

• **Firing accessories.** These items include propellant masts, cable mast, lift-off switches, water-quench masts, fire-fighting systems and boat-tail heater, all mounted on the top deck of the launch platform.

• **Operational test and launch** equipment. Checkout computers, power supplies, test sets and other special electronic equipment will continually monitor the status of the launch vehicle as it travels from the vertical assembly building to the launch stand. This equipment will be housed in compartments within the launch platform.

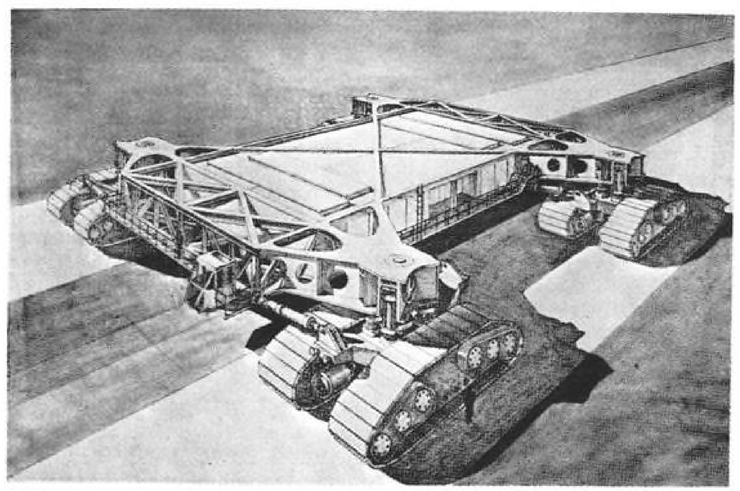
Total weight of the launcher-umbilical tower is expected to be 10.5 million lb. Weight of the empty Saturn 5 and Apollo spacecraft is expected to add another 500,000 lb. to the mobile platform.

Launcher-umbilical tower, with a completely-assembled launch vehicle and capsule aboard, will be moved from the vertical assembly building to the launch stand by a crawler-transporter. This self-propelled prime mover, now under development by the Marion Power and Shovel Co. (AW Feb. 18, p. 37), will be 131 ft. long and 114 ft. wide and will weigh 5.5 million lb. It will move on four double-tracked, steel-link treads, each 41.3 ft. long and 7.5 ft. wide. Two Diesel generators will provide 5,600 hp. for a main drive system powered by electric traction motors on each pair of treads. The four crawler trucks may be steered from one central position or may be commanded as independent front and rear units. Turning radius will be 500 ft.

Velocity of the crawler will be 2 mph. unloaded and 1 mph. on a level surface when fully loaded with a Saturn 5 and Apollo. On a 5% grade—the inclination of the ramp leading up the launch stand—the crawler will be able to do 0.5 mph. It will be able to move its load against a steady, head-on 40-kt. wind.

Hydraulic jacks, integral with the trucks that drive the steel treads and located on the corners of a 90-ft. square, will have a 72-in. maximum stroke to lift the launcher-umbilical tower platform. Jacks will have a level-sensor to position the launch platform within ±10 min. of arc.

The 20-ft. tall vehicle will be driven under the launch platform in the high bay of the vertical assembly building, in which the Saturn 5/Apollo has been assembled. Platform will be resting on six steel pedestals 21 ft. high. Jacks will engage the fittings on the underside



ARTIST'S CONCEPT shows crawler-transporter carrying lifting launch platform to be used with Saturn 5/Apollo vehicle. Device will use steel link treads, electric motors between tread pairs and hydraulic jacks above each set of treads.

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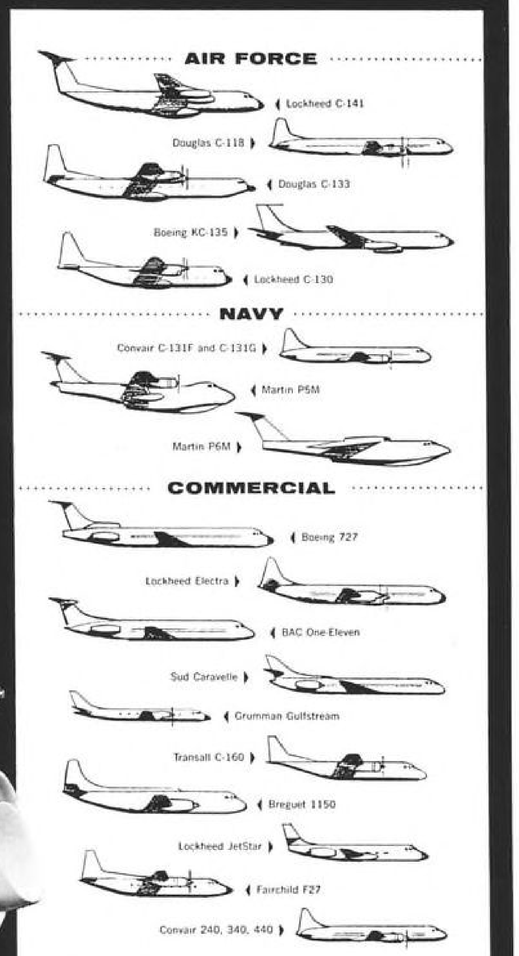
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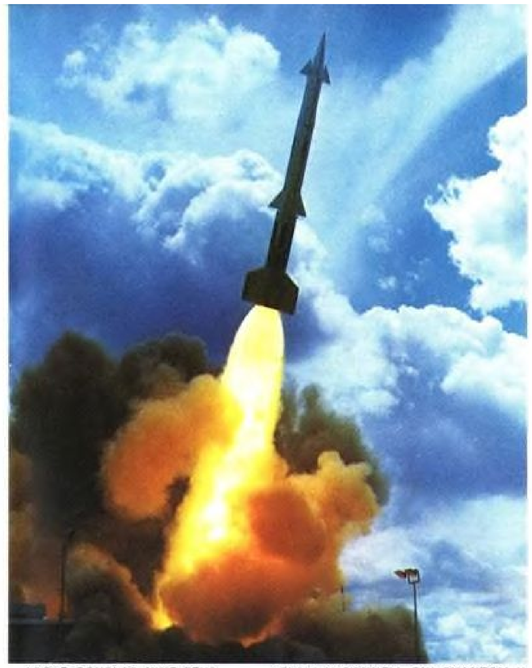


LEFT, HILLER E-4 ABOVE, KAMAN UH-2A SEASPRITE



ABOVE, BEECHCRAFT MUSKETEER, MODEL 23 BELOW, NORTH AMERICAN T-39 SABRELINER





ABOVE, DOUGLAS NIKE ZEUS BELOW, McDONNELL F4H PHANTOM II





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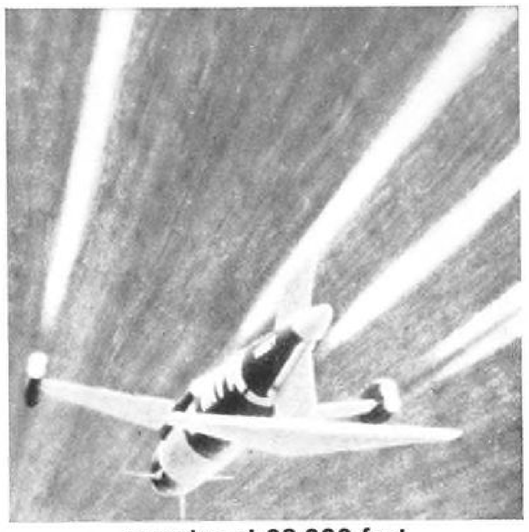
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The Rocket-powered Northrop RP-78



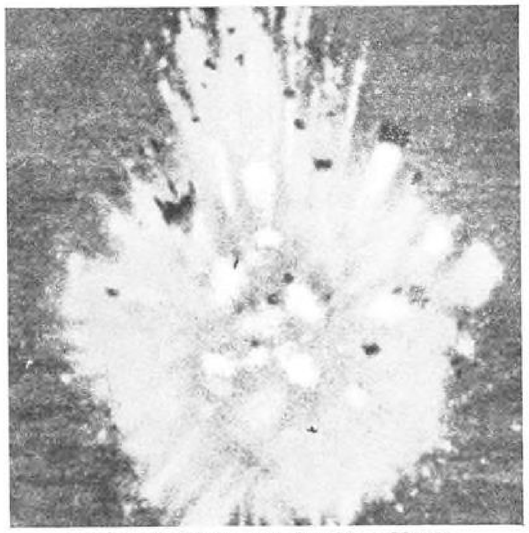
flies at Mach 1.3



operates at 68,000 feet



maneuvers by remote control



and gets blown up for its efforts.

The Northrop RP-78 target drone looks exactly like an enemy bomber when viewed on a radar screen. The same altitudes, speeds, evasive action, and radar reflectivity. It is parachute recoverable, yet is so economical it can be shot down if desired. **NORTHROP VENTURA**

of the platform and then raise the entire unit about 3 ft. to clear the pedestals. Crawler then will move the launcher-umbilical tower platform, with its Saturn 5/Apollo load, from the vertical assembly building to the launch stand on a two-lane, specially built crawlerway. Each lane will be 40 ft. wide and will be separated by a 50-ft. wide trough. Crawlerway will always be at least 8 ft. above sea level.

Platform Positioning

At the launch stand, the crawler will slowly retract its jacks and allow the launcher-umbilical tower platform to sink down upon six steel anchoring pedestals. In addition, the stand also will be equipped with four extendable columns to stiffen the platform against rebound loads in the event that the S-1C engines are shut down after ignition has taken place.

After positioning the launch platform on the stand, the crawler will move out from underneath and pick up the arming tower. This will be a 415 ft. tall tower, with a 150 x 125 ft. base and a 80 sq. ft. superstructure. Primary function of the tower will be the installation of retrorockets, ullage rockets, explosive separation devices, escape rockets and destruct packages; this task is considered to be potentially too hazardous to be accomplished in the vertical assembly building. With its clamshell-enclosed platforms, the tower also will provide access to the rear of the Saturn 5 launch vehicle—an area inaccessible to the arms of the umbilical tower. Tower also will have a stiff-leg derrick crane on the top of the structure, capable of lifting 75 tons and of rotating through 270 deg.

Arming Tower

The arming tower will rest on a platform similar to that of the launcher-umbilical tower. The crawler will transport the tower from its parking area to the launch stand and deposit it next to the launch platform. It will remain there until T—7 hr. on the day of launch, when the crawler will return it to the parking area, some 7,000 ft. away from the launch stand.

There will be three launch stands, A, B and C, at Complex 39. Each will be about 0.5 mi. from the Atlantic Ocean and about 8,730 ft. apart. Each pad area will encompass a site about 3,000 ft. in diameter.

Stands basically will be little more than steel and concrete foundations, since the launch operation will be conducted from the mobile platform. Table surface of the stand will be 48 ft. above ground level. A mobile wedge-shaped steel flame deflector will be positioned on rails 35 ft. beneath the F-1 engines of the booster stage. Deflector, the ridge of which will be made of refractory metal, will roll down the trough of the U-shaped stand for positioning beneath the launch vehicle; it will measure 85 ft. long by 55 ft. wide and 48 ft. tall.

Other facilities in the launch area will include:

- **Pad terminal connection room.** An underground 60 x 100 ft. chamber, this two-story structure will provide all hardline connections between the launcher-umbilical tower, launch pad and launch control center. It also will serve as a distribution center for high-pressure gases and electrical power and will contain electronic simulators of the launch vehicle, spacecraft and launch platform for test purposes when the actual equipment is not present.
- **Liquid oxygen storage tank.** Each stand will have a 880,000 gal. capacity liquid oxygen storage tank located 1,450 ft. away from pad center.
- **Liquid hydrogen storage tank.** Each stand will have a 650,000 gal. capacity liquid hydrogen storage tank located 1,450 ft. away from pad center, opposite the oxidizer tank. Tank will be vacuum-jacketed and pressurized to 75 psi. during transfer operations.
- **RP-1 fuel storage tank.** Each stand will have three RP-1 kerosene fuel storage tanks with a combined capacity of 235,000 gal. RP-1 is used only by the S-1C; it will be pumped at 2,000 gpm. during fueling. These three tanks will be 1,450 ft. away from pad center, on the same side as the hydrogen tank.
- **High-pressure gas storage facility.** Gaseous nitrogen and helium will be

USAF Modifies Astronaut Training

Edwards AFB—U. S. Air Force has modified training courses and entrance requirements at its Aerospace Research Pilot School here to increase its pool of candidates eligible for future astronaut training. First class under the new curriculum begins July 1, and is geared to turn out 36 space-oriented graduates annually from classes starting at four-month intervals.

New year-long curriculum is composed of a six-month experimental test pilot course (shortened from eight months) and a six-month aerospace research pilot course (shortened from seven months). Formerly, most pilots were required to have test pilot experience before attending the aerospace course—this requirement was waived for certain students, however, starting last November.

By dropping entrance requirements from 1,500 hr. jet time (2,000 hr. total time) to 500 hr. in operational, front-line aircraft (including helicopters), in addition to postponing test pilot experience, Air Force hopes to lower the average age of graduates to a 28-29 year level.

Additional 2-3 years of test pilot experience, following graduation, would bring the average age of Air Force's potential astronaut candidates to 30-32 years. This contrasts with the 36-37 year average age of experienced test pilots now in the Air Force. Maximum age for entrance now is 32, compared with 35 previously. Candidates must also have a science or engineering degree.

Age requirement for National Aeronautics and Space Administration's project Gemini astronauts was set at 35 years, which ruled out many otherwise eligible Air Force pilots because of age. Air Force also lowered its requirements to the aerospace course because it has used up most available candidates from its inventory of test pilots.

An additional feature of the newly revised curriculum will be training in reaction control and weightlessness during the space orientation course. Three Lockheed NF-104As, modified F-104As (AW Mar. 25, p. 87), have been ordered by the flight test center here for this job. The planes will be boosted to maximum altitude of 140,000 ft. (120,000 ft. under standard atmospheric conditions) by a Rocketdyne AR-2 throttleable rocket engine.

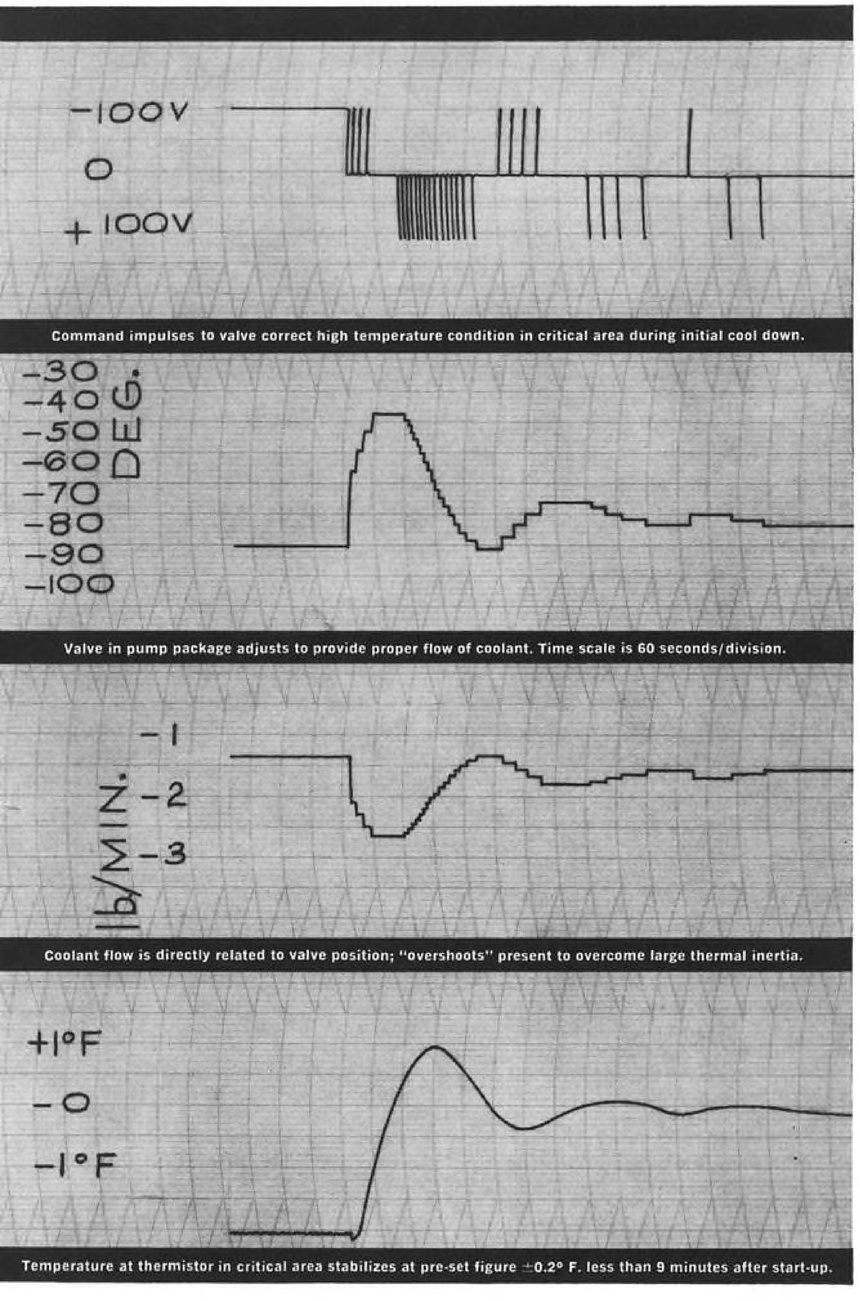
Procedure will be to cut in the 3,000 to 6,000-lb. variable thrust rocket engine at 36,000 ft., after acceleration to high speed and initiate a pull-up to climb to altitude. Air cabin pressure will be dumped prior to starting the climb since one engine eventually is shut down at 75,000 ft. to prevent overheating. Afterburner blows out at about 67,000 ft.

Hydrogen peroxide reaction control system, identical to that used on the X-15, is used to stabilize the airplane during the ballistic trajectory. Engine is relighted on the way down at about 50,000 ft. Test flights of the NF-104As, modified by Lockheed-California Co., will begin in August. As a possible follow-on to the NF-104A, Air Force is now writing specifications for another modified inventory aircraft, which would be capable of reaching 285,000 ft. altitudes.

Additional aircraft used by the Aerospace Research Pilot School and their mission as simulator training devices are:

- Two Convair F-106Bs to investigate variable stability.
- One Convair F-106A to study variable lift-drag ratios.
- One McDonnell F-101A with an adaptive control system. This airplane will be used by the school to study variable stability.

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stored in an underground room, 100 ft. long, 50 ft. wide and 30 ft. deep, under pressures of 10,000 psi. Gas will be pumped into the bottle reservoirs from a converter compressor facility located near the vertical assembly building.

• **Camera sites.** Six camera sites, each equipped with five camera packs, will be located 1,300 ft. radially from each launch stand. Both television and engineering sequential cameras will be installed on these sites.

Saturn 5/Apollo will be ready for flight within three to five days after reaching the launch stand. Checkout and tests will account for the bulk of this time.

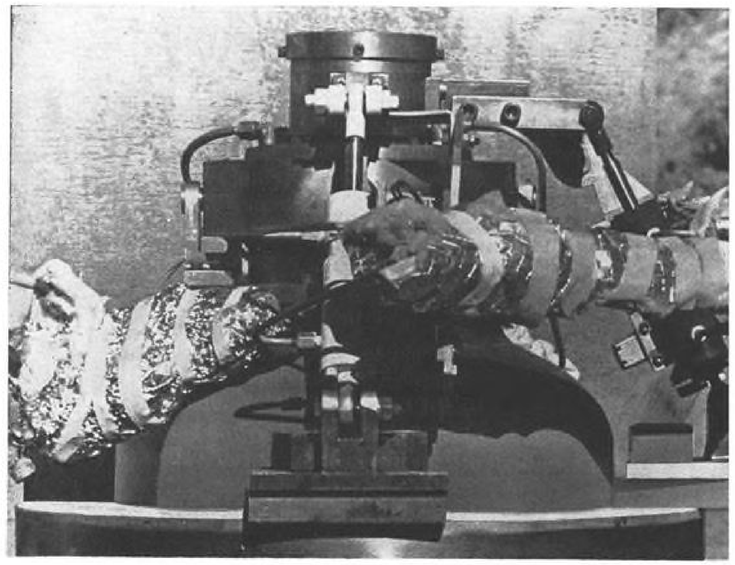
Saturn 5/Apollo Tests

These tests on the stand will include limited verification of certain critical subsystems from the launch control center; checkout of hard-wire backup circuits to the control center; pressurization of Saturn 5 stages to flight levels; propellant loading exercises, radio-frequency interference tests; abort system checkout, and a simulated flight test. This last-mentioned exercise will take a day, proceeding through a simulated countdown, launch and flight. Compatibility with all Atlantic Missile Range stations and Integrated Mission Control Center (AW Dec. 24, p. 52), Houston, Tex., also will be verified at this time.

With the successful completion of the simulated flight test, the actual launch countdown, which will take two days, will begin. Total of 1.3 million lb. of RP-1 will be loaded into the fuel tank of the S-1C the day before launch. All ordnance—retrorockets, escape rockets, etc.—also will be installed on this day.

Early on the day of launch, the storable hypergolic propellants of the Apollo service module will be loaded aboard. These propellants will feed the module's 21,900-lb.-thrust, re-startable engine, which will be used for midcourse correction during translunar flight, deceleration into lunar orbit, escape from lunar orbit and midcourse corrections during return flight to earth. At this same time, the hypergolic propellants of the S-4B's reaction control system will be loaded aboard.

Loading of cryogenic propellants will begin at T—7 hr. on the launch day, beginning with the third stage and liquid oxygen first. Tanks will be pre-cooled, or chilled down, prior to loading and one stage will be loaded as its lower neighbor is chilled. S-4B will be chilled for 12 min. and then loaded for 20 min. at a rate of 1,000 gpm. with liquid oxygen. S-2, at a rate of 5,000 gpm., will require 25 min., including 6 min. for pre-cooling for liquid oxygen loading. S-1C will be filled with oxidizer at a rate of 10,000 gpm. and will require 40 min., including 11 min. for chilling, for the operation.



Gimballed Nozzle Tested for Thrust Vectoring

Gimballed nozzle for solid-propellant rocket thrust vector control has been tested in firings up to 165 sec. by Lockheed Propulsion Co. Nozzle deflected subscale rocket motor thrust ±9 deg. in pitch and yaw. Company says it will weigh about one-eighth as much as fluid-injection system with comparably large thrust deflection. System uses differential hydraulic seal, for prevention of excessive component heating.

Liquid hydrogen then will be loaded aboard the upper stages. At a rate of 3,000 gpm., the S-4B will take about 30 min. to fill with fuel, including 10 min. for chill-down. S-2, at a fill rate of 10,000 gpm., will take 35 min. to fill with liquid hydrogen, including 10 min. for pre-cooling. Topping of both the liquid hydrogen and oxygen will continue until shortly before launch.

At T—4 hr., the three pilots will enter their command module. Insertion and sealing of the pilots will require an estimated 135 min. and bring the countdown to T—105 min. Remainder of the count will be devoted to final systems checks.

Engine Ignition

At launch, the F-1 engines in the S-1C stage will be ignited. The launch vehicle will be held by the holddown-support arms until sufficient thrust has been developed; a launch-commit signal will be sent from the launch control center and the toggle links will be tripped, allowing the Saturn 5 to lift off from the pad.

S-1C will burn for about 150 sec., reaching an altitude of 40 mi. and a velocity of 5,200 mph. S-2 stage then will separate and burn for about 390 sec. At burn-out of the S-2, the vehicle should be at an altitude of 115 mi. and should have a velocity of 15,000 mph. S-4B third stage then will be ignited to inject itself and the Apollo spacecraft into low earth orbit.

The vehicle then will make at least one-half revolution in this parking orbit while its orbital parameters are determined and all systems are determined to be ready for translunar flight.

Titan 3 vehicles (AW Feb. 25, p. 27), consisting of a modified Titan 2 ICBM and two strap-on 120-in.-dia. solid-propellant motors, will be assembled and checked out in a manner similar to that of Saturn 5/Apollo.

Air Force's equivalent of the vertical assembly building will be the vertical integration building. It, too, will consist of a high and a low bay area. The former will stand 217.5 ft. tall, 350 ft. wide and 100 ft. deep. The latter, or low bay area, will be immediately behind the high bay area and will stand 32 ft. high. It will be 350 ft. wide and 100 ft. deep, not including a 60-ft. deep, 70-ft. wide receiving and inspection station at the far end of the building.

Total floor space will be approximately 74,000 sq. ft.

The high bay area will include five bays in a side-by-side arrangement. Center bay will extend through the length of the building, including the low bay area, and will be used to erect the three stages of the Titan 2 core to a vertical position preparatory to assembly. Two bays on either side of the aisle will be used for assembly of the stages into an integrated vehicle and each will contain

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an elevator. Low bay area will open into the back of the high bays and also will be divided into five compartments—four corresponding to the high assembly bays and the fifth, or center, for receiving, inspecting and maintaining the stages as single units.

In operation, a transporter-launch platform—similar to NASA's launcher-umbilical tower—will be moved on railroad tracks into one of the high bays. The platform, on which Titan 3 will be assembled and later launched, will be 60 ft. long, 42 ft. wide and 7 ft. deep and will be mounted on four special railroad cars, each capable of supporting 250 tons. Platform is to weigh 170 tons by itself and include two solid-propellant motor launch mounts, core support mount and two umbilical masts.

Four railroad boxcars, or vans, will be connected in tandem pairs to the aft end of the platform and house launch and checkout equipment. The boxcars, two assigned to the launch vehicle and two to the payload, will precede the platform into the vertical integration building and will be inserted into the low bay immediately behind the high bay where assembly is to take place.

When the transporter-launch platform is properly positioned, the first stage of the Titan 2 core will be rolled down the center aisle into the high bay area on a horizontal dolly. There the single 20-ton bridge crane (with a hook height of 180 ft.) in the high bay area will pick up the stage, erect it to a vertical position, move it to the appropriate bay and set it down on the platform. Similar procedure will be followed with the second stage and transtage. Work platforms will be lowered around the stages as they are emplaced. Platforms surrounding the spacecraft will be vertically adjustable to varying payloads.

Two 1,000-hp. Diesel-electric locomotives, in parallel, will pull the assembled and checked-out Titan 3 core and the four ground support equipment boxcars from the vertical integration building onto a siding, where the direction of the entire unit will be reversed. The locomotives then will push the platform and its cargo of a Titan 3 core plus checkout boxcars into the solid motor assembly building.

Solid assembly building will be 226 ft. tall, with a base 170 ft. wide and 150 ft. long; the structure will straddle the railroad tracks. Two low bay areas, each 138 ft. tall, with a base 130 x 75 ft., will flank either side of the high bay structure. Each low bay building will have a 50-ton capacity overhead bridge crane, with a hook height of 100 ft. High bay area will be serviced by a single 300-ton bridge crane with a hook height of 180 ft.

Low bay cranes will pick up solid propellant segments and move them into individual vertical assembly cells. Each 85-ft. long motor will be built up from five segments, plus caps and nozzle. After assembly and checkout of a solid motor, the 300-ton crane will place the unit on its appropriate mount on the transporter-launch platform which will be waiting in the center aisle of the solid assembly building.

Titan 3s with solid-propellant motors will be the C configuration. Titan 3s flown with the core only will be the A configuration. Titan 3A vehicles will be routed around the solid assembly building and will proceed directly to one of two launch stands, 40 or 41.

After picking up two solid motors, the locomotives then will push the completely assembled Titan 3C to its launch stand, the nearer complex being 8,000 ft. from the solid assembly building. Launch stand, as with the Saturn 5, will be little more than a hardstand.

As the locomotives push the launch platform onto the pad, the vans preceding the platform will roll into a blast- and sound-protected building. This steel-reinforced concrete building will have walls and ceilings 16 in. thick to attenuate the acoustic noise of the solid motors, at launch, to around 140 db.

A 250 ft. tall mobile service tower then will be rolled up to enclose the Titan 3 and its launch platform, which will have been lowered to the level surface of the pad. Locomotives will be disconnected and returned to the vertical integration building.

Motor Exhaust

Platform will have a cut-out in its center, like the Saturn 5's platform, to permit escape of the first stage solid-propellant motor's exhaust. Exhaust duct will run at a right angle to the railroad tracks and will extend for 135 ft. before opening onto the surrounding area. Reason for this long exhaust duct is to attenuate the acoustic noise of the solid motors—USAF and Aerospace estimate a sound pressure of 160 db. will exist in the spacecraft area, but are studying ways of reducing it.

Railroad track system will consist of 7 mi. of two parallel standard gage tracks, the center lines of which will be 27.75 ft. apart. Roadbed will be 27 ft. deep. Maximum axle loads on the transporter-launch platform, carrying 500 tons (including the weight of itself and a fully assembled but unfueled Titan 3C, is estimated to be approximately 140,000 lb.

Only digital signals will be transmitted from the ground support vans at the launch site to one of two identical and interchangeable launch control centers. Analog signals will be converted for transmission into digital form and later reconverted into analog form at the control center. Data required for post-flight analysis will be stored on tape within the vans.



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FIG. 1

► **Low relative speed and closely held clearances between the two Gerotor elements mean high volumetric efficiency is maintained.**

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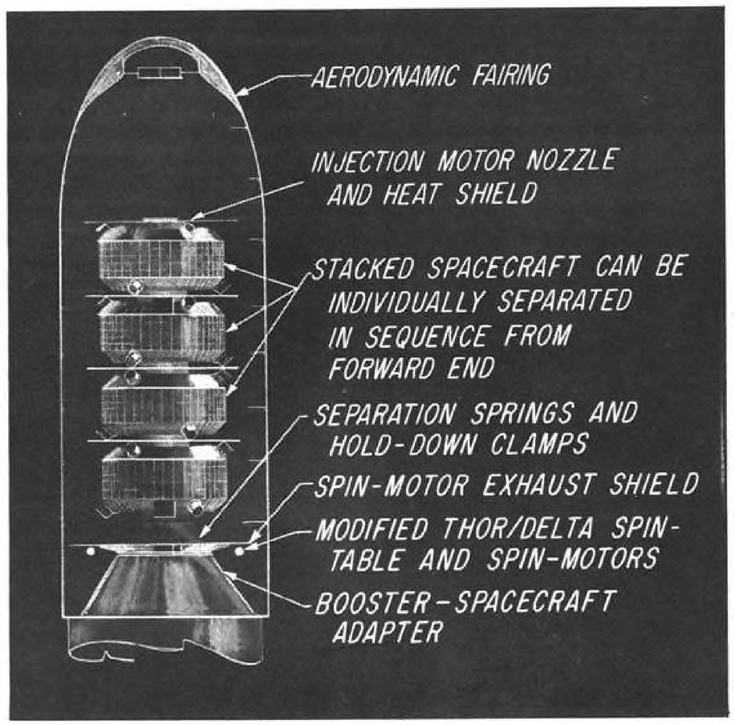
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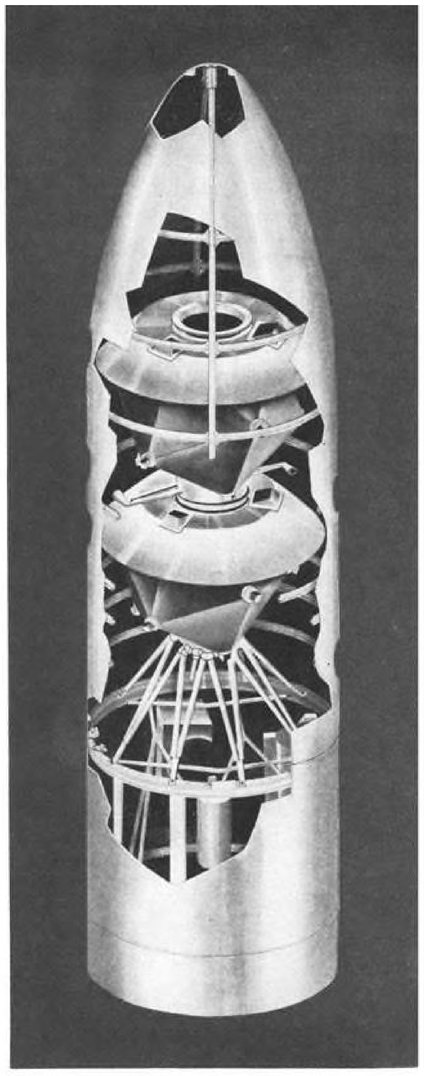
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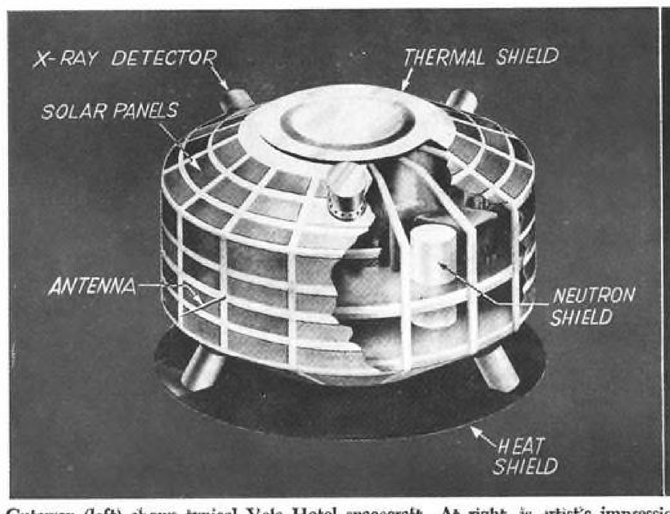


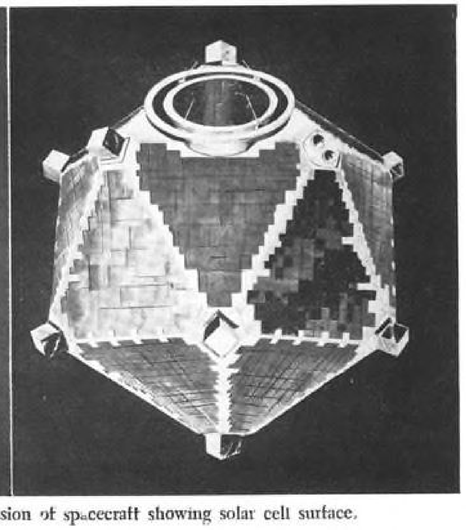




Vela Hotel Configuration Shown

Vela Hotel spacecraft is under the aegis of the Advanced Research Projects Agency and is being built by Space Technology Laboratories for detecting nuclear detonations in outer space (AW Mar. 18, p. 36). Flight testing is scheduled to begin this fall. Spacecraft is a regular polyhedron with 20 surfaces. Solar cells cover the triangular surfaces. X-ray detectors are located at the vertices. Cutaway at right shows two Vela Hotel developmental spacecraft enclosed within a glass fiber nose fairing on a two-stage launch vehicle. Nose fairing is split lengthwise into a two-section clamshell to facilitate jettisoning.





Cutaway (left) shows typical Vela Hotel spacecraft. At right, is artist's impression of spacecraft showing solar cell surface.

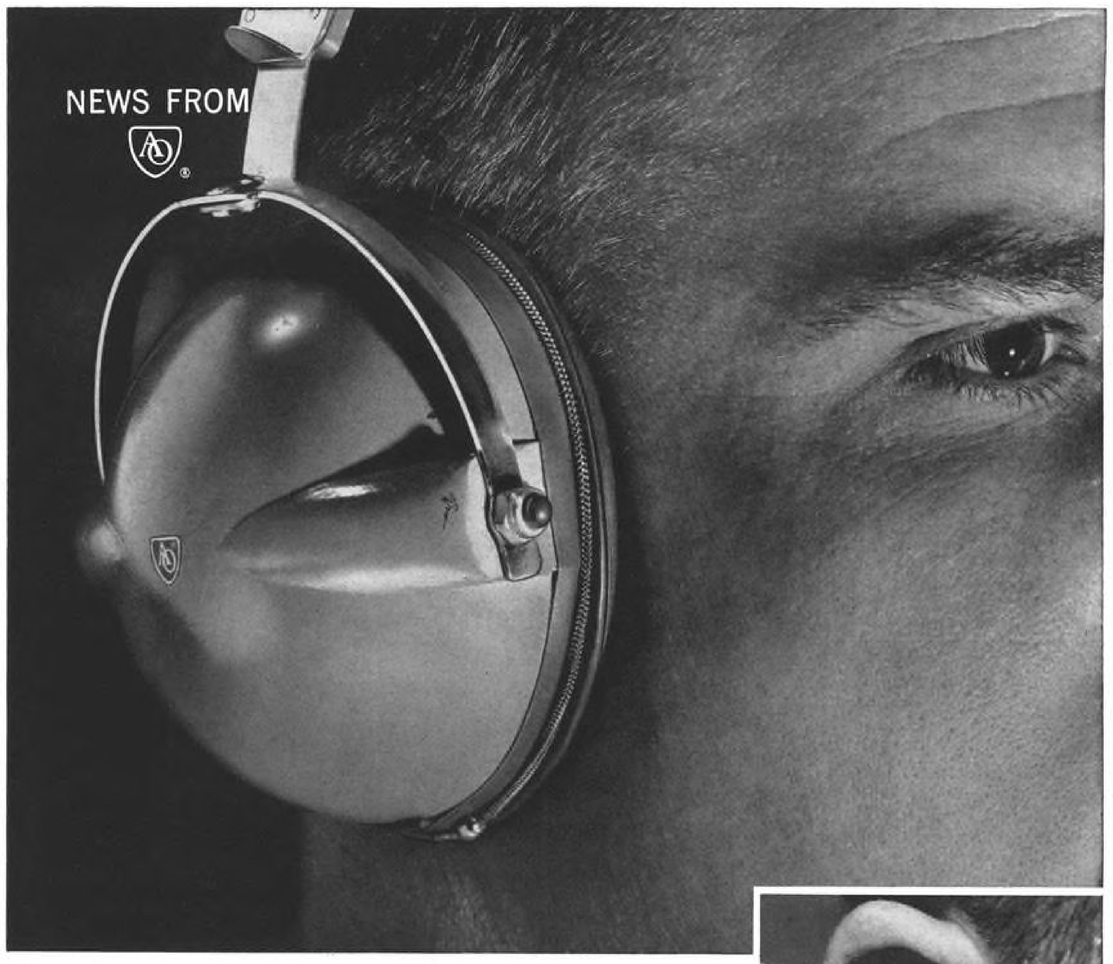


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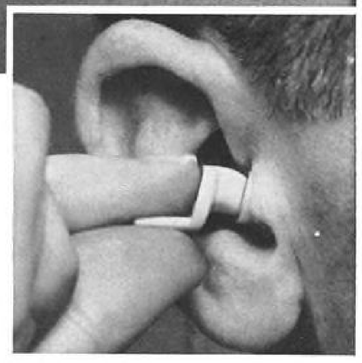
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DOD Funds $15 Million for Laser R&D

New York—Defense Dept. funding of laser research and development is approximately $15 million with an additional estimated $5-$10 million of industry funded effort, Dr. Robert H. Kingston said here during a status report on optical masers by a panel of five experts at the Institute of Electrical and Electronic Engineers convention.

Kingston, a member of the staff of Lincoln Laboratories and chairman of a Defense Dept. panel of laser consultants (AW Jan. 15, 1962, p. 92), said the government-sponsored laser research and development funds are allocated approximately:

- 25%: Basic research in materials and spectroscopy.
- 5%: Developing improved laser materials.
- 10%: Developing improved optical components.
- 40%: Developing new laser devices.
- 20%: Applying lasers to specific military equipment.

Kingston predicted that the coming year would see at least a 10-fold increase in the output power level of lasers and in their spectrum which currently ranges from about 0.6 micron (red portion of visible spectrum) to 28 microns in the infrared region.

Laser Advances

Dr. Charles H. Townes, who with another IEEE panel member, Dr. Arthur L. Schawlow, first proposed the optical maser, said that he has been "very impressed" with the rapidity and variety of laser advances during the past year. Kingston observed that many of them would have been impossible to predict a year earlier, an indication of the speed with which the technology is moving and the difficulty of making sound predictions of future advances.

Kingston cited the following as examples of some of the more interesting laser developments of the past year:

- **Raman laser,** built by Hughes Aircraft Co., in which the beam of a pulsed ruby laser, radiating at 7,431 Angstroms, passes through an organic liquid and produces a laser action within the liquid which radiates at a different frequency, ranging from 7,431 to 9,630 Angstroms depending upon the liquid used. The device effectively functions as a frequency converter, with efficiencies as high as 80%, Kingston reported.
- **Crystal converter,** first demonstrated by Ford Motor Co. scientists, in which a 7,000 Angstrom red beam trained on a solid crystal, generates a second harmonic blue beam at 3,500 Angstroms which emerges from the crystal. Conversion efficiency is about 20%.
- **Gallium-arsenide** semiconductor laser, first announced by International Business Machines Corp. and General Electric, shows promise of providing relatively simple, highly efficient optical maser. But Kingston noted that when the current level in present devices gets too high, the gallium-arsenide laser oscillates at many frequencies and that considerable work must be done to scale-up the device for moderately high power levels.

Laser Uses

Despite the fact that the first laser was operated less than three years ago, the new device already is finding a wide variety of uses, Dr. George Smith of Hughes Aircraft Co. reported. Some of the more promising cited by Dr. Smith included the following:

- **Micro-welding:** Hughes is on the verge of having a practical device for cutting and welding extremely small objects, such as bonding leads to microcircuits, Smith said. Laser beams can deliver more energy in a tiny area than an electron beam, he said, with the important advantage that the operation need not be carried out in a vacuum as required for electron beam welding.
- **Lunar radar probe:** Within a year the state of the laser art should permit its use in an earth-based radar which can make useful measurements of the roughness of the lunar surface.
- **Battlefield range radar:** Hughes-developed portable laser radar for measuring range of targets in a battlefield (AW Mar. 18, p. 83), weighs 44 lb., including a 30-lb. power supply, and was demonstrated for the IEEE. The device uses a pulsed ruby laser with a peak power of more than one megawatt which gives useful range of up to seven miles, Smith said.
- **High-speed photography:** Extremely short-duration, high-intensity illumination from a pulsed laser using a Q-spoiler type high-speed shutter, provides convenient means of photographing high-speed phenomena. University of Southern California scientists are using a ruby laser to study cavitation and fluid flow problems using the Q-shutter to obtain one-half million pulses of illumination per second of 30-nanosecond duration.
- **Medical:** Extremely narrow beam and high energy level of the laser beam has made it useful for eye operations. Where formerly anesthesia was needed to prevent the patient from moving his eye during retina surgery, the laser operates so quickly that no anesthesia is required.

Despite a number of experiments which have demonstrated the apparent value of the laser for wideband communications, Dr. Rudolph Kompfner of Bell Telephone Laboratories cautioned that its usefulness may have been overrated for terrestrial applications where the laser beam must be transmitted through the earth's atmosphere.

Kompfner told the IEEE that Bell Telephone Laboratories had measured as much as 100 db. attenuation of a laser beam over a distance of only 1,000 ft. in a fog. The use of the laser for communications appears most likely in space, outside the earth's atmosphere. Eventually there may be terrestrial applications using long evacuated pipes through which the laser beam will travel. But before such optical long-lines are feasible it will be necessary to develop a whole family of components including such things as efficient modulators, converters, receivers and transmission line optics, Kompfner said.

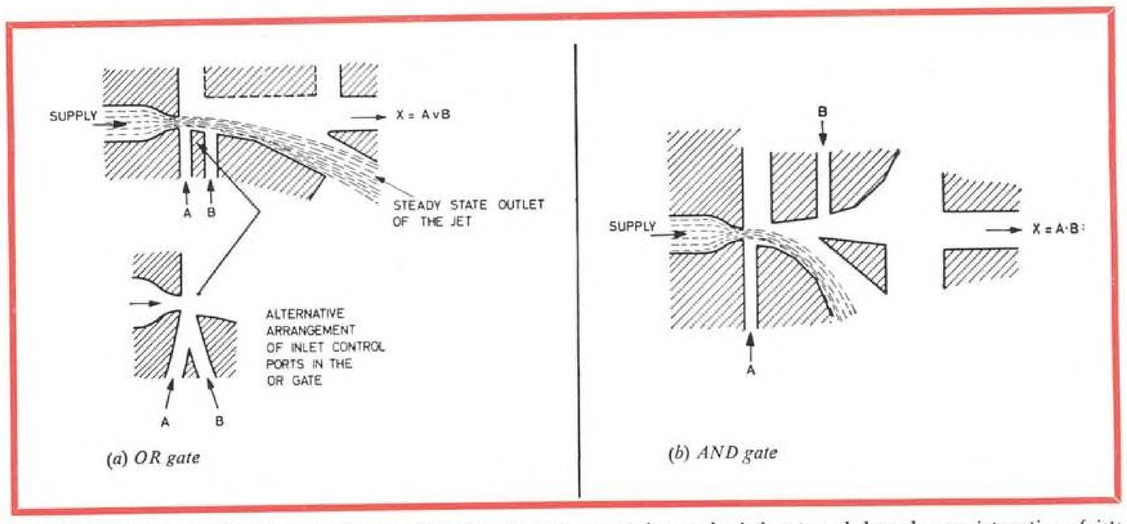
Tough Competition

Townes expressed agreement that the laser faces tough competition from existing communication links and that it would find use only where it can perform functions not now available or feasible with radio and telephone circuits. One such use suggested by Dr. Kingston was for spacecraft communications through the plasma produced by re-entry, which blacks out some radio frequencies, or for penetrating the hot rocket gases during landing of the Apollo Lunar Excursion Module (LEM) to use the laser as a radar altimeter.

In response to a question by Townes as to whether the nation was devoting adequate funds and manpower to lasers, Dr. Schawlow suggested that more effort was needed to apply existing know-how to operating systems. One example he cited was the need for more effort to scale up present lasers to higher powers.

Replying to a question from the floor as to whether it would be feasible to transmit electric energy in the kilowatt power levels by means of laser beams, Dr. Smith said it was "pretty remote."

He pointed out that with the conversion efficiency of present continuous-wave lasers an excitation power in the megawatt range would be required, posing serious cooling problems.



IBM CURRENTLY IS STUDYING hydraulic logic elements which have no moving mechanical parts and depend upon interaction of jets with boundary walls. In the OR gate (left), application of brief control pressure pulse at A or B will cause jet to swing and exit from X. In AND gate (right), control pulse at A and B simultaneously, but pulse at only one point will allow jet to exit at other points.

IBM Lab Taps European Science Skills

By Philip J. Klass

Zurich—International Business Machines' Zurich (Switzerland) Research Laboratory gives the company a communications interface with the European scientific community whose effectiveness ranges far beyond the modest size of its staff.

The 24 professional scientists on the IBM staff here are an international group, representing Switzerland, Germany, Britain, Canada, Sweden, Holland, and India, and with student scientists arriving during the summer from Denmark. Most of the scientists here came to the IBM Zurich Research Laboratory from European universities.

This provides contact with many additional top European scientists. In some instances the IBM Laboratory here carries out joint research tasks with universities or uses its extensive facilities to support research of academic colleagues whose facilities are limited. For example, the laboratory here is collaborating with Prof. Maier-Lebnitz of the Munich Technischen Hochschule in the preparation of thin-films of rare-earth metals.

The IBM Zurich Laboratory, directed by Dr. A. P. Speiser who came from the Swiss Federal Institute of Technology in Zurich, recently has moved into new quarters in Ruschlikon, a suburb of Zurich. Total employment is about 75, one-third of which are professionals. Present plans call for expanding the staff eventually to about 120 of which about 50 will be scientists.

The laboratory was organized by Dr. Speiser and opened in 1956 with a staff of five scientists.

Efforts of the laboratory are nearly equally divided between basic research and applied research, the former devoted to acquiring new knowledge which has no obvious application to IBM's product line while the latter is centered in basic technology suitable for data processing. This is reflected in the background of laboratory scientists. About half are physicists while the remainder are engineers by training, primarily electrical engineers, according to Dr. Harry Thomas, director of the technical staff—a special support group whose scientists are primarily theoreticians rather than experimenters.

Two of four operating sections of the laboratory are working primarily in applied research:

- **Thin magnetic film applications,** under Dr. Gerhard Kohn, is seeking to improve the magnetic thin-film memory developed here and announced in February, 1962. The memory disclosed at that time had a read-write cycle time of 100 nanoseconds (100 billionths of a second) and a capacity of 18,432 bits, the fastest memory of its size developed at that time.
- **Fluid dynamics,** under Dr. H. H. Glaettli, is conducting basic and applied research in hydraulic and pneumatic computer elements and amplifiers.

The two basic research groups in the laboratory are working in these fields:

- **Solid state physics,** under Claus Schuler, currently is investigating the optical constants of thin-films of rare-earth metals which exhibit ferromagnetic properties.
- **Magnetism,** Dr. Thomas is investigating basic principles of magnetism, partially in support of the thin-film memory applications group.

Program to investigate hydraulic logic elements was one of the first projects initiated six years ago at the Zurich laboratory by Glaettli. A variety of basic computer logic functions were developed using tiny valves cast or milled into plastic blocks. These exhibited response times of about one millisecond, enabling them to handle up to 500 pulses per second. Complete shift registers and binary counters were built from groups of such hydraulic logic elements.

While the hydraulic logic elements, like electric relays, are relatively simple and effective devices for performing computer functions, both suffer reliability problems because they involve many moving parts, according to Allan Mitchell, a British engineer in the fluid dynamics group here. To achieve rapid response, the hydraulic spool (piston) was fabricated from lightweight plastic which proved susceptible to wear. Tiny particles and chips resulting from such wear caused malfunctions in subsequent hydraulic stages by jamming their spools.

Several years ago the laboratory here shifted its efforts to hydraulic logic elements with no moving parts which operate by means of interaction between fluid jets and a stationary boundary wall. These elements make use of the "Coanda Effect" in which a moving fluid tends to attach itself to an adjacent wall.

Using this principle it is possible to fabricate a simple hydraulic bi-stable flip-flop, for example, in which an incoming fluid jet can be caused to exit from either of two output ports by applying a brief hydraulic control pulse at right angles to the jet. The fluid attaches to one wall and continues to exit from the selected output port until another brief hydraulic control pulse is applied which causes the jet to swing over and attach itself to the opposite wall exiting from the other output port.

Using this principle IBM has constructed an OR gate in which the presence of a brief pulse of fluid at either of two (or more) control orifices will divert the jet from its normal steady state output port to a signal output port. With only a slight modification of the wall construction, the device becomes an AND gate in which simultaneous presence of pulses from two or more control orifices will cause the jet to swing and emerge from the signal output port.

Because of the many factors which influence the interaction of the main jet and control orifices, including such things as jet velocity, shape of the adjoining walls, thickness and depth of the fluid channels and the unusual geometry required for control functions, a large part of the investigation must be carried out by experimentation rather than by mathematical analysis, according to Mitchell.

Effect of these many parameters is being investigated using the fluid equivalent of a wind tunnel in which dye of one color is used for the main jet while another is used for control orifice pulses. High-speed color motion pictures permit detailed study of fluid jet behavior.

The IBM scientists here concede that hydraulic or pneumatic computers are not likely to replace the electronic types for most applications. But they point out that the non-electronic type logic may be well suited for use in industrial or aerospace applications where hydraulic or pneumatic power is used for the process to be controlled. One such application might be rocket boosters where the fuel could be used for computation-control prior to serving its primary function.

The 100 nanosecond cycle time magnetic memory achieved by the IBM Zurich Laboratory a year ago represented such a major advance in speed that it has not been easy to achieve further improvements, although work is continuing toward that objective, according to Dr. Kohn who directs this effort.

Basic problem is not so much in the thin-film magnetic cells themselves but in the limitations imposed by the associated transistor circuitry used to store and read information out of the cells. While the present thin-film memory cells themselves have a cycle time of only five nanoseconds, they can only be pulsed once every 50 nanoseconds to avoid overheating currently available high-frequency transistors used as drivers.

Because read-out of the present cells destroys the stored information which requires a second pulse to restore it, the total operational cycle time is 100 nanoseconds. Additionally, recovery time of the transistorized sense amplifier also limits cycle time to about 100 nanoseconds, Dr. Kohn says.

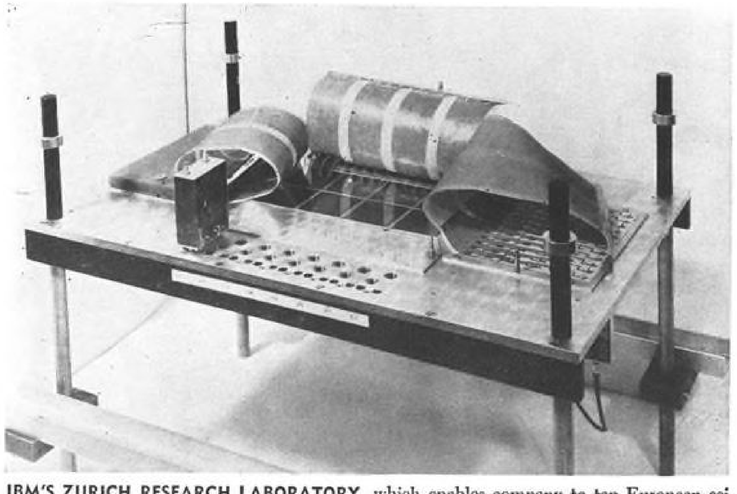
Present hopes are that the use of improved transistors and other techniques will make it possible to reduce the cycle time to 50 nanoseconds or less, he adds.

Although the group of 14 elements called the "rare earths" have long been known, until about 1950 these materials were available only in the form of oxides except for very expensive miniscule quantities. For this reason the basic physical properties of these unusual metals are not known. The modern physicist normally is denied the privilege and pleasure of probing a brand new metal, Claus Schuler points out. But the recent development of ultra-high vacuum techniques for refining the pure rare-earth metals and maintaining them free of oxide offers this unusual opportunity which the laboratory here is exploiting.

As students in beginning chemistry learn when they are exposed to the Mendelyeev periodic table of elements, the rare earths are grouped separately and apart from the remainder of the elements because their chemical properties do not conform to the periodicity of the others. Where most elements have identical inner shells of electrons and owe their different individual properties to different numbers of electrons in their outer shells, the rare earths have identical numbers of electrons in the outer shell but each has a different number of electrons in its inner shell. This gives each a slightly different magnetic property rather than a different chemical property.

In an effort to learn more about the rare-earth metals themselves as well as to gain a better insight into the basic mechanism of magnetism, which is easier to understand in the rare earths than in common nickel, the IBM Zurich Laboratory has begun to probe extremely thin transparent films of rare-earth metals with light, ranging in wavelength from ultraviolet to infrared at about six microns, Schuler says.

To maintain the metal in its unoxidized form, the thin film must be evaporated in a vacuum chamber maintained at a pressure of 10^{-10} mm. Hg. Initially a thin film about 500-Angstroms thick is deposited and polarized light at the selected wavelength is focused on the thin film while it is in the high vacuum, with measurements made to determine how much of the light is transmitted through the foil and how much is reflected. Measurements are made across the spectrum and then an additional layer of the metal is deposited and the experiment repeated. This continues until the thickness of



IBM'S ZURICH RESEARCH LABORATORY, which enables company to tap European scientific know-how, developed technology for this experimental high-speed thin-film memory having cycle time of only 0.1 microsecond (100 nanoseconds). Each of eight squares visible can store 2,304 bits of information. Driving and sensing lines of etched copper foil are curled away from magnetic film substrates to show construction. The Zurich laboratory also is active in hydraulic amplifiers and computer elements as well as conducting more basic research such as investigating "rare-earth" metals.

the foil is built up to the point where it no longer passes any light.

In experiments to date, the laboratory has made such measurements on gadolinium, with the next experiments planned for terbium. The experiment requires a month or more for each rare-earth metal.

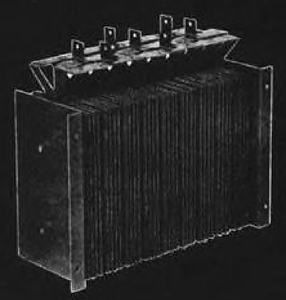
Whether or not these new metals will find any application in the field of computers or data processing is impossible to predict, the IBM scientists say. But it was the studies of basic properties of semiconductor materials at Bell Telephone Laboratories which led to the transistor. And if the IBM research here provides better understanding of magnetism, it may ultimately provide improved computer memories.

The scientists here are given wide latitude in their choice of projects, both by the local management and by IBM's Watson Research Center in Yorktown, N. Y., a freedom which is essential for creative scientists, according to Dr. Thomas. The major criteria is that the project be interesting and important unexplored territory which will reflect credit on the scientist and the firm.

Scientists here who came from European universities when asked how they like their new environment universally respond by commenting about the advantage of having the research facilities they need, a luxury not enjoyed in their former positions. Some say they miss the opportunity to teach and the stimulation of working with promising young students, but others comment favorably about being relieved of routine teaching duties to concentrate on research.

The establishment of research laboratories in Europe to tap its scientific knowledge is one means of avoiding the recent criticism raised in Britain over the loss of scientists to the United States and recent attempts to recruit still more (AW Mar. 25, p. 104). An increasing number of companies are setting up such facilities in Europe rather than attempting to transplant scientists.

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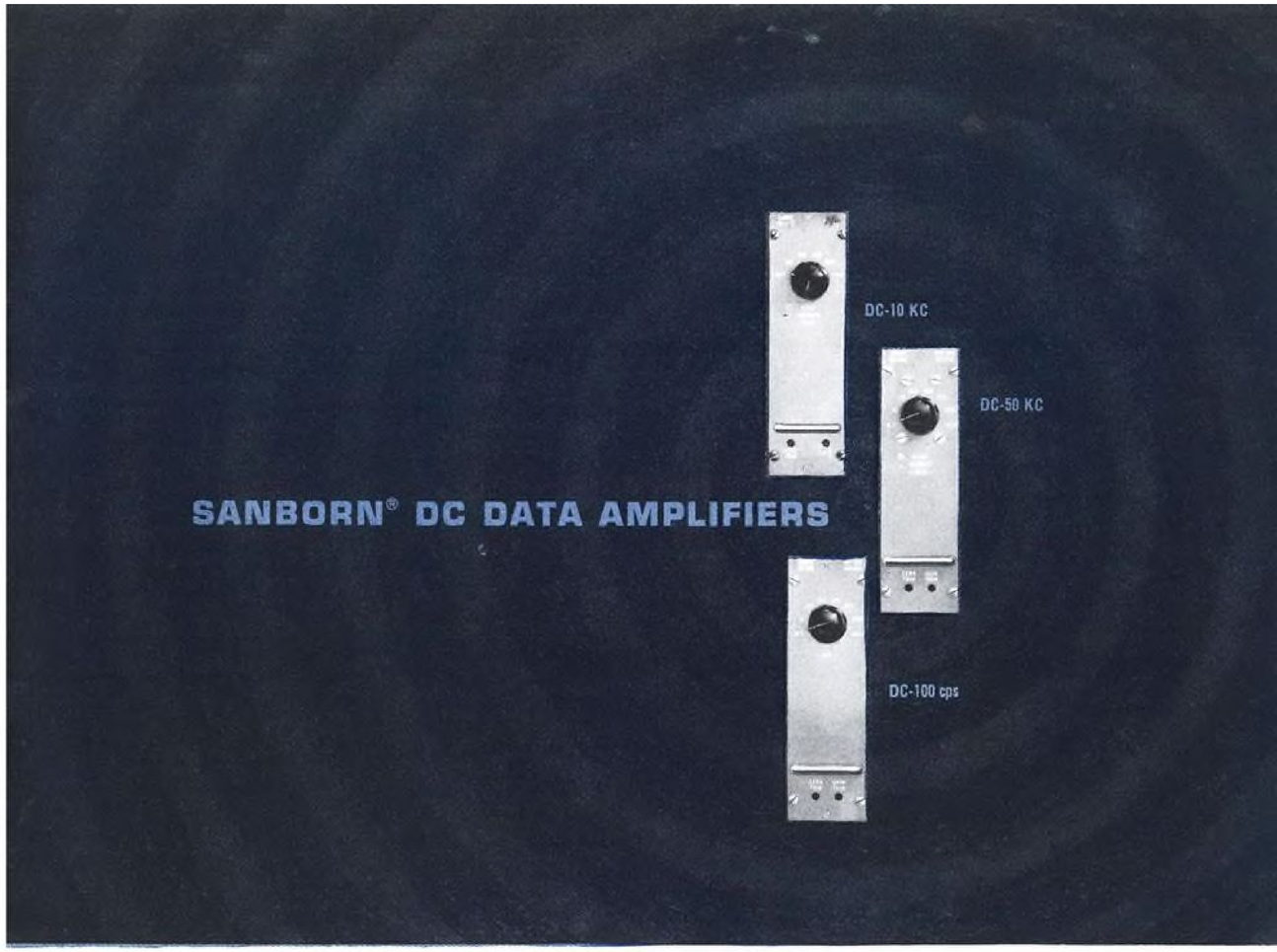
The rectifier stack illustrated is the semi-metallic type designed, built and warranted for three years by Miller Electric Manufacturing Company, Appleton, Wis. It's used in all Miller Gold Star Welders.

FILTER CENTER

► **Navy to Explore Next Decade's Avionics Need**—Program to develop a generation of avionics systems that will be used in aircraft the Navy expects to be adding to its fleet during the decade from 1970 to 1980 will be started soon by the Navy's Bureau of Weapons. Aircraft will be used for missions such as anti-air, strike and anti-submarine warfare and early warning missions. Avionics companies having experience in function integration, fault location, indication design, system and component maintainability design, mission effectiveness and semiconductor microcircuitry are being sought by BuWeps.

► **Computer Design of Microcircuits**—Industry proposals for an Air Force development contract aimed at achieving completely automated production of microcircuits using computers for design and control are being evaluated by USAF's Aeronautical Systems Division. The immediate objective of the effort will be to come up with a technique enabling masks and intraconnection needed in fabricating microcircuits to be designed in minimum time.

► **Marrying Microcircuit Techniques**—Lear Siegler, Inc., and National Semiconductor Corp., Danbury, Conn., have entered into an informal agreement to work together in developing hybrid microcircuits. National will supply Lear Siegler with semiconductor substrates containing necessary junctions for active devices, over which the latter will deposit passive thin film components. The two companies bid jointly on a recent Army microcircuit program, and may propose together on similar future procurements. Lear Siegler is interested in acquiring a semiconductor capability to complement its extensive thin film facilities (AW Feb. 25, p. 97), but it reportedly has not bought into National Semiconductor nor does it hold an option to do so.



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Noise	5 uv rms, DC-10 KC (ref. to input at gain of 1000)	7 uv rms, DC-50 KC (ref. to input)	1 uv p-p, DC-20 cps (ref. to input, at gain of 1000)
Input	Isolated from gnd. and output. Impedance 100 meg. min. at DC in parallel with 0.001 mfd.	Impedance 100 meg. at DC in parallel with 0.001 mfd.	Isolated from gnd. and output. Impedance 500K
Output	Isolated from input and ground. ±10 V at 10 ma. (—4000P has grounded output, ±10 V at 100 ma.)	±10 V at ±100 ma. Sustained short across output will not cause damage to amplifier.	Isolated from input and ground. ±5 V at ±2.5 ma. Part or all of internal 2K in parallel with 25 mfd. may be removed, connected externally.
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KAMAN UH-2A SEASPRITE rescue and liaison helicopter banks steeply during simulated rescue mission.



UH-2A LANDS ABOARD the nuclear-powered carrier USS Enterprise. Note white auxiliary fuel tanks on the side of the helicopter.

Aviation Week Pilot Report:

Kaman UH-2A Demonstrates All-Weather Capability, Maneuverability for Navy Roles

By David A. Brown

Bloomfield, Conn.—Maneuverability at speeds up to 150 kt. design limit, all-weather capability which permits near hands-off flight on landing approaches, and a Doppler navigation system to complement long-range capability are the outstanding features of the Navy's Kaman UH-2A (HU2K-1) rescue and liaison helicopter.

Now entering squadron service with the Navy both on the Atlantic and Pacific coasts, the UH-2A demonstrated its performance during a recent flight here with this AVIATION WEEK & SPACE TECHNOLOGY pilot flying from the co-pilot's seat.

The UH-2A demonstrated:

- **Simulated strafing runs** where angles of bank exceeded 90 deg. during high-speed turns, air-to-air combat with another helicopter, and a low-altitude high-speed run over a paved heliport followed by a pull-up into a high-speed climb.
- **Pictorial Doppler navigation system** designed to allow long-range navigation without reference to a ground station. System is completely airborne; AN-APN-130 Doppler radar is built by Ryan and the ASA-13A computer and PT-429 display board are built by Loral Electronics Corp.
- **Instrument approach** using automatic stabilization equipment and Doppler altimeter, which permitted the helicopter to be flown with hands off the collective control and with only trim adjustments on the cyclic. The helicopter automatically maintained a hover at 20 ft., then made a hands-off takeoff.

Planned originally as a high-speed, long-range liaison and rescue aircraft and later as an anti-submarine warfare helicopter (AW Oct. 26, 1959, p. 92), the UH-2A now is being pushed strenuously by Kaman in the forthcoming Army armed helicopter competition (AW Feb. 18, p. 26).

UH-2A Specifications

Length, stowed condition	36 ft. 8 in.
operating condition	52 ft. 3 in.
Tread	11 ft. 4 in.
Rotor disc	44 ft.
Height to tail rotor tip	14 ft. 8 in.
Engine	General Electric T58-GE-8B
Max. speed	150 kt.
Max. gross weight	10,000 lb.

The helicopter flown was a production version of the UH-2A with standard Navy equipment aboard, including two 60-gal. external fuel tanks.

Two divided tanks located beneath the main cabin contain a total of 276 gal. of fuel, of which about 274 gal. is usable. Of the 120 gal. in the external tanks, about 118 gal. is usable. This fuel gives the UH-2A an endurance of more than 5 hr. at maximum gross weight of 10,000 lb. and an endurance of 6¼ hr. at 7,000 lb. gross weight.

Kaman Test Pilot Alan Ashley flew in the right seat. Wind was 12-15 kt. from the west and it increased appreciably during the flight. Temperature was 41F and the dew point was 23F. Gross weight at takeoff was 8,275 lb., compared with a maximum gross weight of 10,000 lb.

The UH-2A taxies easily after slight up collective is applied. Taxi cannot be accomplished with the collective full down without tilting the rotor plane so far that the rotor head and mast could be damaged. With the collective raised slightly, UH-2A is easy to control on the ground and easily taxies backward.

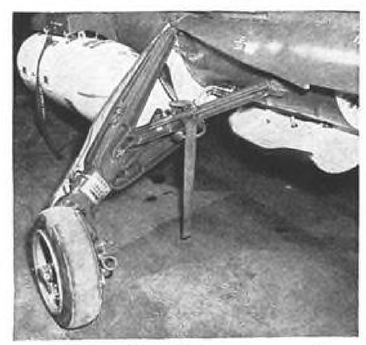
Engine speed was set for flight by use of the thumb beeper—minimum necessary is 92% engine and rotor speed—and the UH-2A lifted into a hover with only a slight upward movement of the collective.

With hydraulic boost on, the helicopter controls were exceptionally light and responsive. Initial tendency was to chase the helicopter with the controls, which caused it to oscillate in hover. By delaying control reaction, the pilot allows the helicopter to damp its own movements and it will hover steadily with little or no cyclic control.

Takeoff was made to the west. Because the UH-2A accelerates rapidly for a helicopter, it was somewhat difficult to estimate airspeed correctly. Frequent checks of the airspeed indicator showed the helicopter usually was traveling 5-20 kt. faster than it appeared to be. Gear was retracted below the 60-kt. retraction maximum. Actually, it may be safely retracted at speeds below 100 kt. New gear design permits higher maximum retraction speeds.

With the automatic stabilization equipment (ASE) off, the UH-2A was maneuvered at 100-120 kt. for familiarization. Flight in cruise configuration was accomplished with the torque meter stabilized at 65 psi.

First impression of the UH-2A, designated the Seasprite by the Navy, is that it has a high and comfortable operating speed with a noticeable lack of vibration, particularly at the higher end of its speed regime. Speed of about 120 kt. is where the helicopter seems to operate best in cruise and it is quite comfortable to fly in this speed regime.



NEW LANDING GEAR design permits retraction at speeds of up to 100 kt. Auxiliary tank is hung on bomb shackle-type fittings.

Controls remain light all the way through the speed regime with boost on. Boost off, the controls are heavy, but not unmanageable. A slight kick was noted when the boost was turned off, caused by the hydraulic actuator being shut down.

Maximum continuous climb was entered after reducing forward airspeed to about 50 kt. and the UH-2A climbed at 3,100 fpm. Limiting factor was turbine inlet temperature, which was held to 630F.

After leveling off at 2,500 ft., autorotation was entered. Airspeed was increased to more than 100 kt. by lowering the nose and vibration level remained low.

During autorotation, the UH-2A showed a tendency to have a rather high rate of descent, although one autorotation was purposely made fast and the others were into a stiffening wind.

Ashley selected a farm field—tree-bordered and with a tower-supported power cable—and demonstrated the UH-2A's high-speed maneuverability with a series of simulated strafing runs. First pass was made at approximately 150 kt. IAS down to an altitude of about 15 ft., followed by a pullup into a steep wingover and a return pass at



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Bendix Radio Division THE Bendix CORPORATION

the same field. Turn radius at the end of each pass was short and pressed to the point where the first indications of grayout appeared. Bank angles exceeded 90 deg. Although the UH-2A had no gunsight, a point on the ground could be held steady with reference to the windshield.

Low-altitude maneuvering was demonstrated by making a high-speed 140-150 kt. run through an area of broken woods, maneuvering through open areas. Bank angles at times approached 60 deg.

Engine torque meter indicated 75 psi. during portions of this demonstration, about 6 psi. above the maximum for continuous operation, but 8 psi. below the 30-min. military rating limitation.

A high-speed, low-altitude run then was made on the Kaman experimental hangar heliport. Speed over the paved area was 150 kt. and altitude was estimated at 3-5 ft. At the end of the pass, the UH-2A was pulled into a steep climb, trading speed for altitude, and rate of climb reached 4,200 fpm.

Another UH-2A was encountered after climbout and a simulated firing run was made, approaching the second helicopter from its right forward quarter. The second helicopter turned right and dived beneath us and Ashley responded with a 360-deg. climbing turn to the right, coming out about 300 ft. above the second helicopter and several hundred yards to his rear. Range was closed by going into a shallow dive to pick up speed and evasive turns were countered by turning inside their radius.

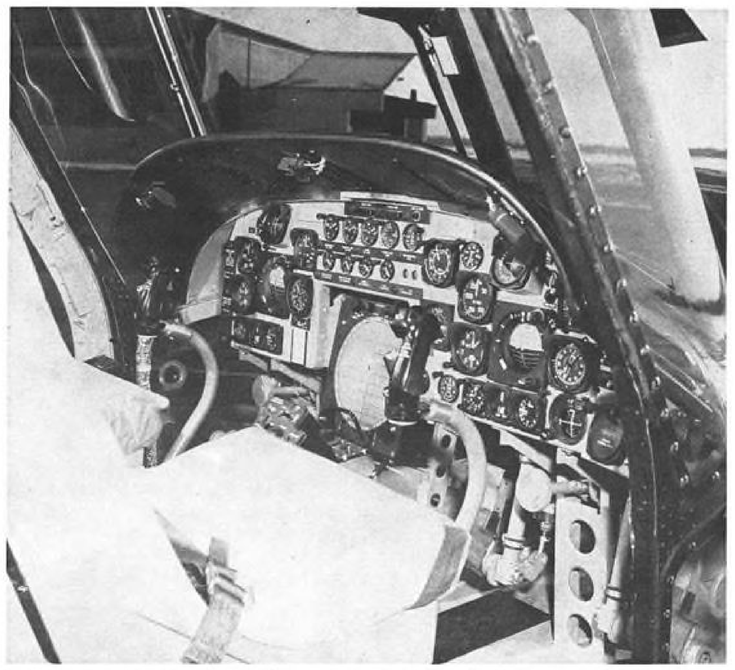
The second helicopter was near treetop level which prevented it from diving away. Rapid scissor maneuvers would have made sighting and firing difficult at longer ranges, but range eventually was closed to a point where these evasive maneuvers would have been of little value.

All-Weather Demonstration

After following several turns, Ashley broke away to the left and returned to the heliport for a demonstration of the UH-2A's all-weather capability. ASE was engaged via a switch on the center control console. Amplifier of the ASE receives aircraft attitude, airspeed, heading, altitude and groundspeed information and control inputs from trim switches and the pilot's flight controls. It then feeds inputs to the flight control system through a hydraulic actuator to maintain airspeed or groundspeed, roll attitude and heading.

The system is effective at all altitudes and airspeeds, including hover. Overriding the ASE system may be done by the pilot at any time without disengaging it by using flight controls or trim switches.

Besides being able to select airspeed or groundspeed hold, the pilot may choose either the radar altimeter or the



INSTRUMENT PANEL of the UH-2A is designed for all-weather operation, with flight instruments grouped in front of each pilot. Tactical display plotting board is in center, with engine gages above it. Note deep glare shield. Collective head, visible over pilot's seat, has fuel and trim controls.

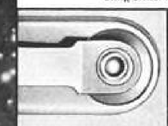
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American Gyro



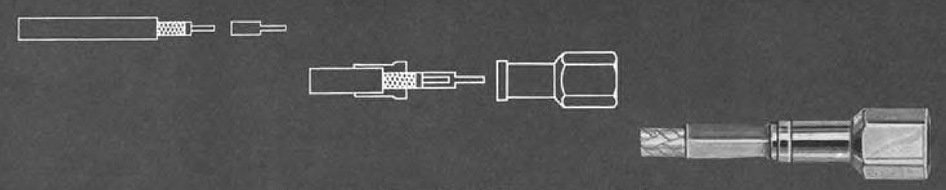
35,000+ hours' reliability on T-38 in flight!

Wiancko Engineering



Simplify static testing with this new high-level transducer

Stoddart Aircraft Radio



Assembles in 45 seconds!

Tamar: three typical contributions to electronics

Tamar Electronic Industries, Inc., is creating advanced electronic devices and systems for both industry and the military. Among the recent achievements of three of the corporation's divisions and subsidiaries are: AMERICAN GYRO — provides Northrop's USAF T-38 supersonic twin-jet trainers with miniature rate gyros which have achieved a reliability in excess of 35,000 hours in flight. WIANCKO ENGINEERING — simplifies static testing with a high-level transducer which drives galvanometer recorders, strip-chart recorders, and automatic data systems directly. STODDART AIRCRAFT RADIO — offers the Tamar-created matched 50-ohm micro-miniature connector which assembles in 45 seconds and requires no soldering of contacts. For more information about Tamar's wide-range capabilities in electronics, please contact Robert Case, vice-president of marketing.

TAMAR ELECTRONICS INDUSTRIES, INC.
California Headquarters: 1360 South Los Angeles Street, Anaheim, California

barometric altimeter to supply altitude information to the ASE amplifier.

Ashley flew a simulated instrument approach with the radar altimeter engaged using the command indicator on the radar altimeter to control a constant rate descent from 200 ft. to 20 ft.

Turns were made by depressing the coordinated turn command button on the cyclic stick and then using the cyclic to bank the helicopter. ASE automatically maintained a coordinated turn, without need for rudder pedal inputs, as long as the turn button was depressed.

Speed corrections were made by simply tapping the pitch trim thumb beeper on the cyclic and the helicopter was brought to a hover above the heliport. Collective control was not touched during the descent and the radar altimeter provided a smooth, constant rate of descent.

Melting snow had covered the heliport with a shallow pool of water. Since the Doppler radar failed to receive accurate signal returns from the water's surface, the helicopter had a tendency in hover to settle until the rotor downwash disturbed the water sufficiently to provide an uneven surface for accurate radar returns. The UH-2A then would climb to its pre-set altitude, where the downwash no longer affected the water and settling would begin again. This effect was not noticed when the helicopter was hovering over asphalt or other solid surfaces.

Radar Altimeter

Radar altimeter is most effective below 200-ft. altitude and at airspeeds of 80 kt. or less. Above 200 ft., its sensitivity is decreased to the point where it is not accurate. Forward speeds greater than 80 kt. will introduce a false climb signal into the Doppler radar return and cause the aircraft to fly below its set altitude. This is inherent in the design and was not the result of an out-of-adjustment set.

Groundspeed information comes from the helicopter's Doppler radar. System was devised to allow a helicopter on a plane-guarding mission to follow a steaming carrier at a fixed speed, regardless of changes in wind velocity.

With the ASE engaged, yaw trim switch, located on the collective head, may be used to make minor changes in direction, usually about 3 deg. or less. Normally it is used to change trim forces on the rudder pedals. These forces on the pedals are trimmed out automatically if the helicopter is making a heading change of less than approximately 3 deg. per second. Movement of the pedals with ASE engaged will disconnect the heading hold signal being received from the gyro compass.

After coming to a hover at the end of the approach, takeoff was made by changing the pitch trim to a nose down attitude, allowing the helicopter to build up forward speed and increasing the altitude command set into the radar altimeter. UH-2A climbed out to 200 ft. altitude at a slow but constant rate climb.

Accuracy of the self-contained Doppler navigation system was displayed by setting the indicator bug, a small point of light encircling an arrow which shows heading, on the cross indices at the center of the tactical display plotting board.

Information is transmitted to the computer group of the system from the Doppler radar, the gyro compass and the airspeed indicator. By correlating information from the three, the system gives the pilot information on wind direction and speed when he is without visual reference.

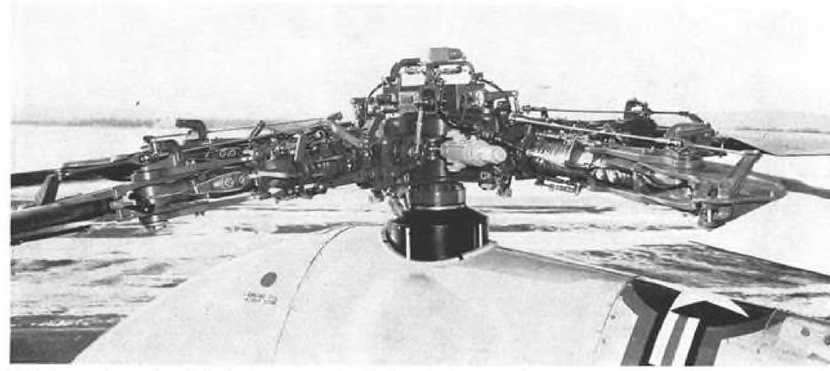
For about 30 min. the helicopter was flown without reference to the navigation system, during which time some high-speed maneuvering was done, with rapid course reversals.

Later, the helicopter was flown with reference to the navigation bug alone until the bug was centered on the indices. Helicopter was then over the original starting point. Error, if any, was too small to be detected with the eye.

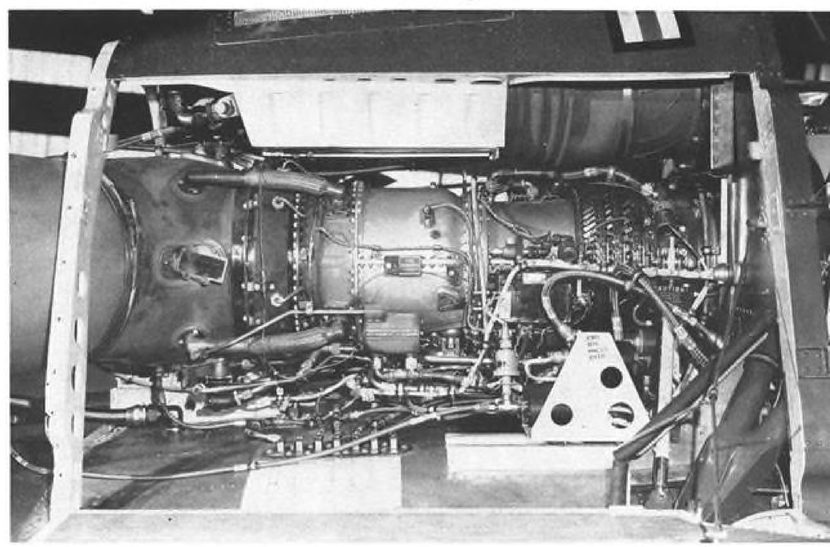
Display Board

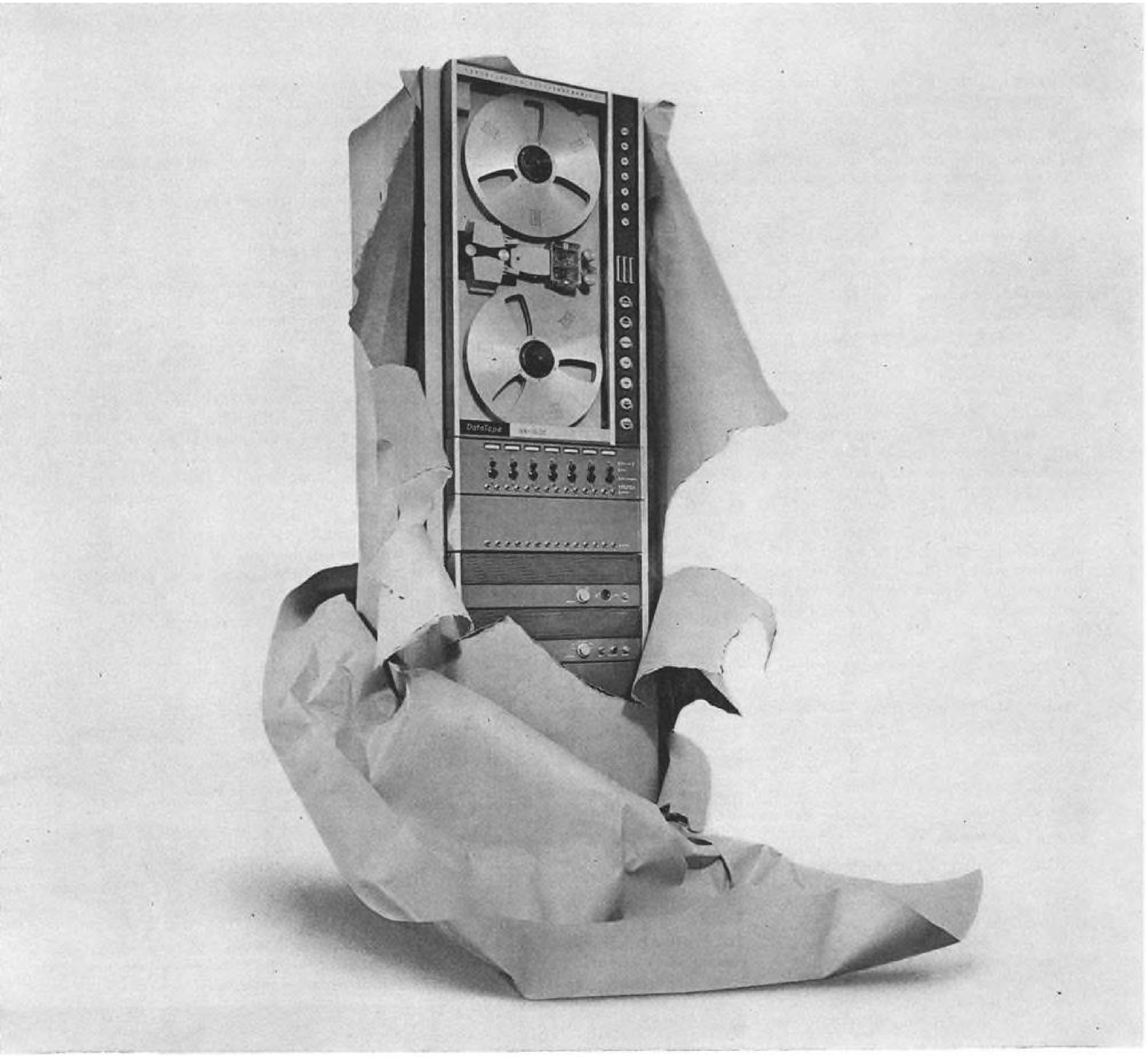
Three scales may be selected for the display board—10, 25 and 100 naut. mi.—and the grid pattern which divides the board into 10ths both vertically and horizontally may be rotated through 360 deg. Bug may be moved to any starting position, so that the helicopter can be flown with reference to a map overlay. Bug also can be made to hold its position.

If the Doppler radar malfunctions, or if a good return is not received, the system will operate from memory of the last good signal and a warning light will inform the pilot of this. He may then manually introduce wind and drift



ROTOR HEAD (above) includes automatic blade tracking mechanism, and blade-folding equipment as well as control linkages. General Electric T58-GE-8B (below) is mounted above cabin. Drive shaft extends forward from rear of engine to rotor shaft.





Who's delivering 1.5 mc recorders to working specs?

(CEC. That's who)

Here's the *first* 1.5 mc recorder sold to *working* specifications — CEC's VR-3600. This means specs that are practical from the *users* viewpoint—all met with one set-up of the tape system, not with separate adjustments before each test.

It's been proven with units built and delivered in quantity.

And the VR-3600's outstanding specifications make it a "state-of-the-art" system, with performance superior to any comparable instrumentation in the extremely wide bandwidth, multi-channel field. Each of the unit's 7 or 14 record/reproduce channels can be used for data storage in the 100 kc to 1.5 mc frequency range . . . with high signal-to-noise and low distortion characteristics.

The direct system has a full 1.4 mc bandwidth, fully amplitude and phase equalized, with less than 2% harmonic distortion. No intermodulation product exceeds 0.75%, and phase response is held to within 0.2 usec.

In the tape transport, skew is under —.30 usec., flutter is less than 0.30% p-p at 120 ips, tape is constantly cleaned by a vacuum/ionization device and tension is held smoothly constant by a closed-loop servo.

Contact your local CEC sales representative, or write for Bulletin 3600-X10.

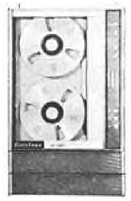


Data Recorders Division

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2 more ways to measure with CEC



You get twice the bandwidth capability of conventional machines at equivalent speeds with two other CEC wide band tape systems, the VR-3300 portable and the VR-2800. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0 to 20 kc with wide band FM techniques. They're designed to fill gaps between the workhorse 100 kc models and more sophisticated machines. Solid state for greater inherent reliability, CEC's VR-2800 and VR-3300 feature standard EMA rack mounting and can be used in the lab, van, ship or blockhouse. Both systems are available for 7 channel (½" tape) or 14 channel (1" tape) operation. Interchangeable electronics means economy in support spares.

Further data? Call CEC or write for CEC Bulletins 2800V-X23 and 3300V-X16.



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information to increase accuracy. Magnetic variation information is normally introduced manually. System needs about 30 min. warmup time.

Kaman considers that the most pressing problem in the development of high-speed helicopters is the elimination of vibration, particularly at higher airspeeds and the UH-2A is noticeably free of vibration, especially above 100 kt.

Foldable Rotors

Four-bladed foldable main rotor system has an automatic blade tracking system to keep blades in track during flight and eliminate or reduce vibrations caused by out-of-track blades. If the automatic system malfunctions, blades can be tracked by the pilot from the cockpit in flight. Both single-blade tracking and differential cone tracking may be done.

Blade tracking control panel is located on the cockpit overhead and can control either C or D blade singly up or down or B and D blades collectively up or down. Blade A is the master blade and remains fixed. Blades are lettered clockwise. Guard circuit de-energizes the tracking systems if the vibrations caused by the blades being out of track exceed .15g.

One blade was untracked during the flight with the manual system until the vibrations were quite noticeable in the cockpit. Automatic system was then turned on and vibrations were quickly reduced to normal, or very nearly negligible.

Ashley attempted to de-energize the system by working the collective up and down to produce a strong out-of-track vibration, but the system detects only vibrations on the frequency of one per rotor revolution, and he was unable to find the right frequency.

System operates only when weight is off the landing gear and when the airspeed increases to more than 50 kt. It is shut down if the airspeed is decreased to less than 25 kt.

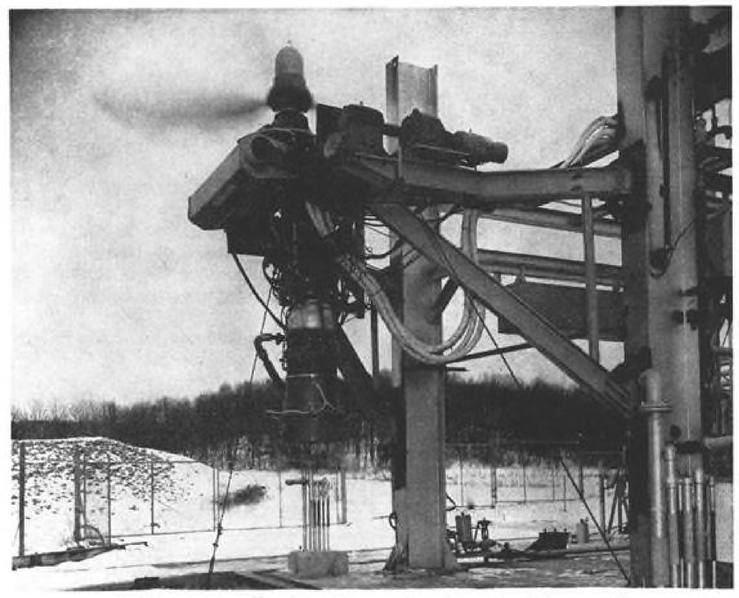
Main Rotor

Main rotor is composed of the rotor hub, four blade retention assemblies and four blades with flapping and lead-lag hinges. Lead-lag hinges have hydraulic dampers. Hub is bolted to the rotor shaft. Rotor tip speed is about 648 fps. at 100% rpm., or 278 rpm.

Blades are constructed of an aluminum alloy spar with glass-fiber ribs at the trailing edge and glass fiber-covered honeycomb blade pockets. Blades have an electrical de-ice system.

Blade folding is manually done. Simple locking device releases each blade and allows it to swing back to the folded position. Blades do not rotate about their longitudinal axis when they are folded so that there is relatively little chance of them being caught by the wind.

Final demonstration was a run-on



XC-142A's Engine Attitude-Tested

General Electric T64-GE-6 turboshaft engine, scheduled for installation in the Vought-Hiller-Ryan XC-142A VTOL transport (AW Jan. 14, p. 60), has been tested over a range of attitude angles at the GE test site at Peebles, Ohio. Design angle range for the engine varies from 100 deg. nose up (above the horizon) to 45 deg. nose down. Engine is rated at 2,850 shp. Four will be installed in the XC-142A.



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EC-121K Modified for Ocean Research

Lockheed Navy EC-121K Super Constellation, modified by Lockheed Aircraft Service Co., will be used by the Naval Oceanographic Office. Aircraft will be used to collect data as part of a network of station vessels, moored buoys and fleet units. Airplane will carry an infrared sea surface temperature measuring device, air-launched expendable bathythermographs, wave height indicators, radiometers and temperature-pressure-humidity recorders.

landing at about 70 kt. to show high-speed ground characteristics. Helicopter touched down gently and rolled several hundred feet across the paved heliport before being lifted off again. Landing gear absorbed the shocks during the roll well and there was no noticeable bumping.

Cockpit of the UH-2A is arranged for instrument flight, with a large glare shield placed over the instrument panel.

Flight instruments, including gyro attitude indicator, dual needle radio magnetic indicator (RMI) and radar altimeter, are grouped in front of each pilot's seat. In addition, the pilot's (right) side had DME, groundspeed drift-angle, groundspeed direction-velocity (hover) and Tacan indicators.

Engine gages are centered above the Doppler tactical display plotting board and each pilot has an individual engine torquemeter.

Central console contains avionics switches. Landing gear, parking brake and emergency jettison handles are located along the right side of the console. Cabin overhead panel contains circuit breakers, warning light panel and various other switches. Tail wheel lock lever and rotor brake are positioned to the right of the overhead.

Start procedure is similar to other turbine-engine helicopters. Rotor brake is placed on and tail wheel locked in a fore and aft position before engine start. Circuit breakers, light switches, hydraulic system generators, fuel system, emergency switches and landing gear control comprise the pre-start check list.

Twist grip throttle on the collective is turned to off and the starter trigger located on the underside of the pilot's collective is energized.

When the gas producer section of the General Electric T58-GE-8B turboshaft engine reaches 18-20% rpm., the twist grip is rotated to the idle position. Ignition should occur by the time the gas producer section has reached 23% rpm. Starter should be released by the time the gas producer section speed is up to 46%.

Rotor brake interlock prevents the throttle from being rotated to the fly position before the brake is released. Once the engine has advanced to 90% rpm., it is controlled by a thumb switch (beeper) on the collective head.

AFOSR Awards

Air Force Office of Scientific Research recently awarded grants and contracts totaling approximately $4.5 million to universities and research firms in the United States and Europe:

Contracts:

Midwest Research Institute, Kansas City, Mo.—$40,383 for research on panel flutter of cylindrical shells.

Aeronautical Research Associates of Princeton, Princeton, N. J.—$23,095 for experimental study of turbulence in driven vortices.

Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.—$74,831 for investigation of high-temperature phenomena in hypersonic flows.

Martin Marietta Corp., Baltimore, Md.—$40,942 for investigation of effect of vacuum environment of mechanical behavior of materials.

Thiokol Chemical Corp., Denville, N. J.—$49,988 for research on solid-propellant spectroscopic tracing methods.

Electro-Optical Systems, Inc., Pasadena, Calif.—$107,872 for study of physical phenomena associated with magnetogasdynamic acceleration.

Radiation Applications, Inc., Long Island City, N. Y.—$39,782 for study of radiation-initiated solid-rocket propellant decomposition.

Rocket Power, Inc., Mesa, Ariz.—$60,753 for investigation of chemical synthesis with monoenergetic ions.

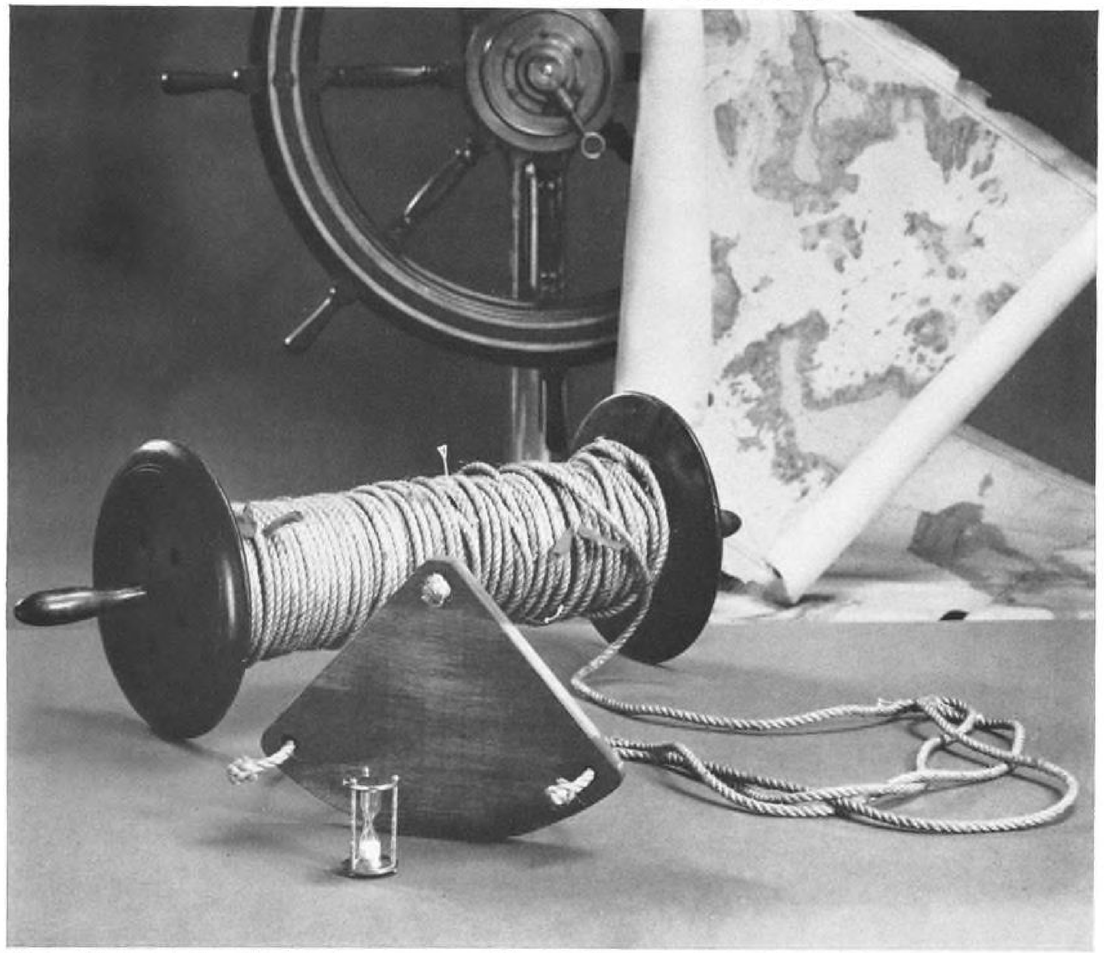
Avco Corp., Everett, Mass.—$297,714 to study properties of collisionless plasmas.

IBM, Yorktown Heights, N. Y.—$22,000 for logical-linguistic studies for machine text perusal.

Sperry-Rand Corp., Blue Bell, Pa.—$21,265 for optimization and standardization of information retrieval language and systems.

Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.—$39,580 for study of inductive methods in language analysis; $9,771 for research on machine translation

FROM CHIP LOG TO ACCELEROMETER



Chip Log (19th Century)—The earliest device known to measure a ship's speed. The chip was attached to a line knotted at specific intervals and drawn through the water during a measured 30 seconds. The knots were then counted, indicating the nautical miles per hour the ship was making. (Dossin Museum)

AC ACCELEROMETERS—These instruments measure the linear acceleration of missiles, aircraft, space vehicles and ocean vessels and convert this information into velocity data. This and other computed data are compared to the vehicle's predetermined course, sensing any deviation from the intended line of motion.

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Our record proves our ability to develop and produce precision guidance system components, and to deliver them on time, at low cost. We welcome the challenge to prove our capabilities and solve your guidance problems. Contact Director of Sales, AC-Milwaukee.



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Pioneer-Central Division THE Bendix CORPORATION

of speech into orthographic English.

Herner and Co., Washington, D. C.—$19,498 for study of indexing procedures and mechanisms.

Optics Technology, Inc., Belmont, Calif.—$31,932 for study of diffraction and coherence phenomena in optical waveguides.

University of Milan, Milan, Italy—$27,400 for study of properties of surfaces and dislocations in alkali halide crystals.

University of Leuven, Louvain, Belgium—$28,800 for investigation of the influence of high pressure of the electrical properties of germanium.

University of Stockholm, Stockholm, Sweden—$62,600 to study high-energy interaction involving antiparticles.

University College, National University of Ireland, Cork, Ireland—$15,300 for microwave investigation of ionization in gaseous discharges; $11,970 to study microwave spectroscopy in the millimeter region; $20,400 to investigate the thin elastic shells, elastic plates, pile groups, magnetic films and boundary layer effects in ion-linear bending of plates and shells; $12,880 for structural and biosynthetic studies of the phycobilins.

Training Center for Experimental Aerodynamics, Brussels, Belgium—$10,000 for mathematical analysis of the problem of re-entry at supercircular velocity; $10,000 for investigation of optimization of recovery trajectories for space vehicles; $49,426 for experimental investigations in low-density aerodynamics.

Grants:

University of Pittsburgh, Pittsburgh, Pa.—$6,692 to investigate atropine detoxication during hypothermia by the isolated perfused rat liver.

University of Michigan, Ann Arbor, Mich.—$20,530 for investigation of selective factors in perception and cognition.

Bryn Mawr College, Bryn Mawr, Pa.—$26,972 for investigation of somatosensory factors in the performance of proximate distance judgment.

University of Delaware, Newark, Del.—$18,200 for study of effects of changes in group composition on group performance.

Antioch College, Yellow Springs, Ohio—$31,466 to conduct comparative studies of vigilance.

University of North Carolina, Chapel Hill, N. C.—$37,535 for investigation of Bayesian models for individual decision-making.

University of Illinois, Urbana, Ill.—$21,754 to study techniques for minimizing forgetting.

Harvard College, Cambridge, Mass.—$6,583 for study of probability statistics and mechanics.

Institute for Advanced Study, Princeton, N. J.—$18,480 for symposium on differential topology.

West Virginia University, Morgantown, W. Va.—$22,478 for development and application of numerical quadrature in applied mathematics.

Kansas State University, Manhattan, Kan.—$20,378 for investigation of synthesis and chemistry of acetals and mercaptals of formyl halides.

Georgetown University, Washington, D. C.—$21,310 to conduct a study of the reaction of metallic ions.

Oklahoma State University, Stillwater, Okla.—$21,708 for investigation of nucleophilic displacements on trivalent phosphorus.

Reed College, Portland, Ore.—$22,460 for investigation of reaction rate studies of gaseous unimolecular isomerizations.

Purdue Research Foundation, Lafayette, Ind.—$27,300 for preparation and study of properties of nitronic esters.

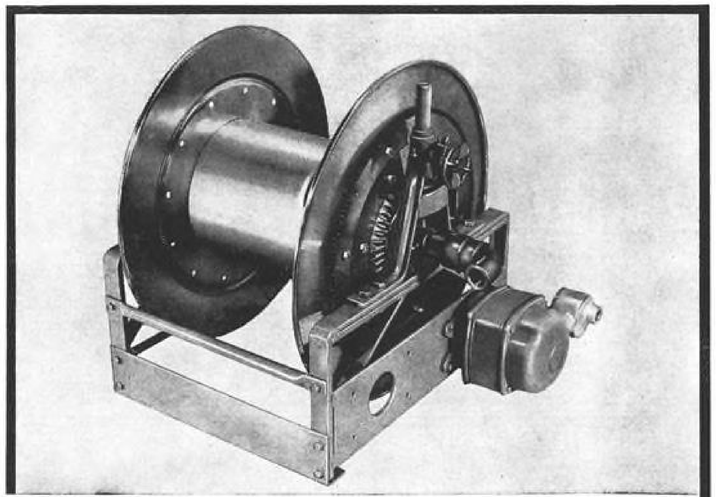
University of Miami, Coral Gables, Fla.—$31,979 for studies in the cyclobutane series.

Lawrence College of Wisconsin, Appleton, Wis.—$26,550 for investigation of surface states in pure palladium.

Oregon State University, Corvallis, Ore.—$20,483 for investigation of oxidation-reduction reactions of organic sulfur compounds.

North Dakota State University, Fargo, N. D.—$22,530 for investigation of solvent extraction behavior of inorganic complexes.

University of Washington, Seattle, Wash.—$42,240 for study of equilibria and preparative methods for boron and silicon compounds.



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PROBLEMATICAL RECREATIONS 165



The planet Octerra is divided into eight countries, each occupying an octant, (thus each country borders three others). In how many ways can a traveler visit each of the other countries once and only once, returning to his home country only at the end of his trip?

—Contributed

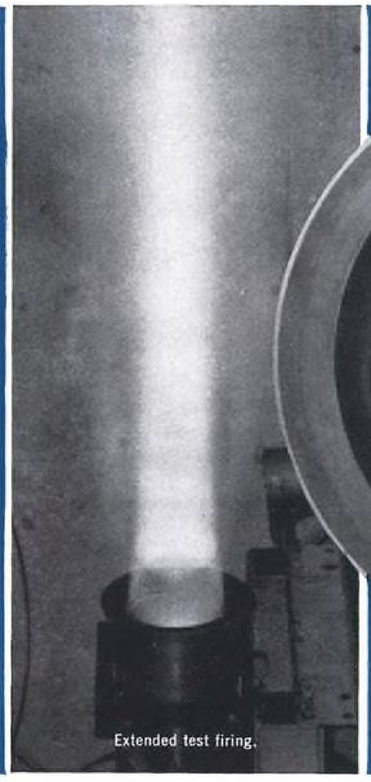
Complete specifications and photographs covering 200 products (60 are new!) are included in a new, quick reference catalog from our Electron Tube Division. You'll find unclassified magnetrons, klystrons, TWT's, millimeter wave tubes, M-BWO's, beam switching tubes, crossed field amplifiers, CRT's, fiber optic tubes, power supplies and tube-related equipment. Ask for this 36-page 1963 Summary of Products and Review of Capabilities from the Marketing Department, 960 Industrial Road, San Carlos, Calif.

ANSWER TO LAST WEEK'S PROBLEM: The smallest integral solution satisfying the given conditions is a = 25, b = 16, c = 39.

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Beverly Hills, California

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DURABLE, THROTTLEABLE, LIGHTWEIGHT


Thiokol all-ablative chamber.


Extended test firing.


No dimensional change.

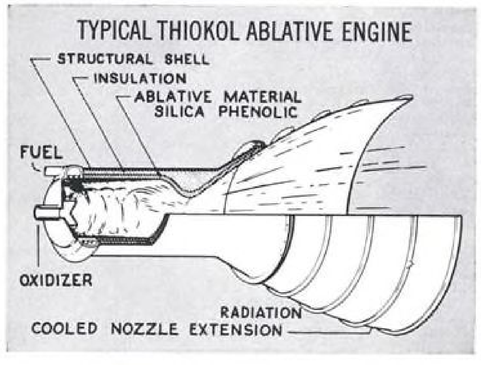
Performance proved above 97% theoretical in multiple tests by Thiokol

Using advanced injection techniques, plus the newest rocket-engineered chamber materials, Thiokol is making important progress in ablative technology.

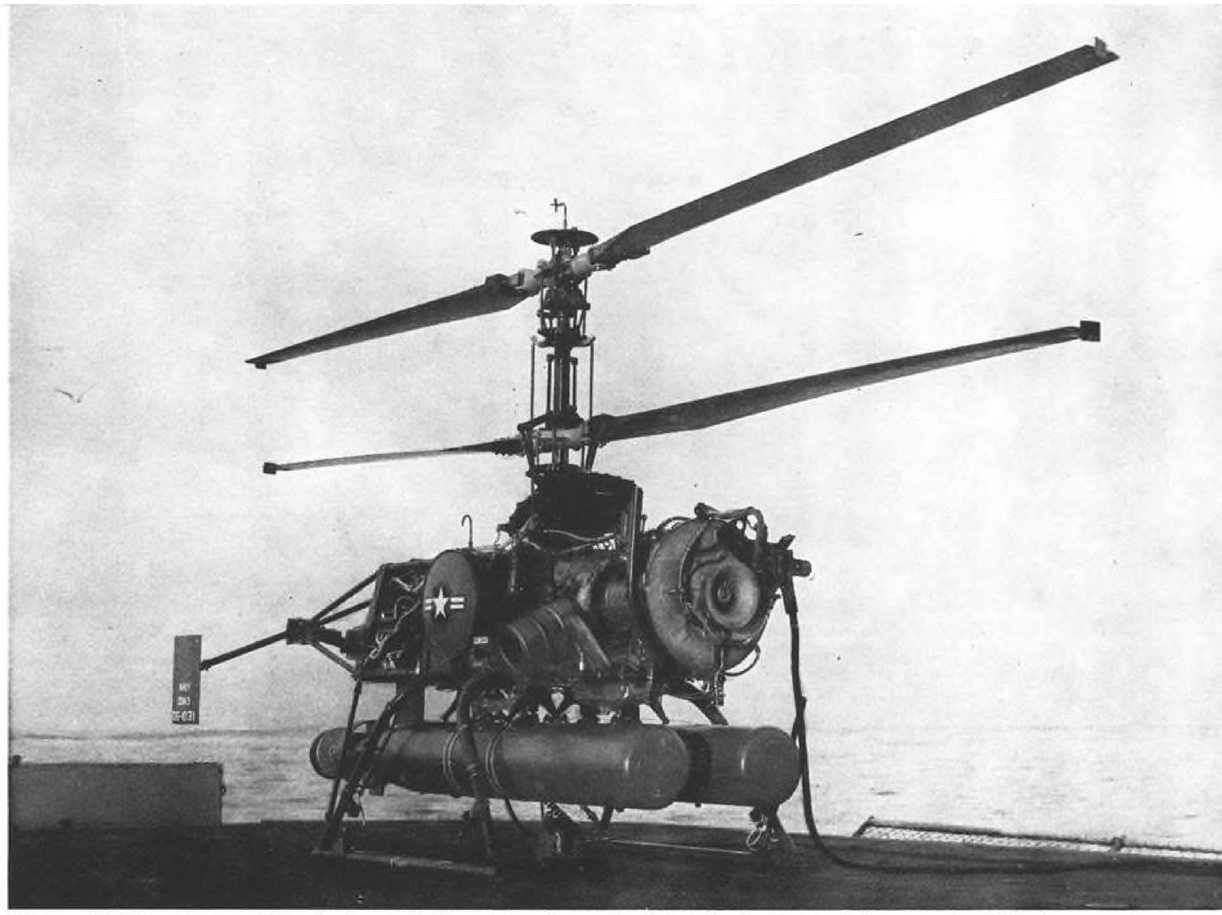
One all-ablative engine has already been fired over 14.5 minutes. Another—an ultra-lightweight space version throttleable over a 40:1 range—was successfully tested at chamber pressures and combustion temperatures of actual lunar operations. Both engines remain suitable for continued service. Ablation rates are exceptionally low and performance, consistently above 97% theoretical.

Their unique throttling injector—providing maximum propellant recirculation, mixing and combustion stability—delivers high performance durability. There is no chemical or thermal streaking of the ablative liner.

The Thiokol engines are 20% lighter than comparable ablative systems of conventional design. *Ablatalite*—a castable, low density insulating material developed by Thiokol—saves many extra pounds in engine weight.



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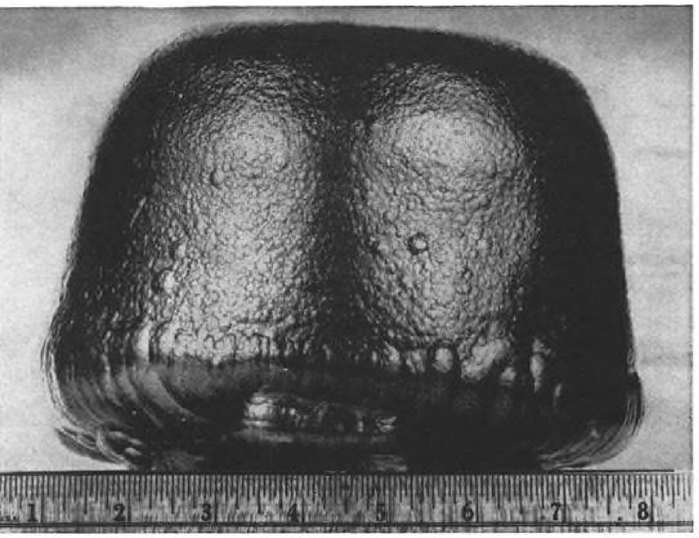
Gyrodyne DSN-3 remote controlled anti-submarine helicopter recently completed operational evaluation flights at sea aboard the destroyer USS Hugh Purvis. DSN-3, part of Navy's DASH (destroyer anti-submarine helicopter) program is equipped with two homing torpedoes.

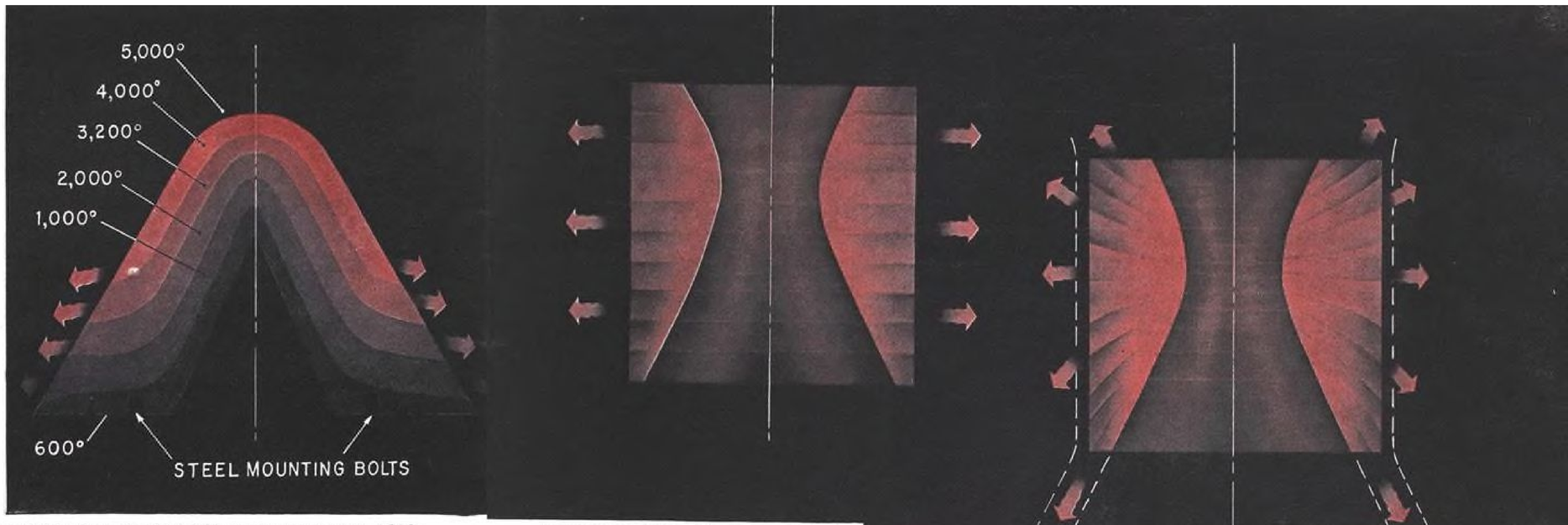
DSN-3 ASW Helicopter Completes Destroyer Tests

Helicopter is controlled from two stations aboard destroyer. ASW vehicle is controlled back to ship by radar until visual contact is made.









SOLID PIECE OF PYROLYTIC GRAPHITE (left) was formed without a mandrel by Space Age Materials' plasma spray process. Thickness of conventional vapor-deposited pyrolytic graphite has been limited to under 1¼ in. in plates and less in coated structures. Pyrolytic graphite nose cone (right) proposed by Space Age Materials for Boeing's X-20 program would have sides 4¼ in. thick with heat conducting planes directed outboard near the base. Thickness of the structure and direction of heat planes would allow fastening with steel bolts.

New Pyrolytic Graphite Formation Method

By Ward Wright

New York—New concept in the formation of pyrolytic graphite structures which could allow nose cone, thrust nozzle, and hypersonic leading edge designers extreme flexibility in directing heat flow is being evaluated by Jet Propulsion Laboratory, Marquardt Corp., and Allegany Ballistic Laboratory.

New method involves formation of pyrolytic graphite structures with heat-conducting planes tailored to the specifications of the designer. First solid-propellant test firing last month of a small pyrolytic graphite thrust nozzle made by the new technique was successful. The firing, by one of the contractors, lasted 40 sec. and reached 5,700F, after which no throat erosion was found.

The pyrolytic graphite material, called "Pyroid," is manufactured by Space Age Materials Corp. here.

Pyrolytic graphite's directional heat-conducting property stems from the high degree of orientation of its crystal lattice. That is, crystals of pyrolytic graphite are aligned in layered parallel planes like plywood.

Heat flows readily along the planes due to the tightly bonded atomic structure in this direction. Between the planes, where attractive forces are weak, heat flow is severely restricted. As with plywood, pyrolytic graphite has great tensile strength along the parallel planes and great compressive strength across the planes, while lengthwise compression of the planes causes fracturing and buckling.

Because of pyrolytic graphite's properties of being an excellent heat conductor in one direction and a very poor one in the other, and its strength above 5,000F, the material offers designers a means of channeling heat away from such hot spots as solid-rocket throats and nose cones with a considerable weight saving and better heat distribution than with metallic or composite metallic-ablative structures (AW Feb. 13, 1961, p. 67).

Several problems have restricted designers and kept the material from reaching its full potential, however. To date, there are no operational flight systems employing pyrolytic graphite in either nozzle or nose cone applications. Research is continuing, and efforts are being made to eliminate these problems.

Progress has been made in identification of the causes, direction and magnitude of thermal and residual stresses peculiar to pyrolytic graphite. Recent achievements center around designing to take advantage of stresses to provide structural integrity or to avoid harmful stresses.

Conventional vapor-deposition method of forming the material imposes a further design restriction. In vapor deposition, pyrolytic graphite is deposited in parallel planes on the inside or outside of a mandrel by decomposing a hydrocarbon gas at temperatures of 1,900 to 2,200C in a vacuum furnace.

Mandrel, usually made of commercial graphite, determines the direction of the heat-conducting planes and the shape of the deposit. The mandrel either shatters from stresses during the deposition process, or has to be broken away from the pyrolytic graphite structure.

Despite progress in stress analysis, quality control and elimination of flaws, present thickness of commercially available pyrolytic graphite formed by the vapor-deposition process is less than 1¼ in.

Space Age Materials' president, Michael Turkat, says that his firm has developed a proprietary plasma-spray process to form pyrolytic graphite structures. Turkat says the process, developed with $190,000 in company funds over the past three years, represents a complete departure from the vapor-deposition method and can control these characteristics of pyrolytic graphite:

• **Thickness.** Pyrolytic graphite structures can be formed in any thickness, Turkat says, limited only by the size of the plasma-spray equipment. To date, the largest single piece of plasma-formed pyrolytic graphite is about 7 in. in diameter. Since the plasma-spray process does not necessarily require a mandrel, it is possible to machine structures from solid chunks of pyrolytic graphite if so desired

• **Crystal orientation.** By not being solely dependent on a mandrel for crystal orientation and shape, Turkat says, the plasma spray allows planes of crystal lattice to be deposited in any direction desired.

• **Strength between planes.** Turkat says his process can be utilized to form a "lock-in" effect between parallel planes of pyrolytic graphite. This can minimize the tendency to delaminate under stress. The lock-in effect is achieved by forming the crystalline planes in an overlapping "S" pattern. Since the parallel planes overlap, the material's tensile strength is conveyed across the planes to resist delamination.

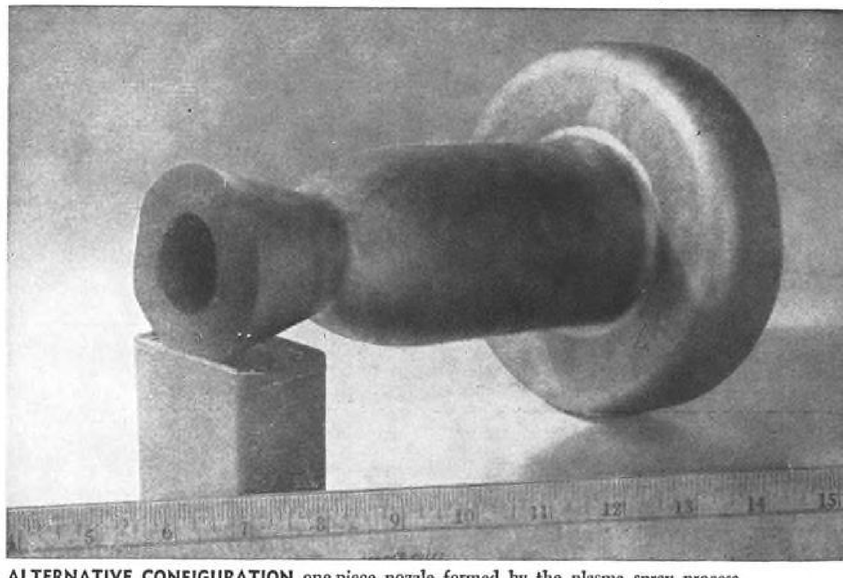
• **Alloys.** Metals such as boron, tungsten, hafnium and others can be alloyed with plasma-formed pyrolytic graphite in gradient amounts throughout the structure, according to Turkat. While this capability exists with vapor-deposited pyrolytic graphite, he says, the thicknesses now available should give designers more freedom to capitalize on the advantages of these promising materials.

• **Stresses.** Plasma-formed pyrolytic graphite is subject to the same stress problems associated with the vapor-deposited material. However, Turkat says his firm, like others, has learned to minimize the effect of these through design. Additionally, massive pyrolytic graphite structures formed by the plasma method should be better equipped to survive the effects of stresses than the thinner structures formed by

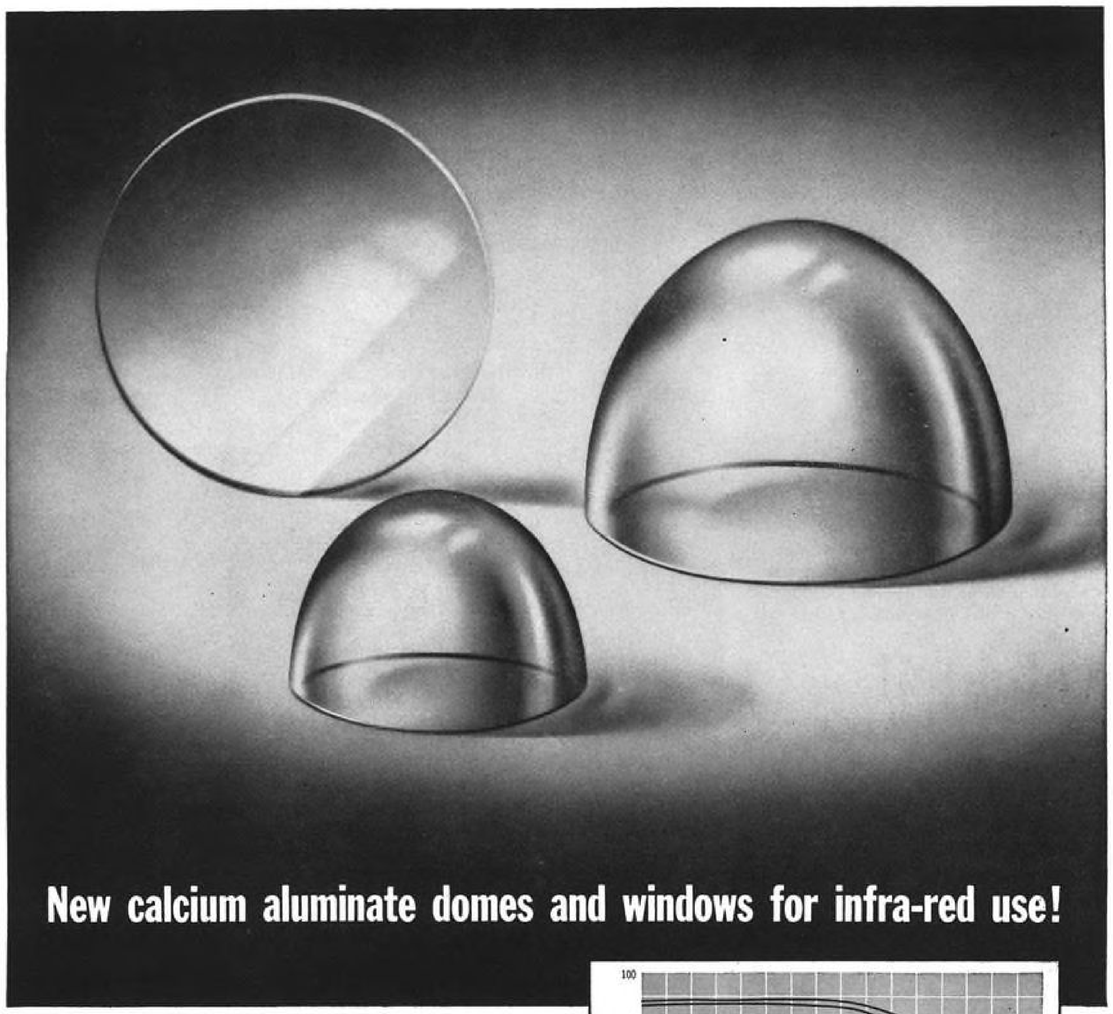
NOZZLE CONSTRUCTED from a stack of bonded or fastened pyrolytic graphite washers machined from flat plates has been tested with good results. Heat flow is radial.

Evaluated

CROSS SECTION of a one-piece plasma-formed nozzle recently fired with success, shows heat conducting planes directed toward the skirt, casing and from the throat. Design gives better heat distribution and eliminates bonding problems of the washer stack design.



ALTERNATIVE CONFIGURATION one-piece nozzle formed by the plasma spray process has concentric heat-conducting planes which faithfully follow the shape of the structure. Heat flow is primarily toward the skirt and casing. Skirt thickness is about ⅞ in.



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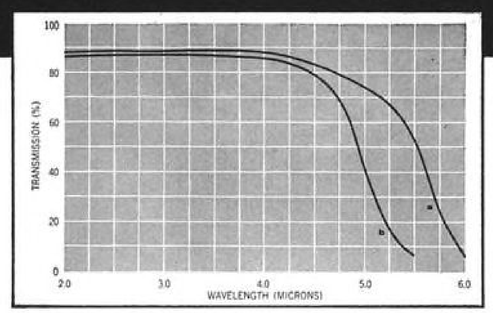
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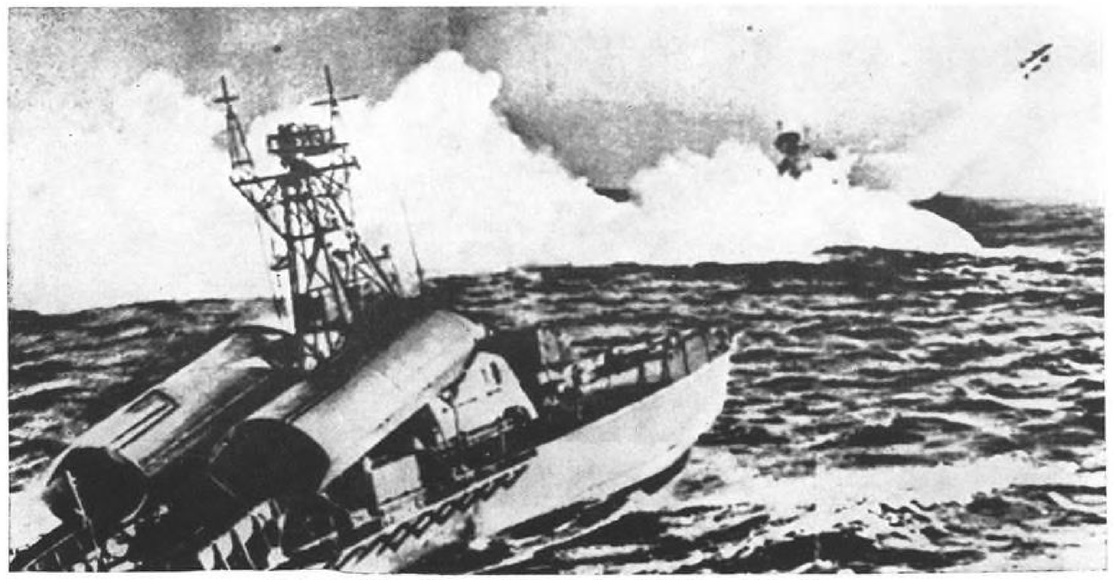
Outstanding mechanical properties! Barr & Stroud Calcium Aluminate glasses are very hard (6 on Moh's scale) and highly resistant to abrasion and thermal shock. They can be used at temperatures up to 800°C. A specially developed protective coating not only guards the glass against attack of water but also increases its transmission by reducing reflection.

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Soviet Gunboat Fires Anti-Ship Missiles

Soviet Komar-class gunboat is shown firing missiles in tests conducted in the Soviet Union. Gunboats are equipped with two missile launchers. Missiles have a range of approximately 15 mi., and are used primarily as anti-ship weapons. The same type of gunboats were reported active in the waters around Cuba (AW Feb. 18, p. 31).

the vapor-deposition process, according to Turkat.

In typical nozzle applications, vapor-deposited pyrolytic graphite is used in one of two ways. First method consists of coating a commercial graphite nozzle liner with pyrolytic graphite. Heat flow is mainly toward the top and bottom of the nozzle, as dictated by the mandrel.

Throat area cracking and delamination have been encountered in this design with the bond between the commercial and pyrolytic graphite due to the different expansion coefficient of the two materials.

Another approach is to deposit pyrolytic graphite in flat sheets, cut it into washers and stack it into a structure from which a nozzle can be machined. Problem here is in holding the washer stack together during firing. Washers have been bonded with an adhesive and fired with good results.

Present approach is to combine adhesive bonding with bolts running through the washer stack. Bolts could be encased in cylindrical insulating or ablative sleeves to protect them from heat.

Advantage of the plasma-formed nozzle over the washer stack variety, Turkat says, is that the former structure can be machined from one massive piece of pyrolytic graphite, eliminating adhesive bonding of washers and the necessity of bolts running through the stack.

Also, the heat-conducting planes in the plasma-formed nozzle can be directed toward the skirt, easing, and radially from the throat for better heat distribution. Heat flow in the washer nozzle is primarily in a radial direction from the throat.

Nose cone recently proposed by Space Age Materials for Boeing's X-20 (Dyna-Soar) boost glider would consist of a solid pyrolytic graphite hollow cone, 16 in. thick at the base and about 11 in. high, formed with pyrolytic graphite 4¼ in. thick.

Heat-conducting planes would taper back from the apex, parallel with the cone, to a spot 4¼ in. from the base. At this point, the heat-conducting planes would curve toward the outside of the cone to radiate heat into the atmosphere.

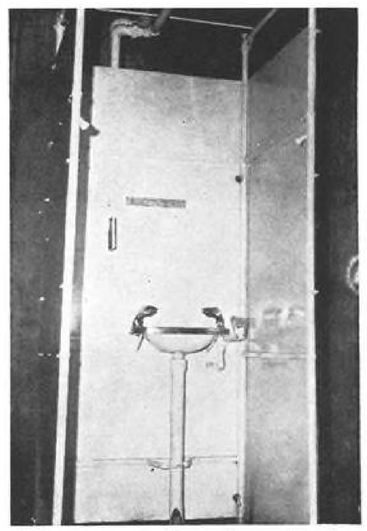
Cone would be held to the fuselage with steel bolts. Small, conical pyrolytic graphite plugs with heat-conducting planes extending from the apex to the base would be inserted between each bolt and the outside of the cone to conduct ambient heat away from the bolts.

Atlas D Phaseout

Atlas D, earliest deployment of U. S. inventory of ICBMs, is projected to be phased out of the operational force by the end of 1965 as solid-propellant Minuteman missiles are built up to replace them.

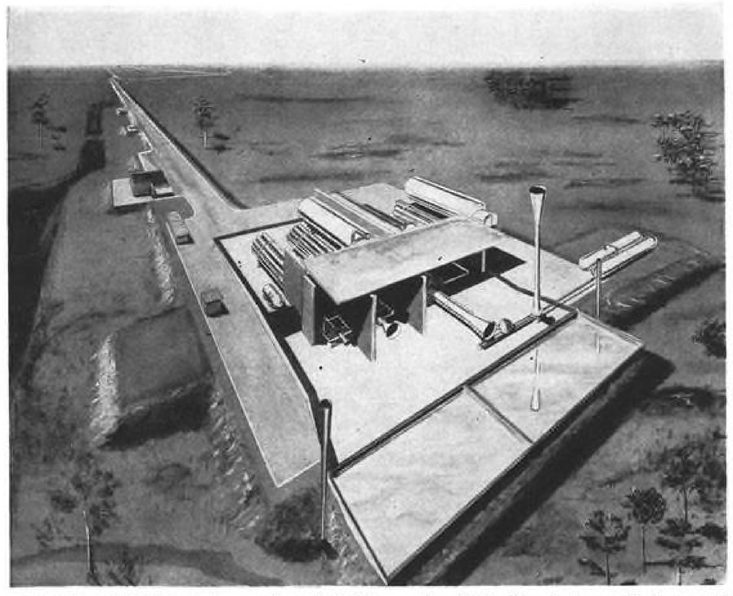
Probability is that phaseout of the Atlas D will be followed by phaseout, by the end of 1967, of the semi-hardened Atlas E, and both the hardened Atlas F and Titan 1, which have to be raised from their silos to the surface for launch.

This would leave Minuteman and Titan 2, both launched from hardened silos, as the U. S. ballistic missiles force.



Decontamination Unit

USAF is using portable decontamination stations at its Little Rock, Ark., Titan 2 site in areas where hazardous missile propellant are handled. Unit, manufactured by Speakman Co., Wilmington, Del., is suspended from a trailer boom.



ARTIST'S CONCEPT of the new Pratt & Whitney Aircraft liquid rocket propellant research facility at West Palm Beach, Fla., shows the three test bays for low- medium- and high-thrust engines. High-pressure propellant reservoirs are installed in back of the stands. A variety of fuel and oxidizer combinations will be tested at the new facility. Test bays will be able to accommodate engines of 1,000-lb., 10,000-lb. and 50,000-lb. thrust, respectively. Bays will have closed-circuit television systems for visual observation of engine test runs. The facility is being constructed as an addition to the company's West Palm Beach center and will cost approximately $4 million. Completion of facility is expected this fall.

P&W Building Rocket Research Facility

High-pressure liquid propellant rocket engine research facility, now under construction at Pratt & Whitney Aircraft's West Palm Beach, Fla., Research and Development Center will be capable of handling a wide variety of cryogenic and non-cryogenic fuels. The facility, being built as an addition to the company's extensive Florida center, is expected to cost about $4 million and should be finished by this fall.

Three test bays in the facility will be able to accommodate rocket engines with chamber pressures of 3,000 psi. and thrusts up to 1,000 lb., 10,000 lb. and 50,000 lb. respectively. Engines mounted in the medium- and high-thrust horizontal stands will be fed from common fuel, oxidizer and additive tanks under 5,000 psi. The low-thrust stand will be fed from two sets of propellant reservoirs, one under 5,000 psi. and the other under 300 psi. for low pressure tests.

Tanks will be capable of handling all known liquid propellants, according to Pratt & Whitney, a division of United Aircraft Corp., including fluorine, diborane, hydrazine and hydrogen, and will be of double-wall, vacuum-jacketed construction.

Data acquisition system will consist of about 100 channels on each stand, interconnected by a patch network. Each bay also will contain a closed-circuit television system for visual observation of engine test runs.

The company listed 10 areas of research that will be conducted at the new facility: propellant combinations performance; combustion stability; injectors; combustion chambers, preburners and gas generators; heat transfer; nozzle performance; ignition; shock vectoring; propellant and materials compatibility and propellant storability.

Windows for Gemini Shipped to McDonnell

Washington—Corning Glass Works has shipped the first set of Gemini spacecraft window panels to McDonnell Aircraft Corp. for testing.

The windows consist of three layers of glass of different thicknesses. Outer and middle panels are made of 96% silica glass, and the inner panel is made of aluminosilicate glass. All of the panels are oblate.

Outer panel is 17.28 in. by 8.33 in. and is 0.33 in. thick. The other two panels are 15.3 in. by 7.6 in. Middle panel is 0.38 in. thick, and the inner panel, 0.22 in. thick.

Countdown For Apollo Detailed

Cape Canaveral, Fla.—Details of the Saturn-Apollo launch countdown were presented recently by Maj. Rocco A. Petrone, chief of the heavy space vehicle systems office in the National Aeronautics and Space Administration's Launch Operations Center here.

Maj. Petrone, an Army officer on loan to NASA, said that the countdown would begin on launch day-minus-one with the loading of 1.3 million lb. of RP-1 fuel aboard the S-1C booster of the three-stage Saturn 5 launch vehicle.

Then, on launch day, the countdown will proceed as follows:

- Prior to T–7 hr.—all ordnance such as escape towers, squibs and pyrotechnic devices, will be connected and the hypergolic reaction control system fuel loaded aboard the spacecraft and the S-4B third stage.
- T–5-7 hr.—loading of liquid oxygen will begin aboard the three-stage launch vehicle, starting with the third stage and working down toward the booster. It will take 32 min., including 12 min. for pre-cooling, to load liquid oxygen aboard the S-4B at a rate of 1,000 gpm. S-2 second stage will require 25 min., including 6 min. of pre-cooling, for liquid oxygen-loading at a rate of 5,000 gpm. S-1C will require 40 min., including 11 min. of pre-cooling, for loading oxidizer aboard at a rate of 10,000 gpm.
- T–5 hr.—loading of liquid hydrogen fuel will begin aboard the S-2 and S-4B stages. Total hydrogen fill time will be about 1 hr., with about 30 min., including 10 min. for pre-cooling, allotted for the S-4B and 35 min., including 10 min. for pre-cooling, for the S-2 stage. Fill rate of the S-4B will be 3,000 gpm. and of the S-2, 10,000 gpm. Topping of all tanks will continue up until the moment of launch.
- T–4 hr.—Three Apollo pilots will board their spacecraft. This operation will take about 135 min.
- T–105 min. until T–0 sec.—Final checks of all systems, booster and spacecraft.

S-1C booster is expected to burn for about 150 sec., placing the upper stages and Apollo at an altitude of 40 mi. and a velocity of 5,200 mph. S-2 stage then will separate and burn until about T+540 sec., placing the third stage and capsule at an altitude of about 115 mi. with velocity of about 15,000 mph. Third stage then will burn to inject both itself and the spacecraft into low earth orbit. Mission requirements then will dictate further burning of the S-4B.

Sud Aviation specifies Sundstrand for the new Caravelle Super B



The Sud Aviation Caravelle, now in service with 17 airlines, is proving to be one of the most efficient of the new short-haul commercial jets. The latest model—designated Caravelle Super B—will incorporate many innovations, including Sundstrand Constant Speed Drives to power the a-c electrical system.

The constant speed drive that will be supplied for the Caravelle Super B is similar to the unit flying on other P&W fan-engine-powered jetliners and transports. Due to the reduced accessory installation area of the fan engine, this drive with an integral all-attitude reservoir has been designed to meet a compact envelope requirement and allow a minimum unit weight. FINNAIR will be the first airline to adopt this improved configuration, which is scheduled for delivery in 1964.

Sundstrand Constant Speed Drives are utilized on most major commercial jet aircraft operating today. Over 12,500,000 flight hours have been accumulated on units flying on 707, DC-8, and 720B aircraft. Throughout the world, Sundstrand equipment provides reliable, efficient performance to more than 35 airlines representing some 20 different countries.

If you are designing electrical systems for future or existing aircraft, *contact Sundstrand Aviation, or . . .*

If you plan to attend the Paris Air Show, June 6-16, 1963, be sure to visit the Sundstrand Booth C70, where the latest type of constant speed drives and cartridge-pneumatic starters will be exhibited.

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Philadelphia Gear Drives

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PRODUCTION BRIEFING

Bendix Corp.'s Mishawaka Div., Mishawaka, Ind., has been awarded a $25-million Navy contract for research and development of the medium-range, surface-to-air Typhon missile system, which will be the next generation missile system for fleet defense.

Ralph M. Parsons Co., Los Angeles, Calif., has been awarded an architect-engineering design contract from North American Aviation's Space and Information Systems Div. for the Apollo Engine Test Facility at White Sands, N. M.

United Technology Center, Sunnyvale, Calif., will conduct laboratory scale research on combustion phenomena of beryllium under a $48,090 contract from Air Force's Office of Scientific Research. Program will include burning of aluminum and beryllium vapor in various oxidizing gases.

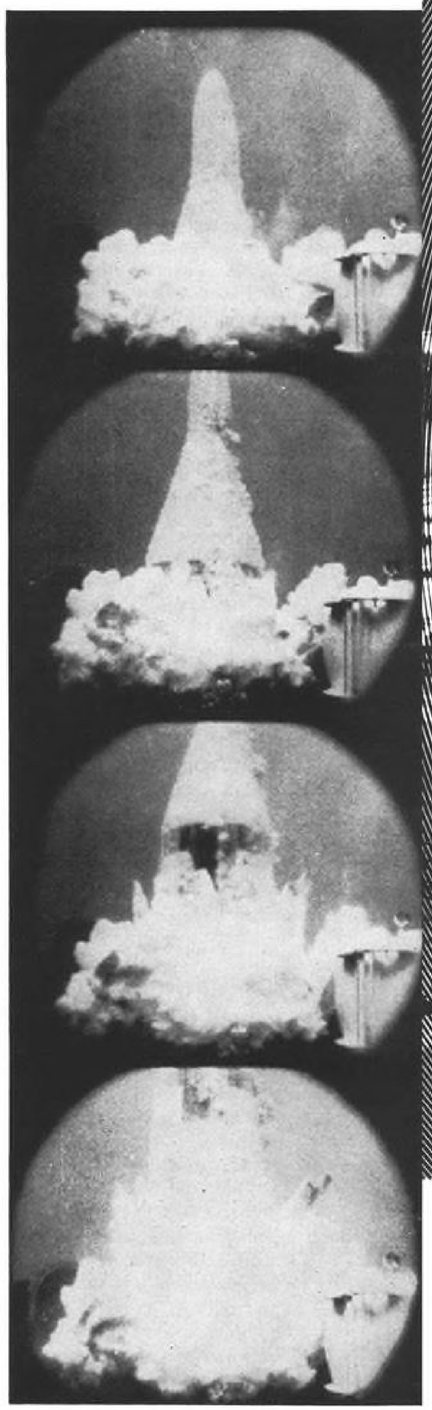
Radio Corp. of America's Data Systems Div., Van Nuys, Calif., will build 300 chassis for use in Minuteman's D-17 airborne digital computer. Work is financed by a $1-million contract from North American Aviation's Autonetics Div.

Northrop's Ventura Div., Newbury Park, Calif., has received a $1,365,000 Navy contract for production of KD2R-5 radio-controlled target drones for use in anti-aircraft gunnery and surface-to-air missile training.

Maxson Electronics Corp., Great River, N. Y., has received a $9-million Navy contract for continued production of the Martin-developed Bullpup air-to-surface missile.

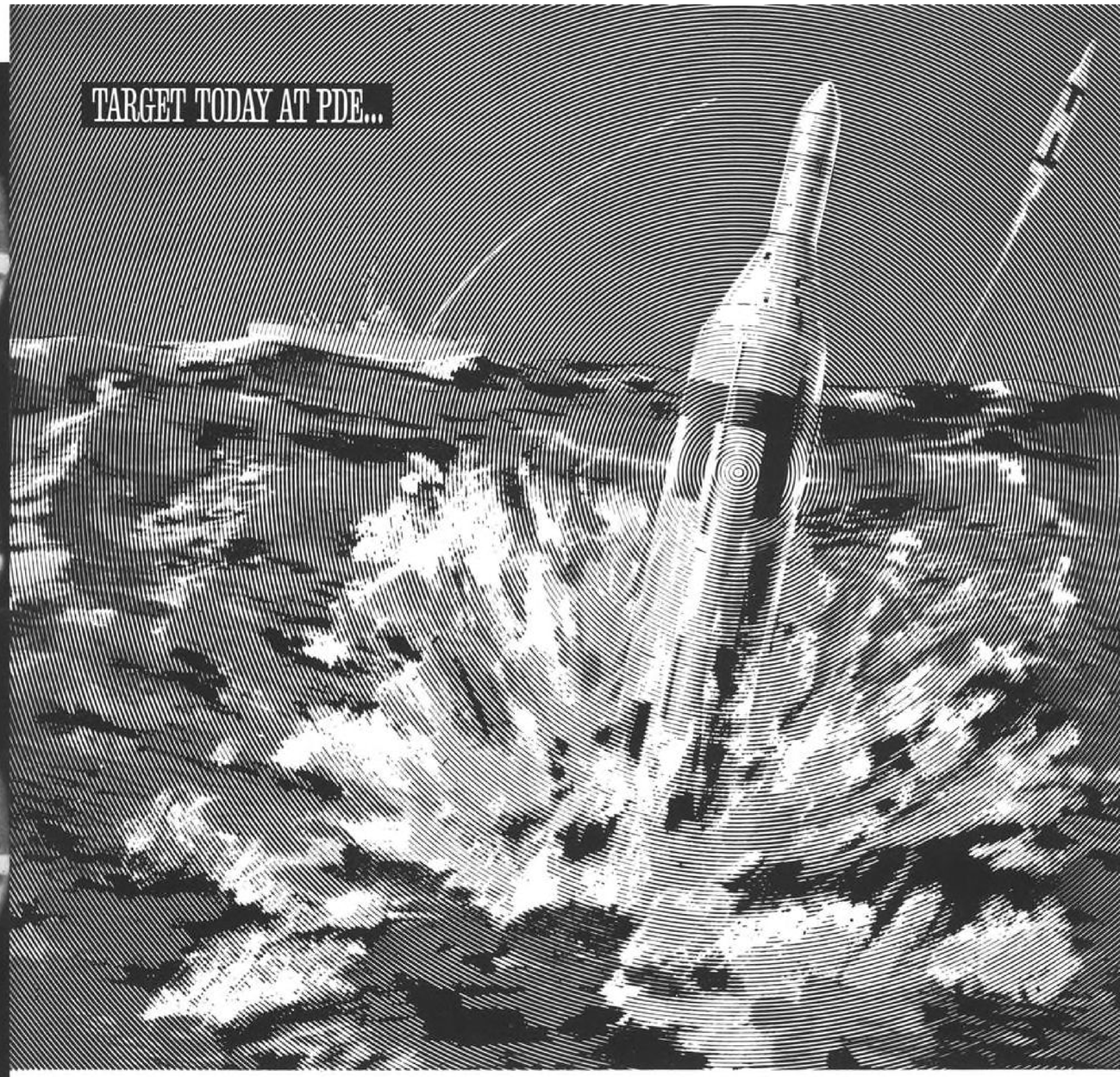
Elgin National Watch Co. was selected by North American Aviation Space and Information Systems Div. to design, develop and produce an electronic metronome timer for the Apollo spacecraft. The timer will synchronize spacecraft electronics and provide time pulses for the sequencer. Amount of the contract currently is under negotiation.

Sperry Rand Corp. will deliver the first of two advanced range instrumentation ships (ARIS) to USAF late this month for Atlantic Missile Range missile tracking and nose cone recovery assignments in the Indian Ocean. Conversion of the 14,000-ton World War 2 transport took 21 months. Second ARIS will be ready in about three months.



Polaris Launch

Underwater sequence photos show ejection of Polaris fleet ballistic missile from launch tube of the USS Theodore Roosevelt off Florida. Missile nose cone emerges (top) from the submarine; air bubbles follow the missile (below).



TOMORROW'S GUIDANCE SYSTEMS

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BUSINESS FLYING

FAA Using Revised Light-Twin Training Program for Inspectors

Oklahoma City—Revised Federal Aviation Agency training program for general aviation operations inspectors calls for them to receive flight proficiency training at home stations in FAA-leased light twin-engine aircraft, rather than coming to the Aeronautical Center here, as in the past.

Aero Commander 560F and a Beech Twin Bonanza J50 have been leased for the program, which is designed to permit field inspectors to remain current in light twin developments as well as maintain proficiency in the type of aircraft for which they will be issuing pilot ratings.

Heretofore, inspectors have had to come here for a minimum two-week period and their training equipment varied. Old system was more expensive also, since inspectors received per diem allowances for their time away from home and travel expenses were high.

New course will provide 15 hr. flight time and 17 hr. ground instruction in four days, with one day reserved for make-up work in case of inclement weather.

Classes are limited to three student-inspectors and consist of 10 hr. flight time as first pilot, 2½ hr. as co-pilot and 2½ hr. as observer. First pilot training will consist of 5 hr. aircraft performance, 1¼ hr. aircraft systems, 2½ hr. integrated flight systems and 1¼ hr. radar, DME and RMI operation.

Seventeen hours of ground instruction will cover performance, systems, integrated flight systems, manuals, weight and balance, power charts, radar, DME and RMI operation and aircraft servicing and inspection.

Total of 1,000 hr. flight time per year is programed for each aircraft and two instructors are assigned to each. Approximately 60 classes will be held each year with the two aircraft, which will account for about 90% of the budgeted flight time. Balance of the time will be spent at the Aeronautical Center here for other programs.

With current schedules, each of the approximately 240 inspectors in the 48 contiguous states should receive the course once every 18 months. Inspectors in Alaska and Hawaii will not participate and will continue to come to the Aeronautical Center for periodic retraining.

Support equipment for the courses—projectors, films, manuals and other teaching aids—will be carried to the field in the aircraft.

Commander 560F is leased directly from Aero Commander, Inc. in Bethany, Okla. Twin Bonanza is leased from Aircraftsmen, Inc., Beech dealer at Will Rogers Field here. FAA provides reimbursement insurance for the two aircraft.

Both aircraft are equipped with standard avionics equipment. Both have Collins FD-107 integrated flight systems, Narco UDI-2 DME equipment, dual needle RMIs and ARC ADF-21A ADF equipment. Commander has Collins AP-102 autopilot, Collins WP-103 radar, Collins 17L-7 transmitters, 51X-2 receivers and VOR-101B omni receiver. Twin Bonanza has RCA AVQ-55 radar, Collins VOR-101B omni equipment and ARC 15F-B-19 RMI converter. Latter aircraft also has an oxygen system and propeller anti-ice equipment.

Scheduled in conjunction with each class in the FAA district (there are 75 districts in the 5 continental regions) are 3-4 hr. seminars for area light twin operators, owners and pilots. Instructors from the Aeronautical Center present a compressed course which covers V-speeds, single-engine operation, powerplant management and takeoff planning. Chief inspectors in each district are in charge of invitation to these seminars, with the limiting factor generally being space available in each locality.

U. S. Business & Utility Plane Shipments

(January 1963)

Make & Model	Units	Factory Billings
Aero Commander 500A, B	5	$380,000
680F	1	
Beech Super 18	1	
23 Musketeer	53	
33 Debonair	8	
35 Bonanza	13	$2,829,000
50 Twin-Bonanza	3	
55 Baron	16	
80 Queen Air	4	
95 Travel Air	1	
Cessna 150	31	
172 Skyhawk	79	
P172	2	
180	11	
182 Skylane	58	
185 Skywagon	8	$4,487,000
205	67	
210	15	
310	13	
320 Skyknight	2	
Champion 7GCB Challenger	6	$54,000
Mooney Mark 21	36	$450,000
Piper PA-18-150 Super Cub	14	
PA-22-108 Colt	17	
PA-23-235 Apache	7	
PA-23-250 Aztec	12	
PA-24-180 Comanche	8	$2,452,000
PA-24-250 Comanche	32	
PA-25-235 Pawnee	26	
PA-28-150 Cherokee	3	
PA-28-160 Cherokee	1	
PA-28-180 Cherokee	35	
Totals	588	$10,652,000

Note: Above shipments compare with 555 units shipped January 1962 having a factory billing value of $10,878,000—much of the decrease in January 1963 being due to fact that fewer (65) twin-engine aircraft were delivered than the same month last year, when 71 were shipped.

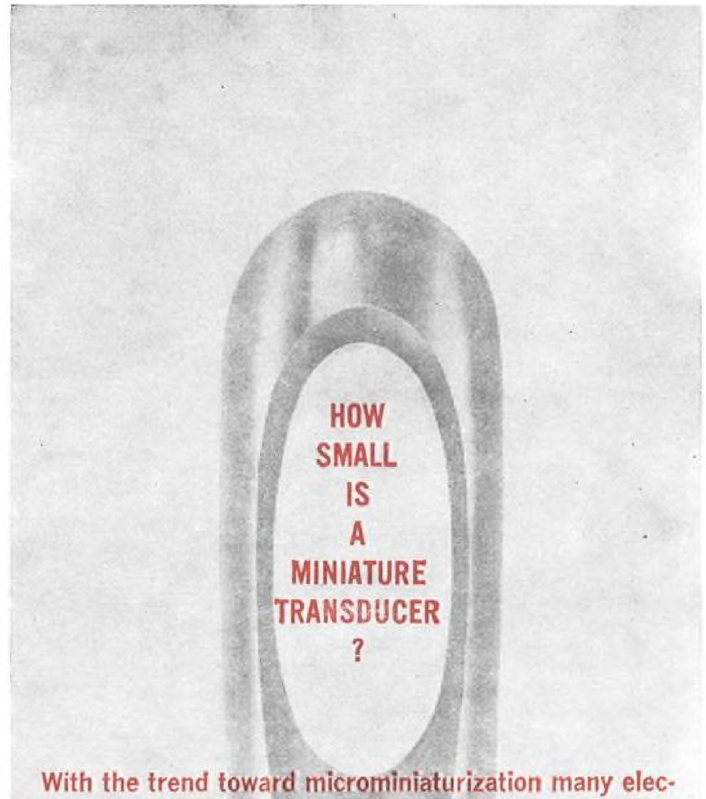
Soviet Geologists Cite Need for Helicopters

Moscow—Russian geologists and electric power line builders have complained in the Soviet press that they can not obtain enough helicopters for their work despite the Soviet Union's repeated claims of possessing more rotary-wing aircraft than any other nation in the world.

S. V. Goriunov, chief of the Russian Soviet Federation Socialist Republic's Main Geological Administration, said that geological field parties under his supervision have more than 100 helicopters available. Many are operating in the far north.

"Even so," Goriunov declared, "we have a severe shortage of helicopters. We ask Aeroflot to give use real help in this respect."

Two Soviet power engineers said recently that the excuse of "very high operating costs" is usually given when requests are made for greater use of helicopters in building electric transmission lines in roadless areas.

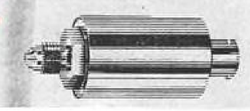


With the trend toward microminiaturization many electronic components are barely visible to the naked eye. Not so with transducers. The assemblage of nearly 35 individual components into one accurately operating instrument necessitates a larger definition of the term "small." Yet, Servonic's H-160 today represents the highest level of miniaturization in high pressure transducer technology. Measuring only 1½" long by 1" diameter and weighing 3.5 oz., this remarkable pressure sensing device is capable of withstanding 35g vibration with less than 1% error. Friction and electrical noise have been virtually eliminated by oil filling the interior. Pressure changes are transmitted through a unique, miniature bourdon tube, eliminating complex linkage systems. Other features of the H-160 include a response time of only 10 milliseconds; temperature range of —65° to +275° F; and a range of 0-800 to 0-20,000 psia or g.

For additional information about the H-160 or other miniature Servonic transducers phone Midway 6-2427 or write:

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McDonnell F-3 carries Beech KD2B-1 target under port wing to 35,000 ft. for launch down Pacific Missile Range during qualification tests.

Carrier Tests Qualify KD2B-1 for Production

Rocket-powered Beech KD2B-1, Mach 2-plus Navy and USAF target system, is in large-scale production following extensive carrier compatibility trials. Initial units of the production order, which totals 500 systems, will be delivered beginning this month and will enter fleet service this summer. Total contract value, including research and development and production through December, 1964, is estimated at $30 million.

KD2B-1 is designed as a supersonic target system which can be carried anywhere in the world by Navy carrier units for practice operations. The system has been qualified from Mach 0.4 through Mach 2.87 and for altitudes between 5,000 and 75,000 ft. Possible future studies would be aimed at extending performance envelope to speeds above Mach 3 and altitudes from 200 to 90,000 ft.

Carrier suitability trials included tests at Naval Air Test Center, Patuxent River, Md., where the KD2B-1 was fitted to a McDonnell F-3 (F-3H) aircraft and catapult-launched, with the airplane then making severe carrier-type arrested landings in crosswind conditions. The aircraft blew three tires and snapped the end of the arresting cable hook during the tests. Checks showed the target system in a "go" condition after these tests.

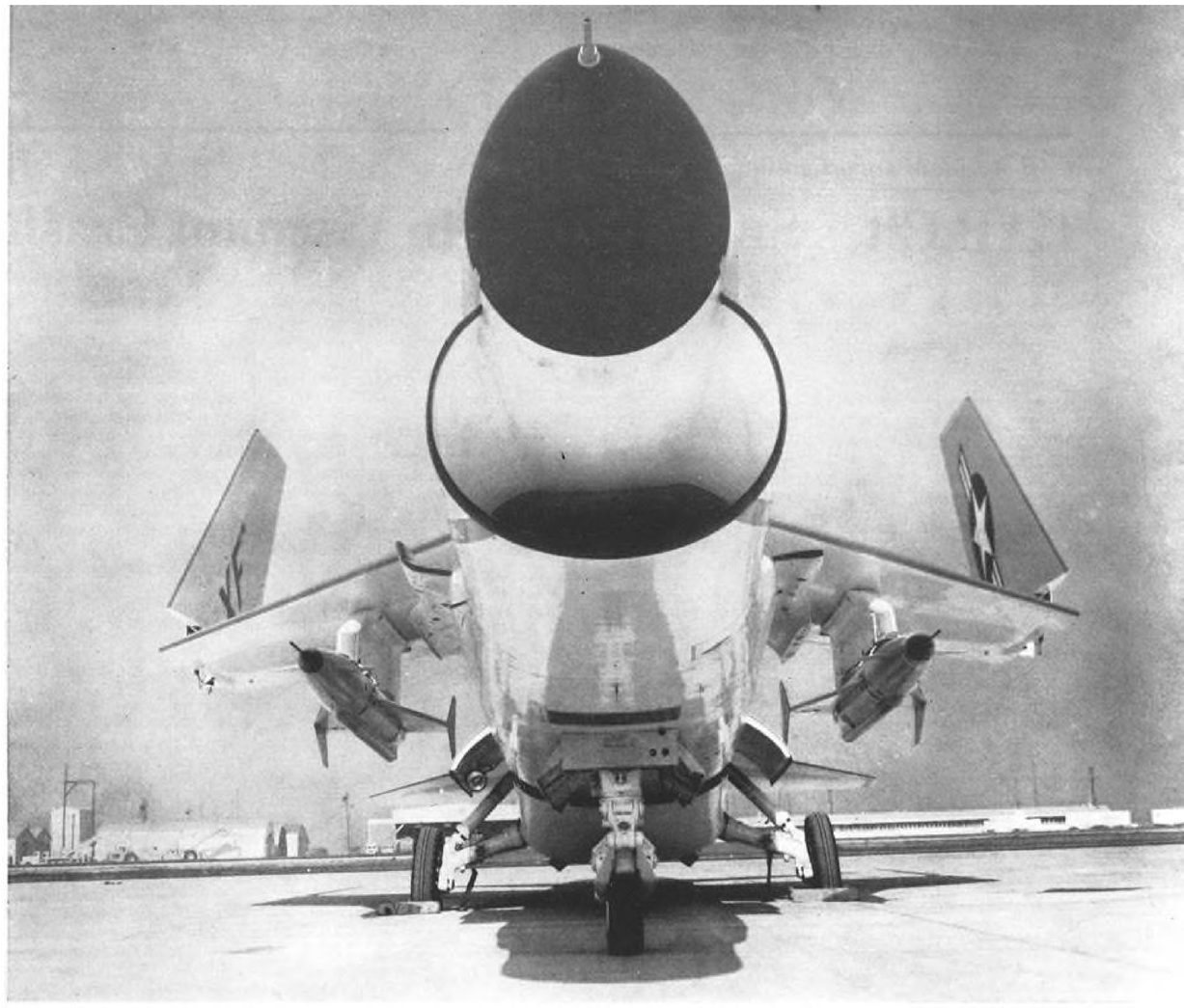
U. S. S. Ticonderoga was used in trials of handling characteristics on the ship and off the flight deck. Because the target measures only 162.67 in. over-all and has a maximum width of 39.52 in., it can be transported through the ship without disassembly. Storage is facilitated by the KD2B-1's use of prepackaged liquid propellants. Tanks are fueled at Beech Aircraft Corp.'s Wichita, Kan., plant and are welded shut before delivery.

Two-year storage capability is a requirement for the system.

KD2B-1 is planned for installation on 11 different types of aircraft utilizing the same launcher. Structural adapter will be used for mating the target to support points on wings or fuselage of different aircraft. Navy plans to use it with McDonnell F-3 and F-4 (F4H), Douglas A-4 (A4D) and F-6 (F4D), Chance Vought F-8 (F8U), North American F-1 (FJ-4) and Grumman F-11 (F-11F). Air Force version, designated Q-12, is planned for McDonnell F-101, Martin B-57 and Convair F-102 and F-106 aircraft.

Qualification programs included 38 free flights of the KD2B-1, of which 30 were termed successful. Roll-yaw cross-coupling with original half-span ailerons was overcome by switch to full-span control surfaces.

The reliability of the directional control system was also indicated during the flight tests.



Twin installation of Beech KD2B-1 supersonic target systems is shown on Chance Vought F-8E underwing pylons. Aircraft is fitted with external stores racks for Bullpup and Zuni missiles. KD2B-1 carrier suitability tests included stowage, unloading from magazine, checkout, aircraft installation and launch with aircraft from the carrier catapult, in addition to land catapult tests and arrested landings.





KD2B-1 is moved into position, left, and attached, right, to LAU-24/A launcher ejection-trapeze extended below wing rack of F-3.





KD2B-1 is ejected from F-3 wing rack, left, during test flight, right, of 100 mi. After launch at 35,000 ft., target climbed to 70,000 ft.

CAB Accident Investigation Report:

CAB Cites Swan Impact in Viscount Crash

United Air Lines Flight 297, a Vickers-Armstrongs Viscount Model 745D, N 7430, crashed in a wooded area six miles west-southwest of Ellicott City, Md., at approximately 1224 E.S.T., on Nov. 23, 1962. All 13 passengers and a crew of four were fatally injured.

Flight 297 was en route from Newark, New Jersey to Washington, D. C. The flight was operating at an assigned altitude of 6,000 ft. when it apparently penetrated a flock of Whistling Swans. At least two of these swans were struck by the aircraft. One swan collided with the right horizontal stabilizer inflicting superficial damage only. The other bird punctured the left horizontal stabilizer, traveled through the structure, and dented the elevator as it egressed. The weakened structure failed in this area, rendered the aircraft uncontrollable, and resulted in the aircraft striking the ground in a nose-low inverted attitude.

The Board determines that the probable cause of this accident was a loss of control following separation of the left horizontal stabilizer which had been weakened by a collision with a Whistling Swan.

Investigation

United Air Lines Flight 297, a Vickers-Armstrongs Viscount, Model 745D, N 7430, was a regularly scheduled passenger flight from Newark, N. J. to Atlanta, Ga., with planned en route stops at Washington, D. C., Raleigh-Durham and Charlotte, N. C. It crashed at approximately 1224[1] on Nov. 23, 1962, in a wooded area six miles west-southwest of Ellicott City, Maryland. All 13 passengers and a crew of four were fatally injured.

An Instrument Flight Rules clearance was issued, clearing the flight in accordance with its flight plan, to Washington National Airport via direct Solberg VORTAC, Victor 3 to the Westminster VOR, the 202-deg. radial of Westminster to Potomac Intersection, direct Washington. The estimated time en route was one hour at a true airspeed of 260 kt. The aircraft was properly dispatched and the captain and first officer were properly certificated.

Flight 297 departed Newark at 1139. Following a position report at West Chester VORTAC at 1203, control of the flight was transferred from the New York Air Route Traffic Control Center to the Washington Center. The flight progressed normally and at 1214, was cleared to descend from 10,000 to 6,000 ft. The following advisory was issued to United 297 at 1219: "Be advised there's been numerous reports of considerable amount of ducks and geese around this area." This report was acknowledged, and a radar handoff to Washington Approach Control effected at 1220. After reporting level at 6,000 ft., Flight 297 contacted Washington Approach Control on the assigned frequency of 120.8 mc. At 1222 the following transmission was made by approach control: "United 297, radar contact, turn left heading two zero zero, radar vector omni final approach course via Alexandria Intersection, landing runway three six, wind northwest 10, altimeter three zero three seven." This transmission was acknowledged and the altimeter setting verified. An additional vector to 180 deg. was transmitted at 1223; however, there was no reply from the flight. At 1224 it was determined that radar contact had been lost.

[1] All times herein are Eastern Standard based on the 24-hr. clock.

Weather Conditions

The nearest official weather observing station to the scene of the crash was at Friendship International Airport, Baltimore, Md. The 1200 report indicated scattered clouds at 5,000 ft., 20 mi. visibility. This was followed at 1300 by a report of clear, and 20 mi. visibility.

Statements were obtained from several eyewitnesses to the accident. Their vantage points bracketed the crash site. A consensus of their observations is that N 7430, when first sighted, was at a very low altitude turning to the left on an east or southeast heading. The aircraft abruptly rolled inverted and disappeared through the trees in a near vertical attitude. Some shiny objects, later identified as parts of the aircraft, were observed falling in the immediate area of the crash. The attention of some witnesses was attracted to the aircraft initially by an unusual noise, the origin of which has not been determined.

A statement was also obtained from a pilot who was flying in the vicinity of Beltsville, Md., at approximately 1230 on the date of the accident. He reported sighting a flock of approximately 50 very large white birds flying in trail, and estimated their altitude to be 5,500 ft., level with him in an area bounded by Ellicott City, Savage, and Clarksville, Md. This position would place the birds within a maximum distance of eight miles from the crash site. He was uncertain of their flightpath, because of insufficient relative motion. There were also reports from airline pilots flying in the area, that radar contacts reported to them by Washington Center were in fact large flocks of birds. In addition to these reports, the Weather Bureau radar log at Washington National Airport indicates echoes described as "birds" or "angels"[2] which were sighted throughout a period from 0815 until 1705. At 1245 these echoes were described as scattered over a 30 mi. radius from the station moving from the north-northeast at 30-40 kt. The crash site is approximately 23 mi. from the radar site.

Wreckage Examined

Examination of the main wreckage site, six miles west-southwest of Ellicott City, Maryland, indicated the aircraft struck the ground in an inverted attitude, at an angle of 46 deg. measured from the horizontal. The heading at impact was 132 deg. There was no evidence of in-flight fire, but a severe ground fire following impact consumed the major portion of the fuselage, right wing, and the left wing inboard of the No. 1 engine. Parts of the left and right horizontal stabilizers and elevators separated in flight. The left horizontal stabilizer and elevator parts were located in an area ranging from 930 ft. on a magnetic bearing of 29 deg. counterclockwise about the main crash site to 2,050 ft. on a magnetic bearing of 347 deg. The right horizontal stabilizer and elevator parts were recovered in an area ranging from 2,908 ft. on a magnetic bearing of 278 deg. to 1,272 ft. on a magnetic bearing of 211 deg.

[2] Contacts of unknown origin, not associated with precipitation, thought to be birds or insects.

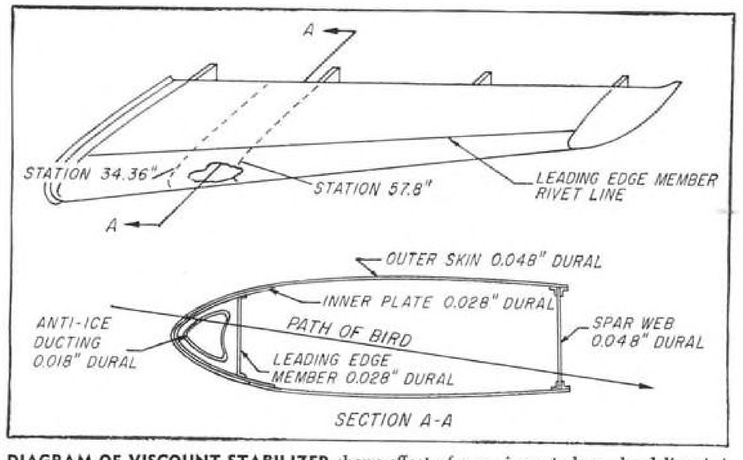


DIAGRAM OF VISCOUNT STABILIZER shows effect of swan impact along chord line A-A.

Bird remains were found on both horizontal stabilizers, indicating two distinct bird strikes on these surfaces. Superficial damage occurred on the right horizontal stabilizer, 22 in. outboard of the fuselage. This strike was a glancing blow and did not result in penetration. The other strike was on the left horizontal stabilizer, approximately 49 in. outboard of the fuselage. In this instance the bird penetrated the leading edge and passed through the leading edge member. Continuing aft the bird fractured the spar web, partially separating it from the top and bottom caps, and then made final contact with the lower leading edge of the elevator, which resulted in denting but no penetration.

The left horizontal stabilizer and elevator failed along a chord plane generally following the travel of the bird through the structure. The direction of failure was downward and slightly aft. In addition to this failure, the right horizontal stabilizer and elevator separated downward and aft approximately 57 in. from the fuselage. Subsequently, the weakened inboard portion of this horizontal stabilizer also failed.

The severe ground fire damage following impact eliminated any possibility of discovering evidence of additional bird strikes which might have occurred on other portions of the aircraft.

All four engines and associated propeller assemblies were recovered at the main crash site. Subsequent teardown and detailed examination of the powerplants revealed that the propeller blade angles were in the flight power regime, above the flight-fine-pitch setting. All four reduction gear coupling shafts had extensive multiple spiral type fractures, further indicating power at impact. There was no evidence of bird ingestion or any abnormal conditions in the operation of any of the engines prior to impact.

Carcass Identified

Subsequent to the accident, a partial bird carcass consisting of a large piece of skin covered with white feathers was found 10 ft. from the separated section of the left horizontal stabilizer. The skin measured 19 in. in length and 9 in. in width. Specimens of feathers, tissue and blood were obtained from the separated parts of the aircraft, and that portion of the horizontal stabilizer still attached to the fuselage. The Chief Medical Examiner for the State of Maryland determined these tissue and blood specimens to be of bird origin. The specimens and carcass were then taken to the Fish and Wildlife Service of the U. S. Department of the Interior. They identified the bird by examination of feathers and bones to be an Olor Columbianus (whistling swan). The largest concentration of these birds on the North American Continent at this time of year is in the Chesapeake Bay area. The average weight of the birds available at the Fish and Wildlife Service was 14 lb. for the male and 11.5 lb. for the female; however, they are known to attain weights in excess of 18 lb.

The aircraft was equipped with a Lockheed 109C flight recorder. It was recovered at the main crash site and removed to the Board's headquarters in Washington, D. C., for readout. Information obtained from this recorder indicates heading, airspeed, vertical acceleration, and altitude traces became suddenly excursive at approximately the same time. In less than one minute from this point the altitude went from approximately 6,000 ft. to ground level and the airspeed increased from 240 to 365 kt. IAS and then dropped sharply into an unreliable range. During this same interval the heading varied erratically generally in an area of 210 deg. to 180 deg., and the vertical acceleration changed from a reading of 1.7 positive to a variable 3 negative g's.

A detailed study of the current flight logs and maintenance records, engineering releases, and airworthiness directives was conducted. This reflected the aircraft to have been continuously maintained in accordance with FAA airworthiness standards and United Air Lines' policies and procedures.

Analysis

Flight 297 progressed according to flight plan, with no indication of any mechanical difficulty being disclosed in their many communications with ground stations en route. The weather along the route of flight is not considered a contributing factor to the accident.

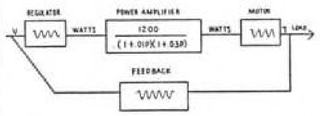
As a result of the numerous radar contacts by Washington Center, which were identified as bird flocks, other pilot reports and ground observers sightings of flocks in the entire general area of the accident, there is no doubt that a definite hazard of in-flight collision with birds existed at the time of the accident.

Investigation disclosed that N 7430 struck two birds, one on the left horizontal stabilizer and one on the right. The damage inflicted by each of these birds is at great variance, and therefore was the subject of close examination. The determining factor in the degree of damage was the angle of impact in relation to the surface of the airfoil at the point of impact. If the bird's line of force were elevated above or below the most forward point of the leading edge of the horizontal stabilizer, the angle of contact would become more oblique, thereby diminishing the force imposed, and consequently diminishing the likelihood of penetration.

The bird impacting the right horizontal stabilizer struck the leading edge surface 2-3 in. above the most forward point of the leading edge. Curvature of the airfoil in this area resulted in impact on a surface sufficiently oblique to the line of force to produce bird deflection rather than penetration. The result was superficial damage only.

In contrast to this, the bird strike on the left horizontal stabilizer was concentrated nearly at the most forward point of the leading edge. At this point the angle between the line of force and the stabilizer skin resulted in penetration. The damage sustained in this instance weakened the structure so that the normal down load initiated immediate failure of the horizontal stabilizer and elevator along a chord plane directly aft of the initial impact point. As these parts failed downward and slightly aft, a violent instantaneous nose-down pitching moment was generated. During the left horizontal stabilizer failure sequence, the

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elevators were displaced beyond their limit, trailing edge upward, thus imposing a severe down load on the right horizontal stabilizer which also failed downward. As the outboard 11 ft. of the right horizontal stabilizer and elevator were in the process of separation they weakened the structure of the remaining inboard stabilizer section, which subsequently separated prior to impact. This breakup rendered the aircraft uncontrollable.

Bird Strike Problem

Collision with birds has, of course, been a problem for many years, but during aviation's formative years it was predominantly one of nuisance. The speed of earlier aircraft was such that damage was usually minor. This slow speed also resulted in slow rates of closure and short maneuver distance so that some degree of evasion was possible. Even then, however, it was recognized that airplanes had a prime point of vulnerability—the windshield, and following several years of study and testing, regulations were promulgated to require a measure of protection through the use of strengthened windshields.

One of the more notable studies was conducted by the Civil Aeronautics Administration between the years 1942 and 1946 during which time bird strike data were collected, collated and analyzed. The resulting report[a] showed that of all bird strikes to all areas of airplanes, 28% were to windshields and that, of the strikes resulting in damage classified as severe, windshields were involved in 37% of the cases. The report further produced some additional figures which indicated that strikes to other parts of the aircraft did not pose a serious hazard:

Strike Area	Percent of Total Strikes
Fuselage	31
Powerplant	9
Wings	23
Other (e.g. antennas, landing gear, and empennage[b])	4

In consideration of the fact that serious damage to such items as antennas, dents and even holes in wings, cowlings, and fuselage do not in themselves render an aircraft incapable of further flight, the industry was justifiably satisfied at that time that further "birdproofing" requirements were unnecessary. This is not to imply that progress ceased, for certainly the industry has constantly strived for and achieved product improvement and increased safety levels, but following the windshield program there was no industry-wide, concerted effort toward further "birdproofing," nor was there any indication of its necessity.

Report Conclusion

The referenced report, written in 1949, contained among its conclusions one which remained valid for many years.

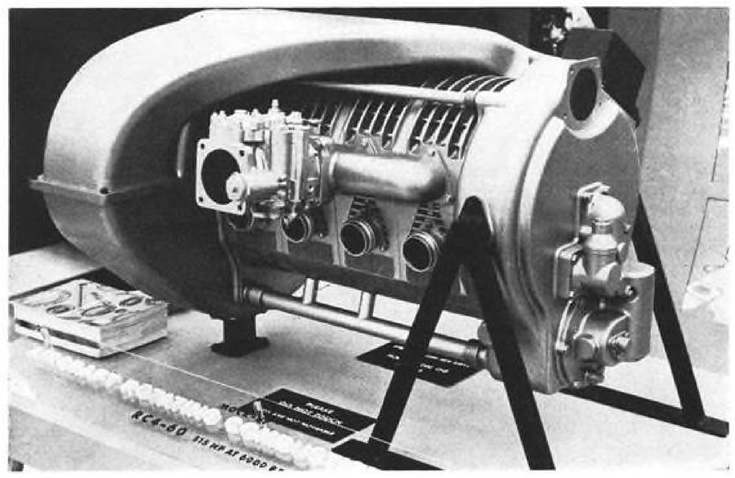
> "No record exists of any fatality in air carrier operations in the United States caused by collision of aircraft with birds."

The validity ended with the crash of a Lockheed Electra at Boston, Massachusetts, on Oct. 4, 1960. This accident clearly demonstrated that even small birds, if in sufficient numbers, could precipitate a chain of events which could render a modern aircraft uncontrollable.

A series of tests and studies were ini-

[a] Kangas and Pigman, *Collision of Birds with Aircraft in Scheduled Commercial Operations in the Continental United States*, TDC Report No. 62, CAA, 1949.

[b] Only 1 of 473 reported collisions caused considerable damage to a tail surface.



Curtiss-Wright Displays Rotating Engine

Curtiss-Wright RC4-60 rotating-combustion engine, shown here in mockup form, is one of several versions of the basic Wankel powerplant now being proposed to civilian and military contractors. Engine is a bank of four 60-cu. in. units designed to produce 515 hp. at 6,000 rpm. Powerplant is air-cooled, and uses a centrifugal blower to force cooling air over the combustion section of the engine. Dry weight is calculated at 328 lb., less starter and generator, but with reduction gearing necessary to give a propeller tip speed approximating 1,000 fps. Over-all length is 41.5 in., width is 23.9 in. and height is 26.8 in

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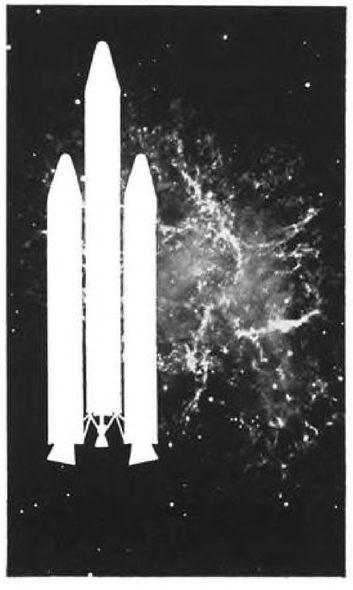
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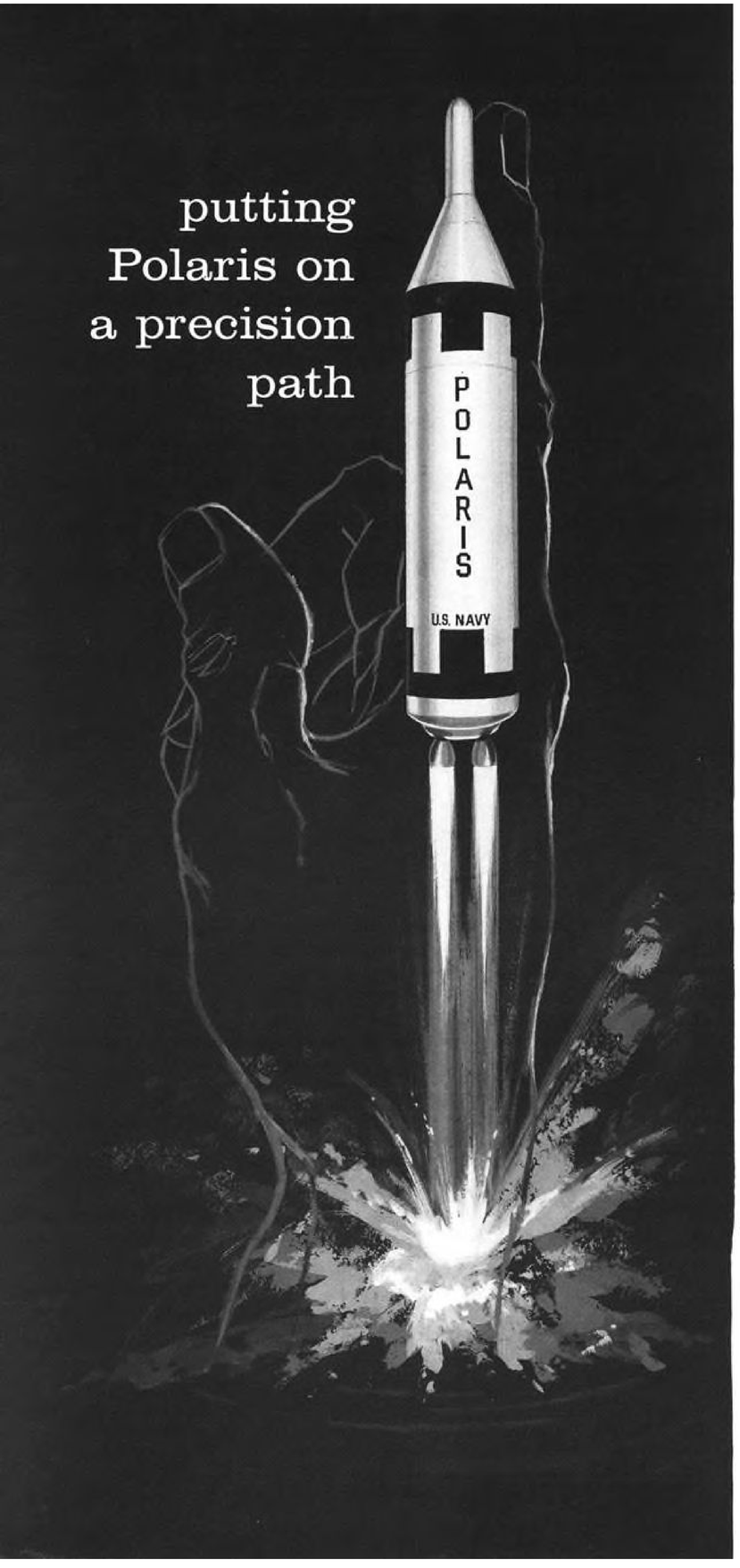
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Douglas A-4E Displays Mixed Armament

Latest version of Navy/Douglas A-4E carries mixed load of two Martin Bullpup-A air-to-surface missiles and 18 conventional bombs. Aircraft also can carry up to five Bullpups or a variety of other combinations. Aircraft was engaged in training exercise in California.

tiated shortly after the Boston accident ranging in subject from the specific engine involved to general analyses of bird populations on and near airports and how best to cope with them. In regard to the latter, the United States Department of Interior issued a short, highly informative report[5] which should be of interest to anyone associated with the problem.

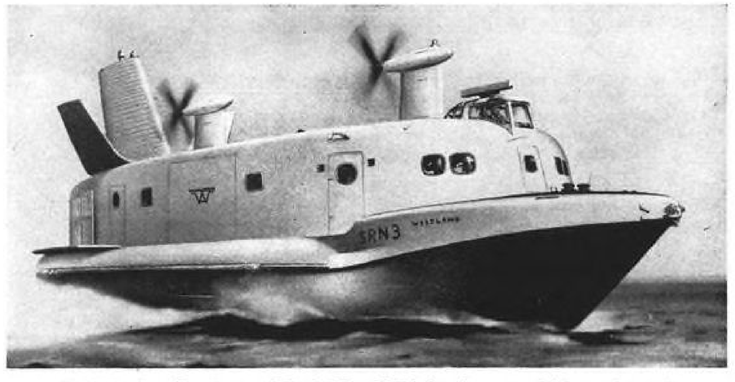
Following the initial engine tests referred to above, the Federal Aviation Agency, on the Board's recommendation, started a more extensive test program into turbine engine bird ingestion, and the resulting power loss and recovery patterns. The Board is hopeful that this program, still in progress, will lead to developments which will further improve the already high safety level of the turbine engine.

The Viscount accident of Nov. 23 has, in the opinion of the Board, revealed a more perplexing problem. The Board determined that the probable cause of the Boston Electra accident was the unique and critical sequence of the loss and recovery of engine power following bird ingestion, resulting in loss of airspeed and control during takeoff. One might even reason, and with some logic, that if the initiating conditions were to be repeated over and over, another accident probably would not result. In the instant case, however, one bird caused immediate separation of a horizontal tail surface, rendering the aircraft permanently out of control. Unlike the Boston case, the ensuing chain of events was a product of, instead of contributory to, the cause of the accident, and no change in these events would have altered the outcome to any meaningful degree.

The Board, in the analysis of this accident and its effect on the industry and the public, has made the following observations which it considers to be most appropriate to the bird strike problem:

• **The low incidence of tail strikes** noted in CAA TDC Report 62, 1949, may no longer be true as a result of the changes in aircraft design. The horizontal stabilizers of transport aircraft of that early era were shielded by propeller discs and wings and

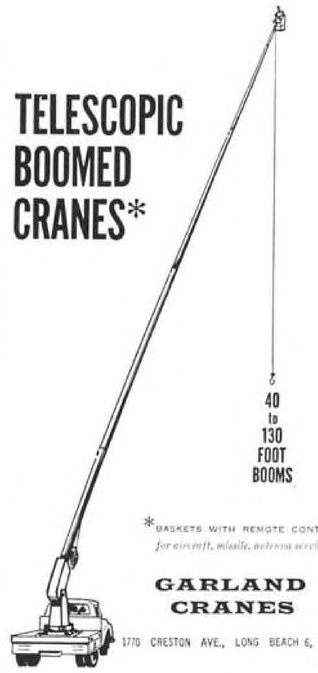
[5] Aldrich, et al., Bird Hazard to Aircraft, Wildlife Leaflet 429, U.S. Dept. of Interior, Fish and Wildlife Service, Washington 25, D. C., January 1961.



British Order SR.N3 GEM from Westland

Westland SR.N3, 37½-ton ground effect machine, has been ordered by the British Ministry of Aviation for evaluation. Delivery will be in early 1964. Powered by four Bristol Siddeley Gnome engines, the SR.N3 will carry up to 150 passengers or 12 tons of cargo. It is 77 ft. long has a beam of 30 ft. 6 in. and a height of 33 ft. 9 in. Artist's concept is shown.

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Utilizing space in long range communications is one of the major program areas at ITT Federal Laboratories. The work embraces research in the space sciences, generation and analysis of systems concepts, and the solution of specific technical problems in the development of earth/satellite communications systems for both military and commercial purposes.

SOME OF OUR GOALS AND TECHNIQUES:

Design of a global communication system through which many may communicate independently and simultaneously.

Phased array radio telescope antennas with 1,000 to 10,000 foot apertures.

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Developing a lunar bounce communications link between ITTFL's fixed space communications station in Nutley, New Jersey, and an ITT terminal in England.

Exploring advanced modulation techniques for space applications, where the bandwidth restrictions affecting terrestrial systems do not apply.

Much of ITTFL's space communications work is contracted by NASA, the U.S. Army Signal Corps, the Air Force and other government agencies. A substantial portion, however, is company-funded. Three years ago ITTFL built its own radio telescope to further experimental investigations. Presently, the staff is participating with NASA in the RELAY program, using the ITT Nutley facility for satellite command and control, and as a ground terminal for a North and South America communications link. The South America terminal, a transportable ground station in Brazil, was also developed and built by ITTFL.

Your own interests in satellite communications, or any other area of information transfer systems, are probably well represented in this multi-laboratory organization. Your inquiry will receive a prompt and confidential reply.

IMMEDIATE OPENINGS IN THESE AREAS

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To apply, or gain more information, forward your resume in full confidence to Mr. W. Bieszard, Box 19-WM, ITT Federal Laboratories, 500 Washington Avenue, Nutley, New Jersey. (An Equal Opportunity Employer)

ITT FEDERAL LABORATORIES

were relatively protected from strike damage. Many of the prop-jet aircraft have the tailplanes mounted higher than the top of the propeller discs; the jet aircraft, of course, have no discs and their high mounted tails make them even more vulnerable. The trend toward the T-tail and the canard supersonic designs is interesting in that the horizontal stabilizer has no protection afforded by the fuselage, wings, and powerplants.

• **The considerably higher climb** and descent speeds of current generation aircraft can result in a higher percentage of severe structural damage strikes than reported in the earlier survey.

• **Although the subject strike involved** failure of a tail surface, conceivably tomorrow some other vital component such as a spoiler, wing flap, control surface, control tab, etc., could be involved. Impairment of a vital control function could have equally catastrophic consequences. Clearly, therefore, consideration should be given to broadening the present requirements to insure over-all protection against catastrophic damage from bird strikes.

• **CAA TDC Report 62** has been of considerable value in evaluating the importance of the bird strike problem. Unfortunately, however, it is outdated and a new study, based on the currently operating aircraft and the greater traffic density, is indicated.

The Board recognizes that any project established to evaluate and attempt solution of catastrophic bird strike damage will be a colossal undertaking, but the problem is no less colossal. Accordingly, the Board has recommended to the Administrator that the program already under way in this regard be expanded to include consideration of broadening the present bird strike requirements. It has been further recommended that physical testing be included to corroborate any analytical studies, and that a new survey of bird strikes be made along lines similar to those reported in TDC Report No. 62. The Administrator has advised the Board that the Federal Aviation Agency is now formulating a series of bird strike tests, and that it is exploring all aspects of the over-all problem from both the engineering and operational point of view.

Probable Cause

The Board determines that the probable cause of this accident was a loss of control following separation of the left horizontal stabilizer which had been weakened by a collision with a Whistling Swan.

By the Civil Aeronautics Board:

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Chairman

ROBERT T. MURPHY
Vice Chairman

CHAN GURNEY
Member

G. JOSEPH MINETTI
Member

WHITNEY GILLILLAND
Member

SUPPLEMENTAL DATA

Notification

The Civil Aeronautics Board was notified of this accident at approximately 1240 E.S.T., Nov. 23, 1962. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958.

United Air Lines, Inc., is a Delaware corporation with headquarters at O'Hare International Airport, Chicago, Ill. The company holds a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board, and a current air carrier operating certificate issued by the Federal Aviation Agency. These certificates authorize the operation over a number of routes including the one here involved.

Flight Personnel

Capt. Milton J. Balog, age 39, held current airline transport pilot certificate No. 171307 with a type rating in Vickers-Armstrongs Viscount. His last first-class FAA physical examination was Sept. 17, 1962. His last proficiency check was on July 18, 1962.

First Officer Robert J. Lewis, age 32, held airline transport pilot certificate No. 1023402; however, because his last FAA physical was dated Nov. 9, 1961, it was not current for pilot-in-command duties. Under these circumstances his certificate was valid as a commercial pilot certificate and he was qualified for the flight. His last proficiency check was on Nov. 10, 1962.

Stewardess Mary Kay Klein completed her company training on June 11, 1962, and was assigned to the line on June 21, 1962.

Stewardess Kaaren G. Brent completed her company training on August 6, 1962, and was assigned on August 16, 1962.

The Aircraft

N 7430 was a Vickers-Armstrongs Viscount Model 745D, serial number 128 manufactured June 30, 1956. It had a total flying time of 18,809:34 hours with 68:59 hours since the last No. 2 inspection, 258:48 hours since the last No. 4 inspection, and 1400:02 hours since the last block overhaul.

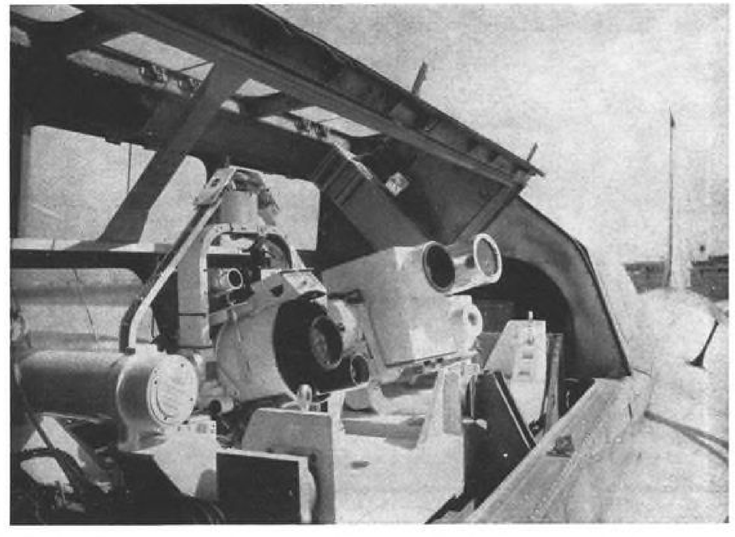
The aircraft was powered by four Rolls-Royce Model Dart 510 engines. The total time since overhaul for No. 1 was 1,951:25 hours; No. 2: 1,956:28 hours; No. 3: 1,305:05 hours, and No. 4: 2,412:58 hours.

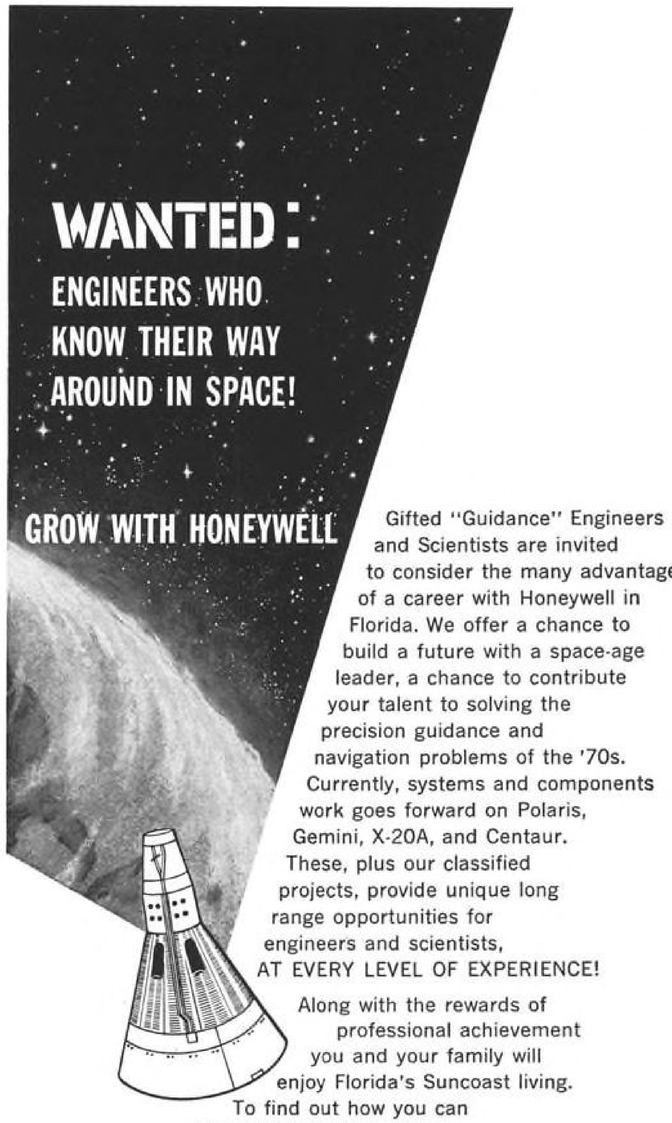
The propellers were ROTOL Limited Model R130/4-20-4/12E with total time since overhaul on No. 1: 4,401:58, No. 2: 3,524:53, No. 3: 1,315:17, and No. 4: 1,935:06.



Modified KC-135 Used in RAMP

Modified USAF/Boeing KC-135 has greenhouse-type canopy (above) to house instrumentation (below) for the joint ASD/ARPA radiation airborne measurement program (RAMP). Sensors include cameras, radiometers, spectrometers and a closed-circuit television system. Windows are of quartz. Program is being conducted by Aerojet-General.





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To investigate openings at other Honeywell facilities, send resume to H. F. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

WHO'S WHERE

(Continued from page 23)

Honors and Elections

Richard A. O'Connor, retired board chairman of The Magnavox Co., has received The Distinguished Public Service Award from the U. S. Navy in recognition for his outstanding contributions to the Navy in the field of weapons technology.

Dr. Marvin Adelson has been named by the National Academy of Sciences-National Research Council as executive director of a committee to direct a study of the utilization of the nation's scientific and engineering manpower. Dr. Adelson is on leave from System Development Corp. where he is a principal scientist.

Heinz Gruner, senior photogrammetrist at Bausch & Lomb, Inc., has received the 11th annual Photogrammetric Award of the American Society of Photogrammetry in recognition of his developmental efforts which provided the mapping industry with an instrument for utilization of 120-deg. photography.

Changes

Dr. Thomas O. Paine, manager of General Electric Co.'s Technical Military Planning Operation (TEMPO), Santa Barbara, Calif. TEMPO will expand its activities to provide advanced planning services to GE's entire Aerospace and Defense Group.

North American Aviation's Columbus (Ohio) Div. has announced the following appointments in Surface Based Electronic Systems: **Dr. J. R. Horsch,** chief scientist, Applied Research; **Richard Holden,** manager, Marine Systems; **Eli Weinberger,** manager, Command and Control Systems.

Don R. Hunter, director of public relations, Aircraft Div., Douglas Aircraft Co., Long Beach, Calif. **Tom Gabbert,** director of financial management, Douglas Missile & Space Systems Div., Santa Monica, Calif.

Eugene Perchonok, associate director, Propulsive Vehicle Systems, Systems Research and Planning Div., Aerospace Corp., Los Angeles, Calif., and **Charles H. Kelley,** program manager, Survival Improvement Office.

Charles D. Hoefelmann, director of technical sales, Van Dusen Aircraft Supplies, with offices in St. Louis, Mo.

Wallace W. Orr, corporate director-marketing and contract administration, United ElectroDynamics, Inc., Pasadena, Calif.

Col. Jack T. Bradley (USAF, ret.), export director, Aerospace Industries Assn., Washington, D. C.

Clyde R. Rockwood, operations manager, Raytheon Co.'s semiconductor facility, Mountain View, Calif.

William H. Danaher, general manager, Pacific Optical Div., Chicago Aerial Industries, Inc., Inglewood, Calif.

James L. Frutchey, military systems sales manager, Weston Instruments and Electronics Div., Daystrom, Inc., Newark, N. J.

Capt. Thomas Oakes, assistant to the senior executive vice president of Eastern Air Lines, Inc.

David S. LeVine, assistant general manager-site activation, Martin-Denver (Colo.) Div., Martin Marietta Corp., succeeding **Vernon R. Rawlings** (AW Jan. 28, p. 23).

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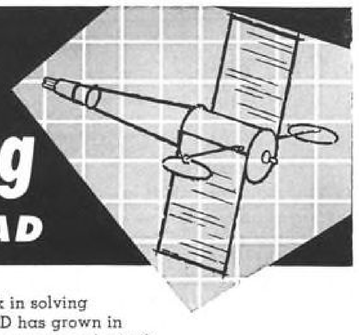
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P-1954, Aviation Week
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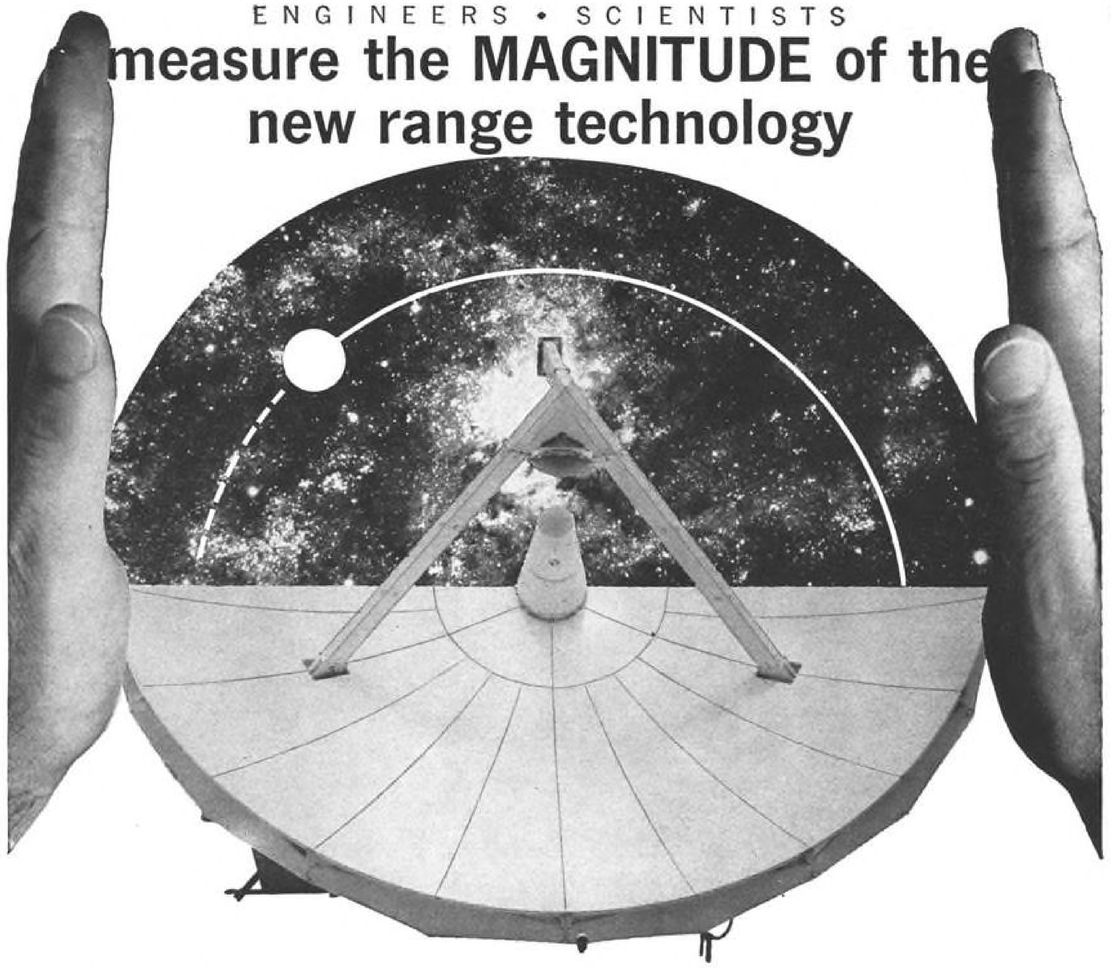
This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

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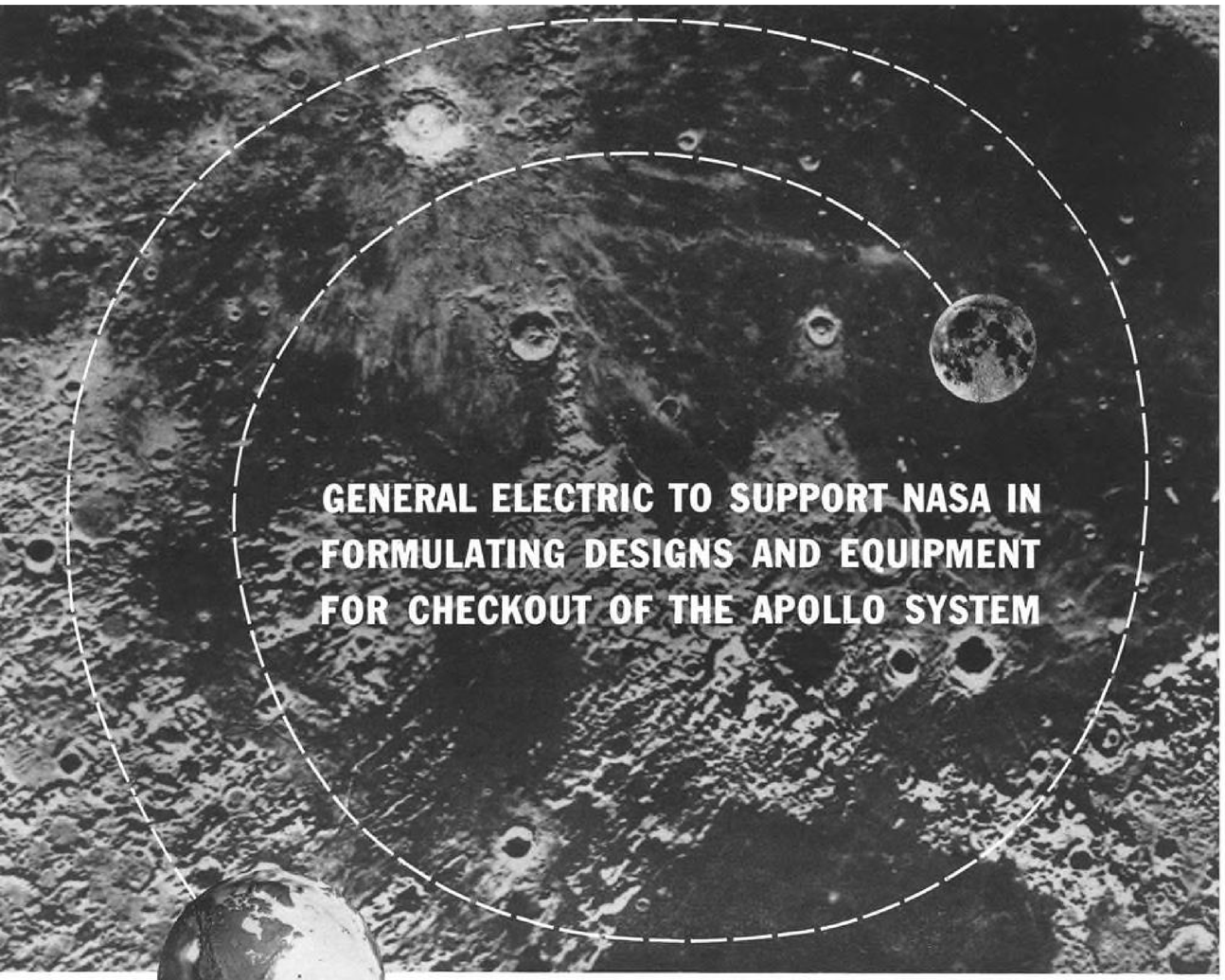
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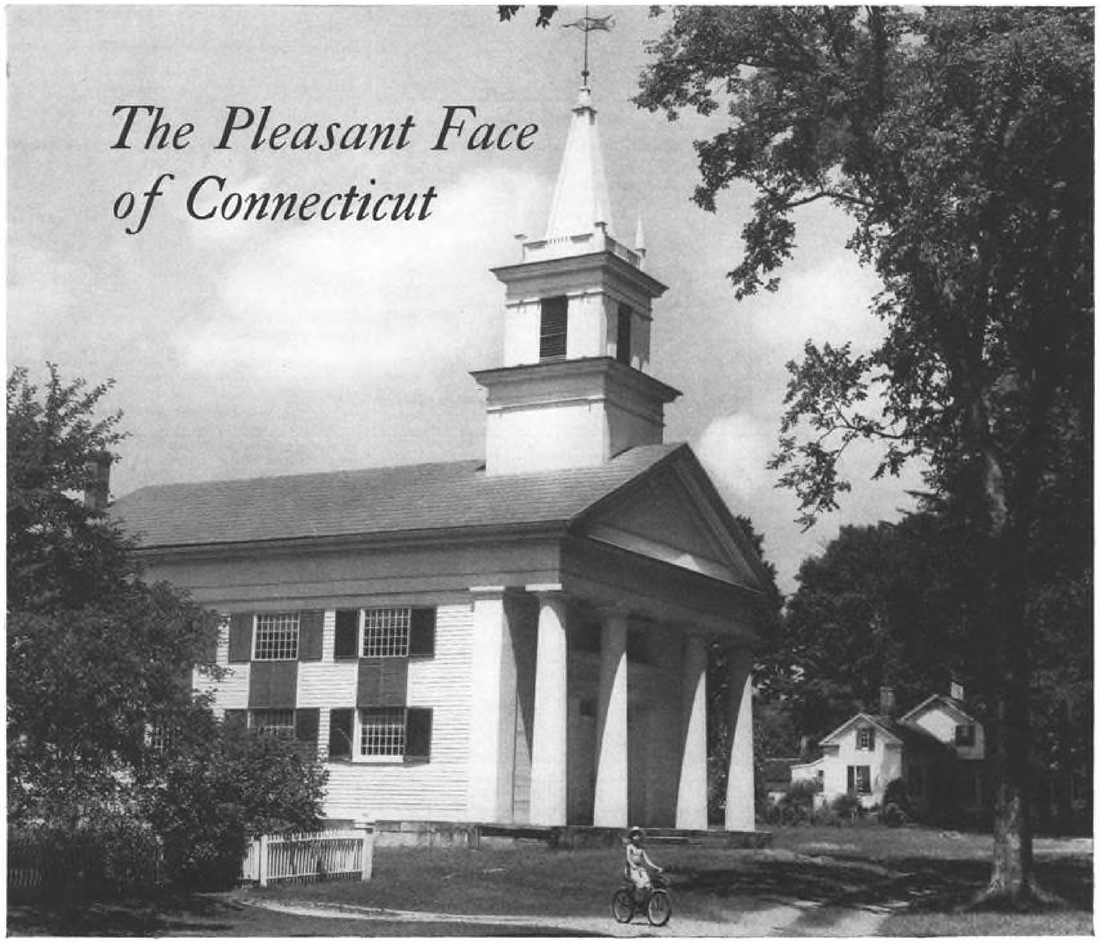
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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, APRIL 8, 1963

AC SPARK PLUG, THE ELECTRONICS DIVISION OF GENERAL MOTORS CORPORATION 89
AIR-MAZE DIVISION, ROCKWELL-STANDARD CORPORATION 13
AIRCRAFT POROUS MEDIA, A SUBSIDIARY OF PALL CORPORATION 8
AMERICAN OPTICAL COMPANY, SAFETY PRODUCTS DIVISION 74
AMPEX CORPORATION 53
ASTRODATA INC. 22

BELL AEROSYSTEMS COMPANY A DIVISION OF BELL AEROSPACE CORPORATION ..... 3rd Cover
BENDIX PIONEER-CENTRAL DIVISION, THE BENDIX CORPORATION 90
BENDIX RADIO DIVISION, THE BENDIX CORPORATION 82
BENDIX SYSTEMS DIVISION, THE BENDIX CORPORATION 58
BOEING COMPANY, THE 48

CAMERON IRON WORKS, INC., SPECIAL PRODUCTS DIVISION 10
CHROMALLOY CORPORATION 12
COLLINS RADIO COMPANY 108
COMPUTER CONTROL COMPANY, INC. 46
CONSOLIDATED ELECTRODYNAMICS CORPORATION 86, 87
CUTLER-HAMMER, INC. 62-63

DEL E. WEBB CORPORATION 44
DOUGLAS AIRCRAFT COMPANY, INC. 50-51
DU PONT DE NEMOURS & CO. (INC.), E. I., TEFLON 70-71

EITEL-McCULLOUGH, INC. 59
ELASTIC STOP NUT CORPORATION OF AMERICA, ELIZABETH DIVISION 5
ERCO RADIO LABORATORIES, INC. 57

FENN MANUFACTURING COMPANY, THE 88

GARLAND CRANE COMPANY 111
GARRETT CORPORATION, THE — AIRESEARCH MFG. DIVISION 61
GENERAL ELECTRIC COMPANY, MOTOR AND GENERATOR DEPARTMENT 107
GENERAL PRECISION, INC., GPL DIVISION 3

HANNAY & SON, INC., CLIFFORD B. 91
THE A. W. HAYDON COMPANY 20
HAYDON SWITCH INC. 83
HONEYWELL 114
HUGHES AIRCRAFT COMPANY 110

INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION, FEDERAL LABORATORIES 112

JANITROL AERO DIVISION, MIDLAND-ROSS CORPORATION 9

KOLLMORGEN CORPORATION 96

LEACH CORPORATION 36-37
LITTON INDUSTRIES, INC. 91
LITTON SYSTEMS, INC., GUIDANCE AND CONTROL SYSTEMS DIVISION 73

3M COMPANY, MAGNETIC PRODUCTS DIVISION 15
MARTIN COMPANY 109
MASON ELECTRIC CORPORATION 60
McDONNELL AIRCRAFT CORPORATION ..... 4th Cover
McGRAW-HILL BOOK COMPANY, INC. 121
MILLER ELECTRIC MANUFACTURING COMPANY 78

NICHOLS COMPANY, W. H. 69
NORTH AMERICAN AVIATION, INC. 6
NORTHROP CORPORATION 64

PACIFIC SCIENTIFIC COMPANY 68
PHELPS DODGE ELECTRONIC PRODUCTS CORPORATION 100
PHILADELPHIA GEAR CORPORATION 100

RAYTHEON COMPANY, MICROWAVE & POWER TUBE DIVISION 18

SKF INDUSTRIES, INC. 17
SANBORN COMPANY 103
SERVONIC INSTRUMENTS, INC. 103
SPACE TECHNOLOGY LABORATORIES, INC., SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC. 56
SPERRY DIVISION SPERRY RAND CORPORATION 24
SUNDSTRAND AVIATION DIVISION OF SUNDSTRAND CORPORATION 98-99

TAMAR ELECTRONICS INDUSTRIES, INC. 84
TEKTRONIX, INC. 7
TELETYPE CORPORATION 11
THIOKOL CHEMICAL CORPORATION 92
TITANIUM METALS CORPORATION OF AMERICA 14

UNITED AIRCRAFT CORPORATION, PRATT & WHITNEY DIVISION 35
UNITED CONTROL CORPORATION 66
UNITED STATES RADIUM CORPORATION 111
UNIVERSAL MATCH CORPORATION, GOVERNMENT PRODUCTS GROUP 16

VAPOR CORPORATION, VAP-AIR DIVISION 102
VOI-SHAN MANUFACTURING COMPANY ..... 2nd Cover

WYMAN-GORDON COMPANY 4

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 115-120
EQUIPMENT (Used or Surplus New) For Sale 120

ADVERTISERS INDEX

A & J Machinery Corp. 120
A.I.R. Corporation 120
Avco 115, 116
Aviation Research Bureau 120
Boreas Corporation 120
EAS Executive Aircraft Service, Inc. 120
Fairchild Stratos 115
Fidelity Personnel 116
Gen. Electric Apollo (Christos) 118
International Aerodyne Inc. 120
Overseas National Airways 120
Pan American World Airways Inc. 117
Sikorsky Aircraft Co. 119
Vickers Inc. 116
West Salem Machinery 120

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LETTERS

Microelectronics

I read with considerable interest Barry Miller's article on microelectronics (AW Feb. 25, p. 84). I consider it a timely and excellent article.

Although I have not yet seen the Arthur D. Little report, I believe their forecasts, as summarized by Mr. Miller, are probably somewhat conservative. I suspect their estimate of $350 million in 1972 may be low by at least a factor of two.

I also do not fully agree with the statement that the impact of microelectronics on the entire electronic industry during the next decade will be less than that created by the introduction of transistors during the 1955-1960 period. My prophesy is that it will be much greater.

J. M. Bridges
Director, Office of Electronics
Office of the Director of Defense
Research and Engineering, DOD
Washington, D. C.

Variable Sweeping

Your editorial "NASA Needs a Watchdog" (AW Feb. 18, p. 21) shows commendable regard for the taxpayer's welfare, but misses one significant point. While the space activities of this agency consume more megabucks than anything not in the defense budget, lets not overlook the aeronautical branch, formerly known as NACA.

The TFX contract, long delayed and currently under investigation, followed a "scientific breakthrough" claimed by NASA and pushed by Tactical Air Command. Actually, the idea of variable sweep about a single pivot point came from Barnes Wallis in England. However, the British, with characteristic wisdom, have decided they won't be enough smarter after having spent the money it takes to prove the principle; their tactical-strike reconnaissance machine, similar in purpose to TFX, is said to employ a fixed wing.

Much has been made of the political influence believed to be at work behind the TFX contract award, but very little has been said about the technical shenanigans involved. While a convenient cloak of "security" prevents open discussion of the holes in NASA's fabric of science fiction, their "proof" of variable sweep feasibility is about as conclusive as that offered in television commercials for toothpaste, stomach distress remedies, and the like.

Having seen what went on in one competitor's TFX proposal, I know that a variable sweep design was submitted because it was clearly indicated that any other kind would be ignored. No alternate concept or criticism of the official legislated stand was permitted, but no responsible engineer I know is privately convinced that a really sound case has been made for variable sweep. Certainly NASA's reports are superficial and unscientific to an alarming degree. By taking liberties with the proportions of test models and extrapolating optimistically for scale effect, they can always be made to look better than the real thing.

In any case, whether the bias in NASA's published rubbish is deliberate or simply the result of ignorance in that agency, the Defense Dept.'s irresponsibility in gambling an estimated $6 billion on such a flimsy "breakthrough" is inexcusable. The most anyone could reasonably justify risking on this idea is the cost of two or three prototypes. The money so far wasted by NASA and industry would have paid for at least one of them. As Adm. Heyward so succinctly put it, "There's plenty of evidence to indicate that no one can pick a winner in the proposal stage."

My company's proposal I know was "optimistic." That is, we lied about what our machine would do. The "winners" must have been even more optimistic. Whoever builds this "advance in the state of the art" may produce the biggest turkey yet, but with any kind of luck, such as that induced by deeper investigation, the taxpayers may be treated to a cancellation of the whole thing before it's built. It wouldn't be the first sole member of its military generation to go down the drain. Remember the F-108? the XB-55? the XP6M?

As a climax to all this nonsense, NASA is now giving industry the opportunity to "evaluate" some of its so-called SCAT supersonic transport proposals. Why? Does NASA sell these machines to airlines? Will they ever be responsible for meeting delivery, weight, performance, and cost commitments? Of course not. Nothing could damage national prestige more than to set the creaking machinery of such a bureau to the task of getting one of those flightless birds built.

Wouldn't it make better sense to select test configurations by an industry-wide competition. After evaluation (not by NASA), let the best two or three be tested in NASA-operated facilities. Put them to good practical use for a change.

This letter expresses an officially disapproved but privately popular view in industry—at least in that slice of industry I frequently meet. It's time for some dissenting opinion to be recorded.

(Name withheld by request.)
California Engineer

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.

Design Concept Level

Subject: "Value Analysis" (AW Feb. 25, p. 124).

J. L. Dorio of the Martin Orlando Value Analysis Staff agrees with me when he writes that "almost all product costs and problems are created during design." However, we part company when he states that "these cost reductions were over and above those achieved at the design concept stage which are usually more difficult to measure and very seldom recorded."

The cost savings at a design concept level not only are not difficult to measure but they have been thoroughly recorded. The automotive industry keeps very diligent track of such costs. For under a thousand units of production I would recommend Thomas McNeil's treatise "Design Cost Guide."

Of the many subjects covered in Mr. McNeil's book are such cost comparisons as brazed assembly vs. investment casting, machined part vs. investment casting, permanent mold vs. die casting, fittings machined from wide tolerance forging vs. forged billet, installed fastener costs. The list is almost endless.

Another subject Mr. Dorio would enjoy is the unit straight line experience curve, the most commonly used method of predicting manufacturing costs. That curve predicted and resulted in a drop in man hours per pound of airframe manufactured from unit #1, almost 15 hr./(PPAM) to unit #700, 1.2 hr./(PPAM) or a 92% reduction in labor cost on an experience curve alone (subject: a Boeing bomber). The Boeing Co. has since World War 2, on the B-29 model, been checking cost reduction by design, tooling and manufacturing costs. Reams of data on that subject are available.

Having read of Boeing's recent experience on the TFX competition, I would certainly not recommend this practice to other aerospace contractors.

H. E. McDonald
Los Angeles, Calif.

'Second-Class Citizens'

Recently I have noted that the presidents of two major airlines used the term "second-class citizens" in public statements.

The first time I noticed this term was in a United Air Lines' newspaper advertisment regarding their one class fare plan, i. e., all coach passengers unconsciously feel like "second class citizens" when they board a coach section. The second time was in the article concerning the purchase of BAC 111 jets by Mohawk Airlines in the Mar. 4 issue of Aviation Week & Space Technology (p. 34). Mr. Peach said, "Your civic resentment from feeling like second-class citizen. . ."

This seems to be, in my opinion, typical of airline industry thinking in general. The passenger will suffer from a mammoth inferiority complex if he does not receive royal service. In other words, if I can't afford a Cadillac I am not fit to be a citizen of the United States.

The airlines seem to have lost sight of the fact that they are in business to provide transportation, and to provide transportation that is within the reach of as many people as possible.

Personally, I believe traveling by air is the only way to travel, however, how can I afford to take my family on a two week vacation to the East or Midwest? Even at present coach fares, the air fare would be equal to a month and one-half net wages.

If air transportation was available at a reasonable fare I would gladly use it, and my ego wouldn't be injured at all.

D. J. Spitzmesser
Paso Robles, Calif.



The Bell X-22A tri-service V/STOL research aircraft in forward flight

It takes off straight up . . . speeds along to its destination and lands vertically. Bell originated this revolutionary V/STOL, is now building it for the U.S. Navy. Designated the X-22A, this compact, high-performance research transport will have speeds up to 350 m.p.h. . . . will be capable of carrying six passengers or a 3800-pound load with full fuel. The jet-powered, ducted fan, rotatable propeller units make this craft completely independent of runways . . . a capability that will open the door to many new military and commercial applications.

It is not surprising that this unique concept originated at Bell, because Bell created and built the X-14 for the U.S. Air Force . . . the first jet-powered horizontal-attitude VTOL craft to take off vertically, transition to normal horizontal flight and then hover and land vertically. A modified version, the X-14A, serves NASA's Ames Research Center today as a lunar landing training vehicle . . . has interesting possibilities as a ground support aircraft . . . is the only two-place jet VTOL presently being flown anywhere in the world.



Take-off or landing attitude

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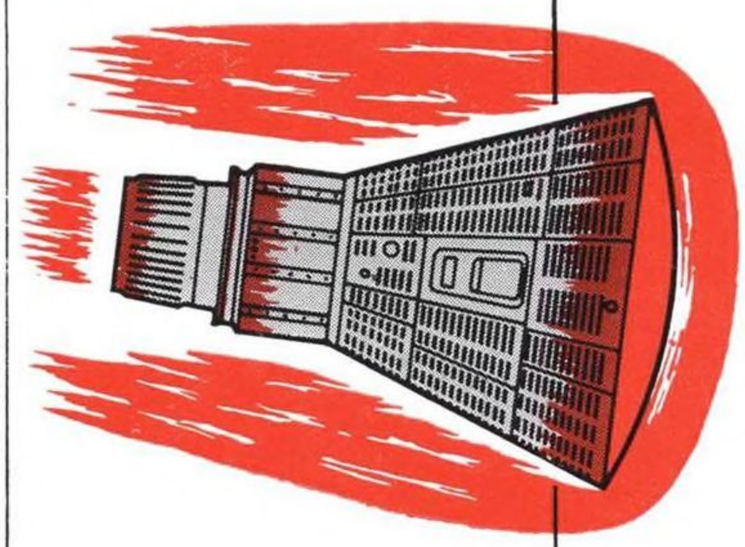
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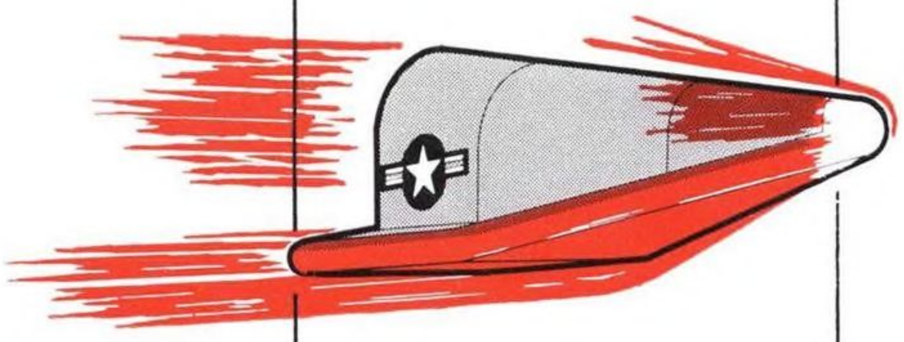
pacecraft programs, each engineered to explore
iverse techniques for earth orbital reentry, are underway at McDonnell.

MERCURY



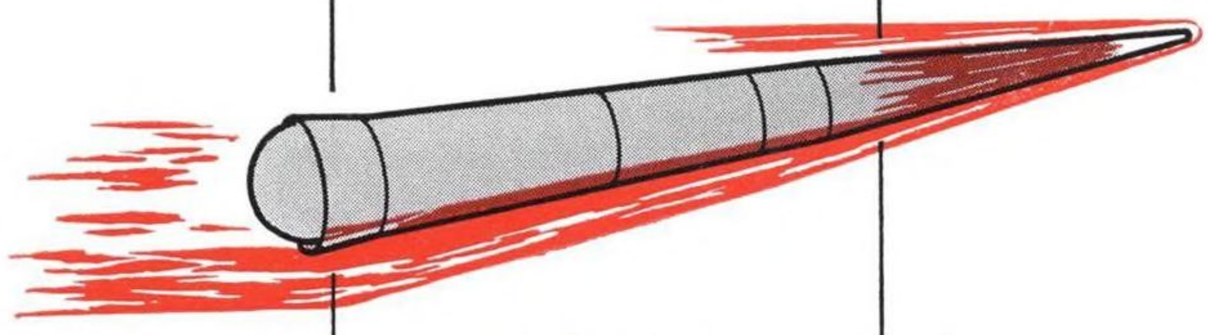
MERCURY, America's first manned orbital spacecraft, utilizes a non-maneuverable ballistic reentry. After retro-rockets slow the spacecraft to bring it out of orbit, reaction jets position it for reentry. Mercury's ballistic shape maintains alignment with the drag vector as it follows a ballistic path through the atmosphere to drogue chute deployment at 21,000 feet. Final descent to an ocean landing is accomplished with a 63-foot ring-sail parachute.

ASSET



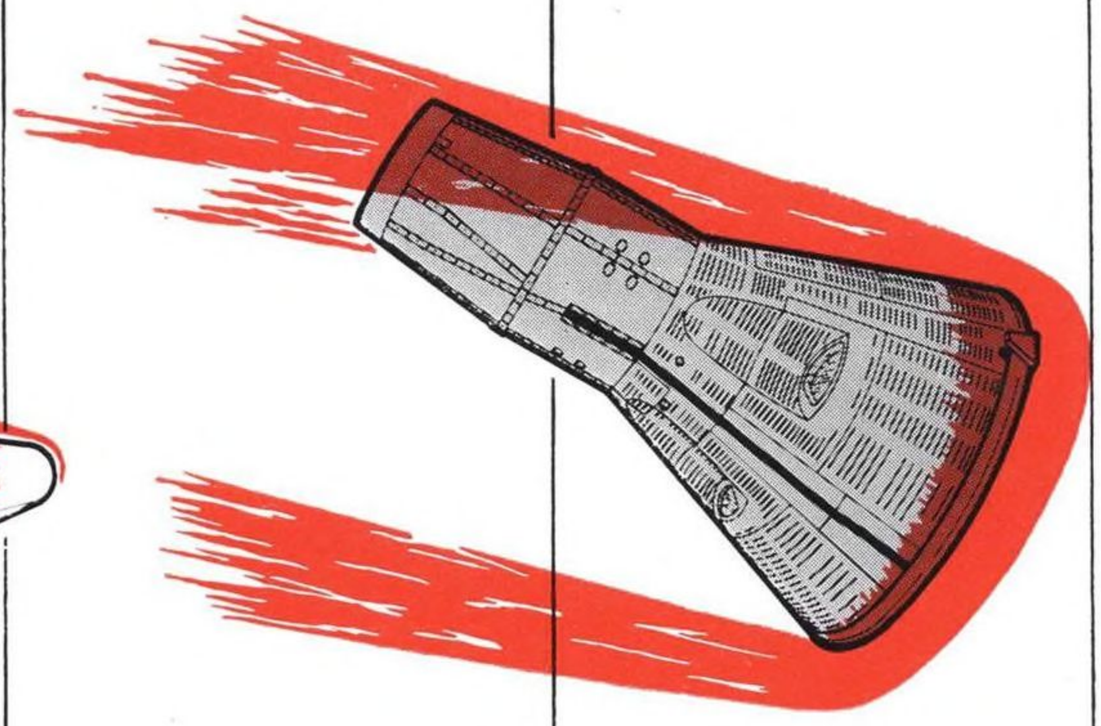
ASSET, an instrumented, unmanned, winged vehicle, will reach speeds of 13,000 miles per hour in sub-orbital flights at altitudes of over 40 miles. This space research program will provide for study of glide reentry technology, refractory materials fabrication experience, and accelerate the development of maneuverable reentry techniques. A parachute landing system enables recovery of vehicle and data package for post flight analysis of test data.

AEROBALLISTIC



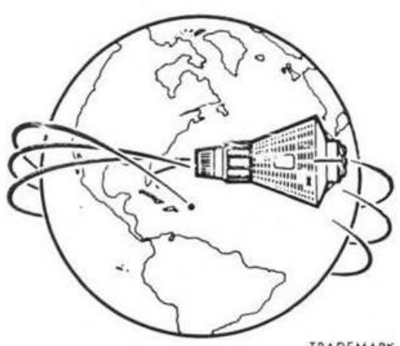
AEROBALLISTIC is a word coined to describe the lifting body concepts proven by flights of McDonnell hypersonic missiles from Cape Canaveral in early 1959. The test flights demonstrated precise atmospheric control, the aerodynamic efficiency of an Aeroballistic vehicle and were the first breakthroughs in the design of maneuverable reentry spacecraft. Space missions utilizing an Aeroballistic type vehicle would terminate with a conventional runway landing.

GEMINI



GEMINI is a two-man orbital spacecraft for long duration and rendezvous missions. Upon reentry, the crew will position Gemini's off-set center of gravity with attitude control jets to re-orient the drag vector and create a lift component. This lift will enable the crew to maneuver Gemini to any point in a 28,000 square mile landing area. A paraglider will be deployed in later flights, enabling precise astronaut control of the glide to the landing field.

With MERCURY, ASSET, AEROBALLISTIC and GEMINI Spacecraft,
McDonnell is perfecting reentry techniques, shapes, materials and manufacturing processes necessary for the achievement of U. S. leadership in space.



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